NEUROPHYSIOLOGY OF SILENCE: NEUROSCIENTIFIC, PSYCHOLOGICAL, EDUCATIONAL AND CONTEMPLATIVE PERSPECTIVES

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NEUROPHYSIOLOGY OF SILENCE: NEUROSCIENTIFIC, PSYCHOLOGICAL, EDUCATIONAL AND CONTEMPLATIVE PERSPECTIVES

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EDITORIAL
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Editorial: Neurophysiology of Silence: Neuroscientific, Psychological, Educational and Contemplative Perspectives

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Neurophysiology of Silence: Neuroscientific, Psychological, Educational and Contemplative Perspectives

The importance of silence has been emphasized in both ancient and modern traditions (Teschner, 1981; Davies and Turner, 2002; Stratton, 2015). In Eastern traditions, silence has been linked to the inner stillness of the mind, a sense of equanimity and unity (Feuerstein, 1996; Lin et al., 2008). At the same time, Western scholars such as Kierkegaard (1993) went as far as to prescribe creating silence as a remedy to the world's condition, and Wittgenstein (2002), who regarded silence as the answer to philosophy's most difficult questions, has stated that "What we cannot speak about we must pass over in silence."

Scientifically, meditative practices have been widely investigated in the neuroscientific, psychological and contemplative fields. However, silence, which is very often a characteristic aspect of those meditative practices, has enjoyed very little focal attention in the same disciplines. The scientific study of silence-induced effects, as well as typological conceptualizations, have only sporadically appeared (Belanoff, 2001; Dénommé-Welch and Rowsell, 2017; Valle, 2019). Consequently, the purpose of the current Research Topic was to advance our understating of the subjective experience of silence, its relation to different contemplative traditions and to current theories of consciousness, its related neural mechanisms, and its possible relation to psychological outcomes, as well as educational and social perspectives.

The project was born with the realization of the first International Conference on the Neurophysiology of Silence (ICONS) held in Assisi, Italy in the summer of 2019. The Research Topic is the culmination of the effort to accumulate and present multiple approaches on silence and initiate new dialogues, and it includes both empirical and theoretical accounts, as well as reviews, for exploring silence.

Theoretical contributions include three papers which consider silence in relation to the study of consciousness without content or with minimal content: one is Srinivasan's contribution, which

is an investigation on traditional statements about a state of consciousness without content in Indian tradition and its actual possibility in light of a current neurophysiological model of minimal phenomenal experience (MPE). Another paper by Paoletti and Ben-Soussan introduces the concept of silence as a tool for sensory saturation that can be hypothetically utilized to produce states of consciousness without content, discussing this hypothesis in the framework of the Sphere Model of Consciousness. In another paper, Josipovic and Miskovic addresses the differences between MPE and non-dual awareness.

Empirical contributions included four studies, utilizing diverse disciplinary and methodological approaches. Glicksohn and Ben-Soussan focus on absorption, visionary experiences and their electrophysiological correlates, pointing out that silence has a role as a creative stimulus for producing a spiritual experience. Woods et al. use evidence synthesis based on expert texts from three meditative traditions, namely Shamatha, Trascendental, and Still Meditation, with the key finding that silence has a particular connection with stillness, and the absence of concepts, mental noise, thoughts, and disturbance. Pintimalli et al. study the effects of a new meditative technique, and explore the relationship between first-person reports related to silence, space, and self-consciousness. Finally, Ben-Soussan et al. utilized neurophenomenology to explore the connection between first-person reports of silence and neuroanatomical changes.

In terms of reviews, Pfeifer and Wittmann analyse the literature and present an exploration of the perception of silence, by exposing individuals to several minutes of silence in different contexts, finding that silence increases relaxation, improves mood states, and alters the perception of time and the orientation toward the present moment. Venditti et al. review a growing body of literature exploring epigenetic changes related with different meditative practices, such as mindfulness meditation, Vipassana, Yoga, Tai Chi, and Quadrato Motor Training. Finally, Naor and Mayseless focus on the experience of solitude in the wilderness, by exploring how the wilderness solo is experienced and understood, specifically as contributing to therapeutic outcome and personal growth. They review the empirical and theoretical literature, pointing to the significance of solitude and silence, to enhance a sense of personal belonging and purpose.

In conclusion, research on silence offers many challenges, including for example, a common definition of silence (e.g., as absence of content), capturing this phenomenon in neuroscientific setups, or measuring it by scales. However, considering silence's possible benefits for the individual and societal level, overcoming such obstacles to research is highly warranted. We further propose that future studies should be conducted in the interface between psychology and education, particularly important in the current pandemic times, to explore how loneliness can be positively re-interpreted as silence and solitude and thus affect well-being differently. We wish to thank Frontiers for their support, the guest editors, authors, and reviewers for their precious time and contribution. We hope that this Research Topic will serve as another step toward integrating the literature on, as well as enrich our understanding of the beauty and utility of silence.

AUTHOR CONTRIBUTIONS

All authors listed have made a substantial, direct and intellectual contribution to the work, and approved it for publication.

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REVIEW
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Waiting, Thinking, and Feeling: Variations in the Perception of Time During Silence

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Research on the perception of silence has led to insights regarding its positive effects on individuals. We conducted a series of studies during which individuals were exposed to several minutes of silence in different contexts. Participants were introduced to different social and environmental settings, either in a seminar room at a university or in a city garden, alone or in a group. Instructions across studies varied, as participants were exposed to real waiting situations, were asked to just think and to explicitly experience the time interval without further instructions or following a session of Depth Relaxation Music Therapy (DRMT)/Hypnomusictherapy (HMT). Silence was judged to significantly increase relaxation, improve mood states, and alter the perception of time and the orientation toward the present moment. We controlled for influences of trait variables, such as impulsivity, mindfulness, daydreaming, and time perspective. Findings empirically demonstrate that exposure to silence can be effective in therapeutic and educational contexts to promote relaxation and well-being.

Keywords: relaxation, silence, time perception, waiting, music therapy, logotherapy, psychotherapy

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INTRODUCTION

"I believe silence is the new luxury. Silence is more exclusive and long lasting than other luxuries" (Kagge, 2018). Erling Kagge, author of the recently-published book "Silence: In the Age of Noise," writes about silence and noise in the context of the current *zeitgeist*. Especially urban living seems to suffer from a loss of the luxury good silence due to an increasing amount of everyday noise. Governments and communities identify this development as a specific challenge for populations, the environment, and nature. They call for innovative approaches and provide research funds to meet this challenge (e.g., the German Federal Ministry of Education and Research, 2016). Noise, among other factors, could be responsible for the confirmed higher risk of individuals living in urban areas to develop mental disorders, like schizophrenia, depression, and anxiety, as compared to residents in rural areas (Lederbogen et al., 2011; Lederbogen and Meyer-Lindenberg, 2016). The interdependence between health and noise is evident in healthcare institutions. Studies show that noise in hospitals negatively affects the patient's recovery (Mazer, 2010), the development of preterm infants in neonatal intensive-care units (NICU) (Gilad and Arnon, 2010), and patient care and causes stress reactions among patients in emergency departments (ED) (Short et al., 2010). In contrast, silence was found to lower the diastolic blood pressure, heart rate, and breathing rate

and to decrease cortisol levels (Bernardi et al., 2006; Trappe and Voit, 2016). Listening to slow or meditative music led to even greater relaxation if combined with randomly-inserted pauses (Bernardi et al., 2006).

Silence may not be a prominent topic in current health-related research, but there is evidence of growing interest. For example, the exploration of silence was listed as one of the newly developing main research topics in present-day music therapy (Oberegelsbacher and Timmermann, 2012). Sitting in silence is an important aspect of mindfulness and meditation practices (Black et al., 2009), and silent meditation leads to alterations in the senses of time, space, and self (Berkovich-Ohana et al., 2013; Thönes and Wittmann, 2016). In a series of studies, Wilson et al. (2014) found out that students did not enjoy "just thinking" in silence alone in a room and that "[. . .] being alone with their own thoughts for 15 min was apparently so aversive that it drove many participants to self-administer an electric shock that they had earlier said they would pay to avoid." Buttrick et al. (2018) repeated the study by Wilson et al. and similarly concluded that participants preferred to occupy themselves with activities, such as watching TV or reading a book, rather than "just thinking" or turning one's attention inward during silence while sitting alone in a room. Fox et al. (2014) published a critical review of Wilson et al.'s findings and stated that spending time with our own unstructured thoughts (mind-wandering, daydreaming) may not be as enjoyable or entertaining as structured activities, but may "increase our overall sense of well-being and life satisfaction." According to this reanalysis of Wilson et al.'s data, there is not actually much support for the notion that participants found the period of "just thinking" to be unpleasant. On average, Fox et al. showed that the response curve is normally distributed with average empirical values close to the means of the scales. It is only relative to a situation of being active with a task or entertainment that "just thinking" is less pleasurable.

Recent studies indicate that "thinking for pleasure" does not come easily; it may even be cognitively demanding, although simple cognitive aids and the right conditions can make it easier and even enjoyable (Westgate et al., 2017; Wilson et al., 2019). Motivation – in terms of motivating subjects to try to enjoy their own thoughts – was also judged to be an important catalyst in making an activity, such as "just thinking" or "thinking for pleasure," enjoyable (Alahmadi et al., 2017). In contrast to Wilson et al.'s above-mentioned findings, Nguyen et al. (2017) stated that 15 min of solitude, sitting on a comfortable chair in silence and alone in a room, effectively reduces arousal and fosters self-regulation. Solitude helped subjects calm down, become quiet, and to regulate their affective states. Silence and related concepts (e.g., mind-wandering, daydreaming, just thinking, thinking for pleasure, meditation, mindfulness, empty time) are being discussed in an increasing number of studies. We conducted a series of studies that focused on silence in various settings (e.g., in a city garden, in a university lecture room) and situations (e.g., as part of a relaxation session, in a waiting situation). Herein we discuss our main outcomes in reference to health, well-being, and therapeutic and educational settings and theories. We structured our review by creating content-related clusters framing the presentation of the individual studies.

(1) Waiting-room study (Jokic et al., 2018).
(2) "Just think" study (Pfeifer et al., 2019c).
(3) Depth relaxation studies (Pfeifer et al., 2016, 2019a).
(4) "Pure" silence study (Pfeifer et al., 2019b).

REVIEW

Waiting-Room Study (Study 1)

The study by Jokic et al. (2018) assessed the participating students' experience of an empty time interval of 7:30 min duration as part of a real waiting situation. Relations between the students' experience of time while waiting and facets of affective well-being, individual impulsivity traits, and time perspectives were of specific interest to us. An earlier study we had conducted was the first attempt to capture a form of waiting time in which we had participants retrospectively judge the duration of a 5 min, resting-state period (reference) by measuring the psychophysiological indices of heart rate and breathing rate (Wittmann et al., 2017). More impulsive individuals relatively overestimated this resting state period.

We then conducted a real waiting study where subjects were given a fictitious explanation of why they had to wait alone in a room. 82 students (51 women, 31 men; mean age: 22.5 years; *SD* = 3.7; range: 18–36) took part. The study was conducted in Thessaloniki, Greece; the majority of the participants were students from local universities. Half of the participants were asked to complete trait-related questionnaires before they went into the waiting room. Afterward, they reported their experience by answering state-related questionnaires. The other half of the students began with the waiting-room situation, then answered the state-related questionnaires, and finally completed the trait-related questionnaires.

Each student spent exactly 7:30 min of silent waiting time (the duration was unknown to the subjects) alone in a very basic, closed room with a desk and a chair. We also asked students to hand over all their belongings, such as mobile devices and bags which might have contained reading materials, before entering the room. In the room, the subjects were told to simply wait for the researcher to come back, as she had to set up the computer in another room. This was the fictitious explanation for the real waiting time.

The Zimbardo Time Perspective Inventory (ZTPI) (Zimbardo and Boyd, 1999) and the Barratt Impulsiveness Scale (BIS-11) (Barratt et al., 1999) were used as trait scales. We had already used the state scales on the subjective time, self, and space (STSS) to assess states of consciousness during silence after depth relaxation (Pfeifer et al., 2016). A non-verbal, pictorial-assessment technique, the Self-Assessment-Manikin (SAM) (Bradley and Lang, 1994), was included to determine the emotions the participants experienced most of the time while waiting alone in the room. A visual analog scale (VAS) concerning felt relaxation was also administered.

Correlational analyses showed that students with more positive emotions (SAM), lower arousal scores, and greater experienced relaxation (VAS) estimated the duration of the

waiting period as relatively shorter. The waiting period was overestimated, and the passage of time was felt to pass slower when individuals felt more irritated and aroused. Correlations with trait variables showed that the higher the scores for self-rated impulsivity and fatalistic and hedonistic present orientation, the less relaxed students were and the greater their overestimation of the duration of the waiting time. Subsequent path analyses revealed an integrative view of the interconnections among these variables. The level of relaxation has an indirect (mediating) effect on subjective time: more impulsive people feel less relaxed, overestimate duration, and experience a slower passage of time.

Interrelations between emotional states and time judgments (Wittmann, 2009; Lambrechts et al., 2011; Schäfer et al., 2013; Wackermann et al., 2014; Droit-Volet et al., 2015), as well as between impulsivity traits, present and future orientation, and time perception (Baumann and Odum, 2012; Mueller et al., 2014; Wittmann et al., 2017), have been reported in previous studies. Higher arousal states and an impulsive present orientation lead to relative overestimations of duration. Our study may be the first that systematically assessed subjective time in a real waiting situation in association with affective reactions and individual differences.

"Just Think" (Study 2)

"Just thinking," or engaging oneself with one's own thoughts alone in a room, was the core element of silence in this study (Pfeifer et al., 2019c). Wilson et al. (2014) had claimed that students did not enjoy a period of silence lasting between 6 and 15 min spent alone in a room with nothing to do but occupy themselves with their own thoughts. Some individual participants even felt this situation to be so unpleasant that they preferred to self-administer an electric shock rather than spend their time "just thinking" while being alone with their own thoughts (see the critical assessment of these claims in the introduction).

We conducted a variation of this investigation relying on the principle study design applied by Wilson et al. (2014), who did not assess time in their study, although it is an essential experience related to waiting. The employed state inventories referred to the conscious dimensions of subjective time, space, and self (STSS), which have proven suitable for assessing longer time intervals, such as a real waiting-time situation (Jokic et al., 2018), a silence after Depth Relaxation Music Therapy (DRMT)/Hypnomusictherapy (HMT) (Pfeifer et al., 2016), and watching a dance performance (Deinzer et al., 2017). Two visual analog scales were used to assess relaxation and boredom, and the Self-Assessment-Manikin (SAM) (Bradley and Lang, 1994) scale was implemented to assess emotional reactions. The Zimbardo Time Perspective Inventory (ZTPI) (Zimbardo and Boyd, 1999) and the Barratt Impulsiveness Scale (BIS-11) (Barratt et al., 1999) were used as trait questionnaires. Sixty four undergraduate and graduate students (51 women, 13 men; mean age: 26.7 years; *SD* = 6.9; range: 19–52) studying "Inclusive Education," "Education," "Social Work/Social Education" or other programs at the Catholic University of Applied Sciences in Freiburg took part in our investigation.

The sessions were held in a seminar room at the Catholic University of Applied Sciences Freiburg. It was a functional room with plain white walls (no posters, shelves, photographs, etc.). The participants were asked to seat themselves with their backs to the window facing the door. After a short introduction (providing relevant information, informed consent, students handing over their belongings, such as cell phones, tablets, etc.), the students filled out the questionnaires and were then asked to spend a period of silent time on their own. The exact instruction was: "Please spend the following time occupying yourself with your own thoughts and please stay seated and awake." The period of silence lasted 6:30 min, but the time span was unknown to the participants. The researcher returned after the interval had elapsed and asked each participant to fill out the set of state questionnaires.

Participants felt significantly more relaxed (VAS), in a better mood (SAM), and less aroused (SAM) after vs. before the 6:30 min of silence alone in a room. Boredom was hardly felt (an average of 10.4 on the 100 mm VAS), participants were on average quite focused on the present moment (53.1%; 19.6% on the past, 27.3% on the future), and time seemed to pass comparably fast for them (an average of 77 on the 100 mm VAS). Time was not felt very intensely (an average of 32.1 on the 100 mm VAS), whereas the self was felt quite intensely (an average of 5.0 on a scale between 0 and 6). The instruction to wait and occupy oneself with one's own thoughts apparently led to more self-awareness, but in an emotionally positive way.

We emphasize that we did not tell the students beforehand how long the silent period would last. Such situations of uncertainty are typically experienced as irritating (Zakay, 2015). In the study by Wilson et al. (2014), the participants were given specific or approximate information about the waiting period of 10–15 min. Although Wilson et al. claimed that their study participants felt quite irritated while waiting, they actually felt less pleasant only relative to situations in which they were actively engaged. The re-analysis of the Wilson et al. (2014) study by Fox et al. (2014) showed little support for the notion that participants found the period of "just thinking" to be aversive. Subjects rated the experience of engaging themselves with their own thoughts with mean values around 50 mm on the VAS. These results and our own indicate that people on average do not feel uncomfortable when just thinking.

Depth Relaxation (Studies 3 and 4)

This section provides details on two studies (Pfeifer et al., 2016, 2019a) in which a period of silence followed a DRMT/HMT session or a control condition. The main difference between these two studies lies in the setting where they took place: study three (Pfeifer et al., 2016) was performed indoors and study four (Pfeifer et al., 2019a) outdoors in a city garden.

DRMT/HMT as the experimental intervention in our two studies was developed by Hans-Helmut Decker-Voigt (2007, 2009) and has been influenced by various techniques and approaches, such as expressive art therapy, Gestalt theory, Milton Erikson's hypnotherapy, autogenic training, psychoanalytic and humanistic psychology, and guided imagery. DRMT/HMT is a therapeutic method to facilitate relaxation. It can be applied in various therapeutic contexts, supports the general aims of music therapy as framed by various

professional associations (World Federation of Music Therapy (WFMT), 2017; American Music Therapy Association, 2019; German Association of Music Therapy (DMtG), 2019), and proceeds along seven steps or "building blocks." The building blocks are, for example: "sensitization to the feeling of 'comfort' in the body," "sensitization to feelings, mental images, thoughts," and "sensitization to the auditory perception of music." A time limit from 3 to 8 min is suggested for the receptive music phase in DRMT/HMT. Longer periods could create difficulties in the participants' reorientation. Instead of "normal" music, we used silence during the DRMT/HMT receptive music phase.

Depth Relaxation Indoors (Study 3)

Sixty students (45 women, 15 men; mean age: 22.9 years; *SD* = 2.6; range: 19–31) completed the study (Pfeifer et al., 2016). All were enrolled in undergraduate and graduate programs ("Inclusive Education," "Social Work/Social Education," etc.) at the Catholic University of Applied Sciences. The students were divided into five groups, three of which first received a 16 min session of DRMT/HMT followed by 6:30 min of silence (the intervention). One week later, these three groups had a 16 min seminar focusing on aspects of silence in therapy and counseling succeeded by 6:30 min of silence (the control condition). The other two groups also received both conditions, but in reverse order. The sessions took place in a seminar room at the Catholic University of Applied Sciences Freiburg and commenced with a brief instruction providing information on the procedure and other relevant details. Students were also asked to switch off any mobile devices and to take off their wrist watches.

The DRMT/HMT sessions were led by a professional music therapist (the first author of this article, E.P.) who accompanied the participants through the DRMT/HMT steps ("building blocks" I–V) by using speech to induce depth relaxation. All subjects were asked to remain in a seated position during the procedure while the therapist provided positive connotations ("All the thoughts circulating in your mind are allowed to do so. . .") and suggested the participants make themselves comfortable by changing the positions of their feet, backs, heads, etc. After 16 min of DRMT/HMT, the therapist invited the students to focus their attention on the acoustic surrounding. The following 6:30 min period of silence was of unknown duration to the students. A subsequent short phase of re-orientation to the "here and now" (building block V) ended the session and initiated the final step, during which the participants filled out the questionnaires.

The students in the control condition were invited to participate in a group discussion and to share their experiences, ideas, and opinions concerning silence, its forms of occurrence and applications in health-related, therapeutic, and counseling settings. Case examples, the beneficial potentials of silence, risks, indications, and contraindications were discussed. The discussion was moderated by the same music therapist (E.P.), lasted 16 min, and was followed by a 6:30 min period of silence of unknown duration to the students. Afterward, the participants were asked to fill out the questionnaires while remaining seated.

The state scales we employed were the subjective time, self, space (STSS) and an additional VAS measuring relaxation. The trait scales we used were the BIS-11 (Barratt et al., 1999) on impulsiveness and the Freiburg Mindfulness Inventory (FMI) for the assessment of mindfulness (Walach et al., 2006).

Participants considered the 6:30 min of silence preceded by 16 min of DRMT/HMT significantly more relaxing than a silent period of the same duration following the seminar discussion. Students felt that the silence after DRMT/HMT vs. the seminar condition had lasted significantly longer, and their sense of space and time and future perspective was relatively reduced. The individuals' levels of impulsiveness and mindfulness as trait variables did not affect these outcomes. The fact that silence after DRMT/HMT lasted subjectively longer than in the control condition is worth discussing. Typically, an overestimation of duration is associated with negative affect and increased arousal (Droit-Volet and Meck, 2007; Pollatos et al., 2014). Corresponding with other recent studies on the effects of mindfulness meditation which lead to an overestimation of the experienced duration in the range of milliseconds and seconds (Droit-Volet et al., 2015; Singh and Srinivasan, 2019), we showed that a similar overestimation in the range of minutes can be related to a more relaxed state of being in the present moment.

We conclude that silence after DRMT/HMT effectively promotes relaxation and well-being. The stronger present orientation after DRMT/HMT-induced silence indicates less rumination and circular reasoning, which are typical signs of irritation and anxiety about the past and future events. Previous studies have already highlighted the ability of music and music therapy to reduce anxiety (Walworth, 2003; Gimeno, 2010; Nguyen et al., 2010; Stegemann, 2013). Silence embedded in relaxation methods like DRMT/HMT could promote relaxation and effectively mitigate stress-related illnesses. In a group setting, this intervention can be cost effective in various health-related contexts, such as prevention programs.

Depth Relaxation Outdoors (Study 4)

Study 4 (Pfeifer et al., 2019a) had an almost identical design as study 3; it only differed in the environmental surrounding where the sessions were held and in the selection of some measuring instruments. The sessions in study 3 took place indoors (in a seminar room at the Catholic University of Applied Sciences). In study 4, 16 min of DRMT/HMT followed by 6:30 min of silence (the intervention) vs. 16 min seminar/group discussion on silence in therapy and counseling followed by 6:30 min of silence (the control condition) were performed in a city garden. All sessions were led by the same qualified music therapist (E.P.).

Eighty four participants (74 women, 10 men; mean age: 24.2 years; *SD* = 6.0; range: 20–58) completed the study. Most of the subjects were enrolled in health-related and/or social undergraduate or graduate programs ("Social Work/Social Education," "Education," "Inclusive Education," "Nursing," etc.) at the Catholic University of Applied Sciences in Freiburg. Some participants were visiting students studying music,

music education, or psychology at other universities located in Freiburg. The students were divided into seven groups, four of which began with the control session (16 min of seminar/group discussion on silence in therapy and counseling followed by 6:30 min of silence) and received the experimental condition (16 min DRMT/HMT followed by 6:30 min of silence) 1 week later. The other three groups started with the experimental condition and had the control session 1 week later. The students were asked to switch off any mobile devices and to take off their wrist watches. They were asked to remain seated on the ground and awake during the whole process. The students did not know how long the period of silence would last.

The measuring instruments included the Daydreaming Frequency Scale (DDFS; Gutiérrez et al., 2019), the Multidimensional State Boredom Scale (MSBS; Fahlman et al., 2013), the scales on subjective time, self, space (STSS) (Pfeifer et al., 2016), and an additional VAS measuring relaxation.

Relaxation was significantly increased after silence in both conditions. On average, the level of relaxation was significantly higher after DRMT/HMT and silence as compared to before the intervention, as was the average increase in relaxation after the seminar and silence as compared to before. Being in the city garden led to increased relaxation, regardless of the intervention (DRMT/HMT vs. seminar discussion). The period of 6:30 min of silence after the DRMT/HMT condition was judged to pass significantly more slowly than after the seminar session. The students who were more relaxed during the experimental condition (DRMT/HMT) felt themselves more intensely, felt that time had passed more quickly, and experienced space to a lesser extent. On average, subjects after the DRMT/HMT condition felt that time had passed more slowly, but those individuals who were more relaxed as a result of the specific body-focused relaxation method felt that time had passed more quickly. Following DRMT/HMT, one subscale referring to the MSBS significantly correlated with relaxation: those participants who had had significantly higher scores on the boredom-arousal scale were less relaxed afterward. In the seminar condition, all MSBS subscales correlated with relaxation, indicating that the more bored individuals were before the seminar, the less relaxed they were after the period of 6:30 min of silence.

Previous studies (e.g., Ulrich, 1979, 1984; Berry et al., 2015; Bratman et al., 2015) and our results indicate that a natural setting alone is beneficial. In our study, combined DRMT/HMT and silence and a period of silence preceded by a group discussion on silence, both held in a city garden, significantly increased relaxation and affected the students' perception of the duration of silence and the speed of time passage. Our findings coincide with the results from other studies (Kramer et al., 2013; Droit-Volet et al., 2015) and indicate an increased (more mindful) interoceptive awareness after meditation (Wittmann, 2015, 2018). Mindfulness is related to a positively experienced, slower passage of time. Participants in the DRMT/HMT setting who were more relaxed after the silence experienced a faster passage of time, suggesting that some individuals experienced states of "flow." Time passes faster if one is fully immersed in activities (sports, work, performing music, playing) accompanied by positive feelings (Csikszentmihalyi and Csikszentmihalyi, 1988).

"Pure" Silence (Study 5)

Study 5 (Pfeifer et al., 2019b) also involved students as participants and a 6:30 min period of silence of unknown duration to subjects. We did not combine the period of silence with a preceding element, such as DRMT/HMT or a seminar/group discussion. We incorporated 6:30 min of silence alone conducted either indoors (in a university seminar room similar to study 3) or outdoors in a natural setting (in the same place in the city garden as in study 5). Both conditions were guided by the same professional music therapist (E.P.).

Forty-six participants completed this study (42 women, 4 men; mean age: 23.5 years; *SD* = 4.9; range: 20–52). Subjects were regular students at the Catholic University of Applied Sciences Freiburg registered in the undergraduate BA program "Inclusive Education." The participating students were divided into two groups and experienced the two conditions in reverse order with 1 week between each session, which began with a brief introduction focusing on general information (e.g., study aims, informed consent). Students then filled out questionnaires before and after the period of silence. They were also asked to take off wrist watches, to switch off and put away mobile devices, and to sit comfortably and stay seated and awake during the silent phase.

State scales on subjective time, self, and space (STSS) (Pfeifer et al., 2016), a VAS measuring relaxation, and a VAS measuring boredom related to the period of silence were used. We also included the Zimbardo Time Perspective Inventory (ZTPI) (Zimbardo and Boyd, 1999) and the Barratt Impulsiveness Scale (BIS-11) (Barratt et al., 1999).

The period of silence led to a significant increase in relaxation in both conditions (city garden and university seminar room). However, in the natural setting of the city garden, students experienced less boredom during the 6:30 min of silence than in the indoor condition. In the outdoor condition, the sense of being present was enhanced (experiencing the moment), while thoughts about the past (memories) were reduced. The more relaxed the students were after the silence indoors, the less intensely they were aware of time. There were hardly any significant correlations of the subscales of the ZTPI and the BIS-11 with any of the state variables. In fact, merely one significant correlation with one state variable was identified: the higher the negative past perspective, the lower the rating of the perceived self in the natural setting of the city garden.

Simply being surrounded by nature seems to positively affect psychological well-being by being more relaxed and feeling less boredom. Our findings coincide with empirical study outcomes emphasizing the relaxing, health-fostering, and recuperative effects of nature and natural surroundings (Ulrich, 1979; Berger and Lahad, 2013; Berry et al., 2015). Results also support the theory that nature can play an active role as a co-therapist in therapeutic processes (Pfeifer, 2017). Participants in the outdoor condition felt more in the here and now (present) and less in the past, which correlates with Jordan's (2015) claim that working outdoors with patients during therapy increases their present

awareness and "now moments." Previous investigations showed negative correlations between dispositional mindfulness – an increased ability to be present-oriented – and the propensity of mind-wandering (Mrazek et al., 2012; Weiner et al., 2016). Mindfulness meditation decreases mind-wandering measured as less distraction from task-related performance (Mrazek et al., 2012; Mooneyham and Schooler, 2013). Our study results indicate that simply being exposed to silence in a more natural setting has an effect similar to those experienced in mindfulness interventions. Exposure to nature reduces rumination and associated prefrontal-cortex activation (Bratman et al., 2015). Whereas preceding studies indicated that meditative music is more relaxing if intermingled with silence (Bernardi et al., 2006) or that silence has significant relaxing effects if combined with DRMT/HMT (Pfeifer et al., 2016), this study indicates that silence itself experienced in a group in a natural setting is beneficial, especially in the presence of a qualified therapist (Grawe et al., 1997).

CONCLUDING DISCUSSION OF THE MAIN RESULTS

"After all, silence is not nothing. It is better to say that from something comes something" (Kagge, 2018). We agree, as several minutes of silence affects time perception and mood, leads to more relaxation, and changes the perception of self and space. The following sections (see also **Table 1**) subsume relevant findings of our studies and discuss health-related therapeutic and educational contexts. Our use of the term silence includes the various "silent situations" in our studies (a period of "just thinking," a real waiting situation, "pure" silence in a natural setting, a period of silence following DRMT/HMT or following a group discussion as part of a seminar). We relied on relative rather than absolute or total silences in all of our studies.

Time Perception and Time Orientation

In the waiting-room study (study 1), those students who were more relaxed and judged the passage of time to have elapsed more rapidly also estimated the duration for the waiting period to be comparably shorter than individuals who were more irritated because of having to wait for an uncertain period of time. When subjects were instructed to "just think," time on average was judged to pass comparably quickly, although the subjects were alone in the room (study 2). During silence in a natural setting after the DRMT/HMT intervention, participants experienced time to have passed significantly slower than during a period of silence preceded by a seminar group discussion in the same natural surrounding (study 4). This is the specific effect of the music-therapy, depth-relaxation intervention similar to a mindfulness intervention. Participants significantly overestimated the duration of the period of silence after DRMT/HMT both indoors and outdoors (studies 3 and 4).

Mind-body interventions, such as meditation, yoga, and other relaxation techniques, like resting in a floatation tank, have been introduced into the clinical and health sciences (Esch

TABLE 1 | An overview of the main results of our studies regarding the students' experience of a period of silence in varying conditions.

	Study 1 (Waiting room)	Study 2 ("Just think")	Study 3 (DRMT indoors)	Study 4 (DRMT outdoors)	Study 5 ("pure" silence)
Passage of time	Judged to be fast when relaxed and in a positive mood	Judged to pass quickly		Judged to be slower in DRMT than in the seminar condition (71% of subjects)	
Duration of time	Underestimated when relaxed and in a positive mood		Overestimated in DRMT vs. the seminar condition (76% of subjects)	Overestimated in DRMT vs. the seminar condition (71% of subjects)	
Intensity of time			Felt less intensely in DRMT vs. the seminar condition (58% of subjects)		
Time orientation		Increased present orientation	Reduced future perspective in the DRMT condition (51% of subjects)		Increased present orientation and reduced past perspective outside (76% of subjects)
Relaxation		Increased	Increased; greater increase in DRMT	Increased in both conditions (DRMT, seminar)	Increased; greater increase outdoors
Mood and emotion	Correlation with subjective time	Less aroused and in better mood			
Perception of space			Decreased in DRMT vs. seminar		
Perception of self		High; more self-awareness			
Impulsiveness and mindfulness	Correlation with subjective time and relaxation	Did not have an impact on results	Did not have an impact on results		Did not have an impact on results
Boredom		Hardly felt		Boredom leads to lower relaxation effects	Felt less outdoors vs. indoors

et al., 2013; Feinstein et al., 2018; Kohls et al., 2019). Combined DRMT/HMT and silence could be an effective approach to induce relaxation. Short breaks of silence could prove beneficial when taken regularly to lessen the pressure of modern life (Berger and Lahad, 2013) caused by noise (pollution), stress, time constraints, and other factors (Lederbogen et al., 2011; German Federal Ministry of Education and Research, 2016; Lederbogen and Meyer-Lindenberg, 2016; Kagge, 2018).

A period of silence also altered the participants' subjective time orientation. The present orientation (experiencing the moment) increased during silence, and the future perspective (plans and expectations) and the past perspective (memories) decreased (see studies 2, 3, 5). This finding is important from a therapeutic and educational point of view. Rumination, the negative form of being engaged with one's own thoughts about the past or the future, can enhance passivity and prevent one from being active and effective in the present (Frankl, 2006, 2008; Markert, 2018). Rumination is also associated with depression, anxiety, and obsessive-compulsive disorders (Modini and Abbott, 2016; Lawrence et al., 2018; Tibi et al., 2018; Nasiri et al., 2019). Silence in a natural setting or indoors and/or combined with DRMT/HMT may be comparable to mindfulness-based approaches' positive outcomes in reducing rumination and mind wandering (Frostadottir and Dorjee, 2019; Gutiérrez et al., 2019) and foster a present orientation. In Frankl's humanistic approach in psychotherapy (logotherapy), such a focus on the present moment is crucial to realize meaning in our lives. "Meaning also rests in the appreciation of the moment. When our awareness is focused on the past or on the future, we lose connection to *now*. [. . .] When we work in awareness of the moment, we stay connected to meaning" (Pattakos and Dundon, 2017). *Dereflection* is a method applied in logotherapy to help move one's attention away from negative (rumination) to more positive and enjoyable thoughts and situations (Frankl, 2014). Silence could be a useful "tool" to accompany methods like *dereflection* in the treatment of depression, anxiety, and obsessive-compulsive disorders.

Relaxation

Studies two to five showed a significant increase in participants' relaxation after vs. before the silent interval. Regardless of whether students experienced silence alone in a room (just thinking), as part of a group indoors or outdoors in nature, or combined with DRMT/HMT, they felt on average significantly more relaxed after silence. Silence as part of the experimental conditions in studies two ("just think"), three (DRMT indoors), four (DRMT outdoors), and five ("pure" silence in nature) led to significantly greater relaxation.

Surveys highlight the fact that stress is a common reaction among students these days (AOK Bundesverband, 2016). Participants in our studies were students who judged silence to be effective in increasing relaxation. Implementing silence as a relaxation-inducing practice into educational settings, applied indoors, in nature, or preceded by DRMT/HMT, could enhance students' and teachers' well-being. Experiencing silence from time to time could help prevent stress-related diseases and reactions like burnout. Previous investigations in educational settings using MBSR-interventions showed positive results in this context (Gouda et al., 2016). Silence is a flexible and an effective resource to enhance relaxation. Our findings add to knowledge regarding popular relaxation techniques, such as mindfulness meditation, progressive muscle relaxation, autogenic training, guided imagery, and hypnotherapy. The combination of silence and DRMT/HMT as an effective approach widens the spectrum of music-centered relaxation techniques (Frohne-Hagemann, 2007; Stegemann, 2013). Further research on the implementation of silence and DRMT/HMT in different therapeutic and educational settings is indicated.

Mood and Emotion

In the real-waiting-time study (study 1), students with more positive emotions and higher scores in relaxation felt that time had passed faster during the silent waiting situation and relatively underestimated its duration. Conversely, the period of waiting was over-estimated when subjects felt more irritated. Subjective time and mood are interrelated. When asked to wait and "just think" (study 2), students felt significantly less aroused and in a better mood after a period of silence alone in a room. These reactions are typical signs of relaxation and flow induced through various activities (Csikszentmihalyi and Csikszentmihalyi, 1988; Conti, 2001; Pfeifer et al., 2016; Wittmann, 2016). Being alone in a room for a period of silence in the range of a few minutes positively affected emotion, arousal, and relaxation in a similar way. Nguyen et al. (2017) conclude that solitude could induce affective self-regulation. Such an approach could be useful in clinical and non-clinical therapeutic and educational settings fostering well-being and health.

Perception of Space and Self

A period of silence preceded by a session of DRMT/HMT led to a significant decrease in the perception of space (study 4). This coincides with outcomes linked to comparable induction techniques, such as rhythm-induced trance, meditation, or listening to music. These lead to alterations in states of consciousness and mutually affect the senses of self, time, and space (Berkovich-Ohana et al., 2013; Schäfer et al., 2013; Wittmann, 2015).

The sense of self was comparably intense when just thinking in silence alone in a room (study 2; an average of 5 with an item range between 0 and 6). An increased sense of self is often associated with boredom and irritation combined with a slow passage of time (Deinzer et al., 2017). In our study, the "simple" task of engaging oneself with one's own thoughts in silence led to greater self-awareness in an emotionally positive way (study 2; Pfeifer et al., 2019c). From a therapeutic perspective, silence "[. . .] may be a fertile space to refocus and redirect creativity or a space of self-reflection [. . .]" (Kirkland, 2013). In her meta-analysis, Pesek (2007) concluded that music therapy is highly effective (0.83; according to Cohen's d) in supporting patients' self-concepts. Accordingly, silence could, on the one hand, be a meaningful addition to the methodical approaches in music therapy, and, on the other hand, a promising topic for future research initiatives.

Impulsiveness, Mindfulness, Boredom

Whereas the participants' self-rated impulsivity affected relaxation and time estimation during a silent period of waiting (study 1), the students' individual levels of impulsiveness and mindfulness did not have an impact on the results of studies two, three, and five. Impulsiveness and mindfulness did not interfere with the positive results (increased relaxation, better mood, less arousal, stronger present orientation) resulting from a period of silence spent in nature, being engaged with one's own thoughts or as part of a DRMT/HMT session. This negative finding may be due to the group of studied subjects who were mainly students. In this comparably homogeneous group of individuals, the variance of traits was probably limited. Considering this, silence as used in clinical and therapeutic applications will have to be investigated furthermore with different patient groups in order to see how traits such as impulsiveness might affect DRMT/HMT interventions.

Students hardly felt boredom during 6:30 min of just thinking in silence alone in a room (study 2) and experienced significantly less boredom during 6:30 min of silence in nature than during a silence of equal length in a seminar room at a university (study 5). Correlations could be found in study 4. The more bored individuals were before the outdoor group discussion/seminar condition, the less relaxed they were after the period of silence. In the DRMT/HMT condition, those participants who had significantly higher scores on the boredom-arousal scale were less relaxed afterward. Higher pre-intervention levels of boredom in participants seem to lower the relaxing effects of a period of silence. Frankl (1992; Pattakos and Dundon, 2017) correlated boredom with what he called the "existential vacuum." He claimed that boredom leads to more problems than distress and referred to phenomena such as depression, aggression, addiction, and even suicide in his discussion of problems resulting from boredom and an existential vacuum. Although further research needs to be conducted, our findings, in correlation with Frankl's assumptions, suggest that silence is effective in many ways, with boredom hardly being perceived during silence. Boredom was lower in nature as compared to the indoors situation. Nature itself seems to be effective regarding the lack of boredom. Nature experiences reduce rumination and associated prefrontal-cortex activation (as one study showed: Bratman et al., 2015). This could provide a meaningful approach to the prevention and therapeutic treatment of diseases/symptoms like depression, addiction, and aggression.

Nature, the Therapeutic Relationship, and DRMT/HMT as Influencing Factors

In studies 1 and 2, participants experienced silence alone in a room while just thinking or waiting. The situations in studies 3–5 were held outdoors, and the subjects took part in a group in the presence of a music therapist. According to Grawe et al. (1997), the therapeutic relationship is one of the five effect factors in psychotherapy. A music therapist is specifically qualified to prepare and lead individuals through acoustic experiences, including silence, providing an atmosphere of reliability (Petersen, 1996). These factors were also crucial to the performance of DRMT/HMT. Although our studies were not performed in a clinical or therapeutic context, DRMT/HMT is a music-therapeutic method that only qualified therapists should apply. Even outside a professional DRMT/HMT setting, silence in nature had a positive effect by inducing relaxation.

In study 4, one of the conditions took place outdoors in a city garden. In study 5, both conditions were performed in the city garden. The influence of nature was the focus of these studies. Pfeifer (2017) once described nature as a co-therapist in therapeutic processes. Simply being surrounded by nature in silence positively affects psychological well-being, promotes relaxation, decreases boredom, and increases the present orientation. Previous investigations led to similar results (Ulrich, 1979, 1984; Berger, 2009; Berger and Lahad, 2013; Berry et al., 2015; Bratman et al., 2015; Davydenko and Peetz, 2017). Jordan (2015) found "a growing evidence base that points toward the role of nature and its preventative and curative effects [. . .] and [a]n increasing number of therapists [. . .] taking their practices outdoors and walking with their clients while conducting therapy." A study by Lee et al. (2015) showed that green micro-breaks consisting of a 40 seconds view of a flowering meadow on a green roof boost multiple attention networks. Our findings provide further insights that encourage this outdoor-therapy tendency. Combined silence and nature may also prove useful to work settings and relevant psychological requirements.

PERSPECTIVES

Silence, as part of waiting or "just thinking" situations, combined with DRMT/HMT, alone or in a group setting, indoors or outdoors, is effective in many ways. A few minutes of silence significantly increased relaxation, improved mood states, altered the perception of time and self, and the orientation toward the present moment.

Statements by Antonovsky (1979); Becker (2000), Frankl (1992, 2014), and Maslow (1968, 1987) highlight the importance of meaning in life to health and well-being. Why not interlink silence and meaning in life in subsequent studies? Only few attempts have been made in this direction so far. Alahmadi et al. (2017), for example, mention that a silent period of thinking for pleasure can be a viable way to meet people's goal to find meaning. According to Frankl (1992), one can discover meaning by realizing creative values, experiential values, or attitudinal values. He lists arts and music as relevant to these values (Frankl, 2004). Current arts-based conceptualizations in healthcare (e.g., *music, health, and well-being*) define music through its social function. Depending on the social context, silence, like any sound, may be labeled music (MacDonald et al., 2012). Cage (1973) argued similarly: "The material of music is sound and silence." Therefore, silence could possibly enhance meaning related to all three value categories: experiencing silence as part of a relaxation or mindfulness exercise (experiential values), silence involved in a creative process

(creative values; e.g., a musical work, such as 4′33″ by John Cage), and silence as part of a therapeutic process leading to an attitude change toward unavoidable suffering (attitudinal value) (Pfeifer, 2019).

Pattakos and Dundon (2017) identified a growing lack of meaning among employees in the working world. A lack of meaning can negatively affect well-being, performance, resilience, work quality, and engagement, as regularly demonstrated in Gallup polls (Gallup, 2017). Further investigations could investigate the benefits of silence in work settings.

Our studies were of quantitative nature. Our study designs led to a variety of results and insights regarding silence in different situations, surroundings, and settings. Qualitative approaches would definitely provide further insights into the subjective perception of silence. Silence is a multifaceted phenomenon, and our studies indicate its potentials for therapy, education, and the working world.

AUTHOR'S NOTE

In memory of our dear friend and colleague Henrike Fiedler (1991–2019).

AUTHOR CONTRIBUTIONS

The empirical work reported in this review was designed, planned, and statistically evaluated by EP and MW as the principal investigators. EP drafted and revised the manuscript. MW provided substantive suggestions for revisions and critically reviewed the manuscript. Both authors reviewed and approved the final manuscript.

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Silence in Shamatha, Transcendental, and Stillness Meditation: An Evidence Synthesis Based on Expert Texts

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Shamatha, Transcendental, and Stillness Meditation are said to aim for "contentless" experiences, where mental content such as thoughts, perceptions, and mental images is absent. Silence is understood to be a central feature of those experiences. The main source of information about the experiences is texts by experts from within the three traditions. Previous research has tended not to use an explicit scientific method for selecting and reviewing expert texts on meditation. We have identified evidence synthesis as a robust and transparent method that is suitable for this purpose. In this paper we use evidence synthesis based on expert texts to examine silence/quietness as a feature of the contentless experiences in the three practices. Objective criteria were used to select a sample of 135 expert texts. A database containing the expert descriptions of the meditation techniques and experiences was produced by extracting the relevant material from the publications and coding that material to differentiate individual features. The database, which forms part of the **Supplementary Material** for this paper, identifies each feature of the contentless experiences referred to in the expert texts, including silence/quietness. Our key finding is that the experts indicate silence/quietness has a particular connection with stillness, and the absence of concepts, mental activity/noise, thoughts, and disturbance. Further analysis leads to the following insights. The silence/quietness reflects the absence of thoughts and sounds, and this fits neatly with a conception of silence/quietness as the absence of internal and external noise. In some cases the terms silence and quietness may also reflect the absence of other disturbances such as non-auditory perceptions, mental images, and negative feelings. That would fit with a conception of silence/quietness as complete calm or absence of disturbance. It is not clear from the expert texts how silence/quietness is distinct from other features such as stillness that also reflect the absence of disturbances. As a separate matter, silence/quietness has connections with all the other features of the contentless experiences, but the closeness of the connections varies. Our work uncovers fine distinctions and ambiguities which lead to new research questions that can be explored in future studies.

Keywords: traditional accounts, shamatha, transcendental meditation, stillness meditation, contentless experience, pure consciousness, phenomenology, database

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INTRODUCTION

Numerous meditation practices are understood to aim for experiences that are "contentless," in that mental content such as thoughts, sense-perceptions, body-perceptions, and mental images is absent (Stace, 1960/1961; Forman, 1990, 1998; Shear, 2006d)[1]. Contentless experiences are often treated as *pure consciousness*, or consciousness itself (Stace, 1960/1961; Forman, 1990, 1999; Shear, 1990b; Fasching, 2008), and are therefore of great interest in cognitive science and philosophy (Millière et al., 2018; Metzinger, 2020). In this paper we will concentrate on three of the practices: the shamatha meditation focused on by Alan Wallace ("Shamatha") (Wallace, 2006a), Transcendental Meditation ("TM") (Maharishi Mahesh Yogi, 1963/2001, 1967/1974), and Stillness Meditation (Meares, 1967/1968; McKinnon, 1983/2016).

Shamatha is a Tibetan Buddhist practice[2]. The Shamatha meditator cultivates attention on a meditation object, and then at a very advanced stage releases the object and enters the contentless experience (Wallace, 2006a). According to TM experts, the TM technique formed part of the Vedic tradition of ancient India (Shear, 2006c, pp. 23–24; Pearson, 2013, p. 397; Roth, 2018, p. 38; cf. Williamson, 2010, p. 86). Maharishi Mahesh Yogi is said to have revived the technique in the 1950s, distilling it from the wider set of traditional Vedic practices and understandings (Shear, 2006c, pp. 24, 47; Rosenthal, 2011/2012, p. 4; Pearson, 2013, pp. 28, 44, 397, 437). The TM meditator repeats a mantra silently in their mind, and this is said to initiate a movement toward and into the contentless experience where awareness of the mantra is lost (Faber et al., 2017). Stillness Meditation was developed by an Australian psychiatrist, Ainslie Meares, in the 1960s (Meares, 1967/1968; McKinnon, 1983/2016). The Stillness Meditation practitioner gives up the effort of *doing* anything, beyond maintaining the meditation posture, and this is said to lead to the contentless experience.

Shamatha and TM have been the subject of major research programs (e.g., Jacobs et al., 2011; Pearson, 2013, pp. 399–430, Rosenberg et al., 2015; Zanesco et al., 2019) and are therefore obvious candidates for further investigation. Stillness Meditation, in contrast, is not well known, and has received little research attention (Seymour, 1999; Hosemans, 2017). Our interest in Stillness Meditation derives from the experience of one of the authors (TW), who has practised it for over 20 years. We have included it as one of the practices that we are focusing on because it has a detailed literature on the contentless experience, and because it does not involve a meditation object, making it quite different to Shamatha and TM.

The contentless experiences aimed for in the three practices are referred to as experiences of silence or stillness. Wallace (2011b, p. 120) describes the "sheer silence, the stillness" in Shamatha. Travis et al. (2005, p. 128) quote a meditator who remarks of their TM practice, "I am completely still. It's absolute silence." Stillness Meditation is named as such because of the experience of stillness that is said to emerge. The experience is described as a "silent stillness" (Meares, 1984, p. 46) and as "only stillness . . . an all-encompassing silence" (McKinnon, 2011, p. 44).

Since thoughts and sounds are said to be absent, contentless experiences make an excellent subject for researchers interested in silence. Furthermore, since silence is central to the experiences, understanding the specific feature silence is essential for understanding each experience as a whole.

There are very few participant-based studies of the contentless experiences in Shamatha, TM or Stillness Meditation (e.g., Seymour, 1999; Travis and Pearson, 2000; Hosemans, 2017). The major source of information about the experiences is written accounts of experts from within each of the meditation traditions. We will refer to these as *expert texts*, *traditional publications*, or *traditional accounts*[3]. If researchers wish to understand meditation experiences, it is critical that they have regard to documents of this type (Lindahl et al., 2014, p. 1; Gyatso, 2016, p. ix).

The aim of this paper is to understand how silence is described in the expert texts[4]. How do meditators refer to a silence without thoughts and sounds? Does the silence purely reflect the absence of thoughts and sounds, or are there other facets that are important?

To the best of our knowledge, the paper is the first to examine the experience of silence in Shamatha, TM and Stillness Meditation based on traditional publications selected and reviewed using a scientific method. Since use of scientific method is a key contribution of our work, it will be helpful if we now explain why that approach is important in this area.

One challenge for researchers is that there is typically a large number of traditional publications for each form of meditation. For Stillness Meditation there are well over 50, and for Shamatha and TM there are likely thousands. Since it is rarely feasible for researchers to review all of the publications, they generally focus on a relatively small subset.

A limitation of the existing research is that it tends not to use an explicit scientific method for the selection or review of the traditional publications. This is understandable given that reliance on traditional accounts is still at a nascent stage, but it gives rise to the following problems.

If researchers wish to use an explicit scientific method, what should the method for selecting the traditional publications be? In other words, how can researchers select publications in a

[1]In this paper we use the term *content* to refer to experiential qualities that meditators may report when describing what an experience was like. The term *contentless* refers to the absence of certain types of content, including thoughts, perceptions, and mental images. The term does not denote the absence of *all* forms of content. For example, meditators report that during contentless experiences they were conscious and awake, and this indicates that certain forms of content may be present in the experiences.

[2]Wallace focuses principally on three types of Shamatha practice: *mindfulness of breathing*, *settling the mind in its natural state*, and *awareness of awareness*. He derives his presentation of mindfulness of breathing mainly from Tibetan and Theravadin Buddhist teachings (Wallace, 2005, p. 12). He bases his descriptions of the other two techniques primarily on teachings in the Tibetan Buddhist lineage known as Dzogchen (Wallace, 2001/2003, p. 119; Wallace, 2006a, p. 7; Van Waning, 2013/2014, p. 59).

[3]Terms like traditional publications and traditional accounts are sometimes used by other researchers to refer only to old/historical accounts. Our use of the terms extends to modern texts.

[4]In this paper we will focus on silence rather than stillness, but in examining silence we will also consider stillness to some degree.

rigorous manner that will provide a strong understanding of how the meditation technique and experience is described within the tradition? It may be best for them to focus on high quality publications, but how should they decide which publications meet that standard? If they can decide, then which high quality publications should they look at first? Is there any point at which they can stop? And, if not, what if there are too many high quality publications to review?

There are further issues once the publications have been selected. How can the researchers review them in a rigorous manner? And how should they document the overall process to give confidence to the reader? Without an explicit scientific method, the reader can be rightly concerned that the researchers may have deliberately or inadvertently cherry-picked particular publications or points within them. Those publications and points may fail to properly capture key aspects of the technique and experience as understood within the tradition.

We have identified *evidence synthesis* as a method that can provide solutions to these problems. Evidence synthesis involves a structured process for selecting and reviewing the most relevant publications from a wider body of literature. A structured process is one that is rigorous and transparent, and addresses or tests a specific research question or hypothesis (Petticrew and Roberts, 2006; Pope et al., 2007; Briner and Denyer, 2012; Gough et al., 2012/2017; Bailey et al., 2015; Aromataris and Munn, 2017).

Use of a structured approach ensures that the process can be critiqued or audited, and that the findings are precise and reliable (Centre for Reviews and Dissemination, 2009; Booth et al., 2012/2016; Briner and Denyer, 2012). Pre-established guidelines and criteria are used to select the publications for review, and to extract from them and analyze the relevant material. As a result, there is much less scope for cherry-picking (Petticrew and Roberts, 2006; Booth et al., 2012/2016; Briner and Denyer, 2012).

Identifying evidence synthesis as an appropriate scientific method is only the first step toward establishing a detailed method for a particular research question. Researchers must next select the most suitable type of evidence synthesis from the wide variety that have been developed. Each type provides a particular framework for selecting and reviewing the publications. Once researchers have selected a suitable type, they must design detailed elements within the framework that are appropriate for the specific research question.

In this paper we use evidence synthesis based on traditional accounts to examine silence/quietness as a feature of the contentless experiences in Shamatha, TM and Stillness Meditation. The type of evidence synthesis and the detailed elements of that framework are described in the next section.

The paper is part of a broader project which we will refer to as the "Contentless Experience Project" or the "current project." The project employs a distinction between the "goal-states" and the "interim-states" in the practices. The term goal-state refers to the subjective experience of a state aimed for in a practice. Since Shamatha, TM and Stillness Meditation aim for contentless experiences, in those practices the contentless experiences are the goal-states[5]. The term interim-state is used to describe an experience in a practice on the way to achieving the goal-state/s.

The Contentless Experience Project includes the present evidence synthesis and two additional evidence syntheses (Woods et al., 2020a,b). The present synthesis focuses on silence/quietness as a specific feature of the goal-states, and the other two syntheses will examine the meditation techniques, interim-states, and other features of the goal-states.

The three syntheses are based on a single database containing material extracted from the expert texts. The database includes the material on silence/quietness required for this paper, and material on the other features needed for the two additional syntheses. The material has been coded in the database to differentiate individual features.

The method described below principally concerns the production of the database. The main additional element is the explanation of how the database was used to compare the feature silence/quietness across the three practices. This paper presents the database and our findings concerning silence/quietness.

MATERIALS AND METHODS

Use of Narrative Synthesis

The type of evidence synthesis that we selected for the current project was *narrative synthesis* (Popay et al., 2006), which is a form of *qualitative evidence synthesis*. Qualitative evidence synthesis involves the review of qualitative publications and provides options for the selection of texts where a comprehensive search is not feasible. That is the case for this project: For Shamatha and TM traditional publications likely number in the thousands, and for Shamatha they include texts dating back hundreds of years that are difficult to access outside Tibet and India. Another form of evidence synthesis, *systematic review*, requires comprehensive searching (Petticrew and Roberts, 2006; Pope et al., 2007), and is therefore not appropriate for the project.

Narrative synthesis is principally a textual, as distinct from quantitative or numerical, form of synthesis. It is distinguished from a *narrative review* – meaning a traditional literature review – on the basis that it is a structured approach, as described above (Mays et al., 2005a,b; Popay et al., 2006; Pope et al., 2007; Centre for Reviews and Dissemination, 2009).

The essential factor distinguishing narrative synthesis from other forms of qualitative evidence synthesis is that it is flexible (Popay et al., 2006; Madden et al., 2018). One aspect of that flexibility is that the reviewer can choose between a series of techniques identified by Popay et al. (2006), and then select particular forms of those techniques that are most appropriate for their project. The technique selected for the current project was thematic analysis (see section "Synthesis" below).

The decision to employ narrative synthesis rather than one of the more specialized qualitative evidence synthesis methods

[5]Shallower goal-states in Stillness Meditation can involve very dull perceptions (see **Supplementary Table S3**, section "Reduced Awareness/Perception, Loss of Logical/Critical Faculties"). For simplicity, in this paper we will focus on the deeper goal-states where there are no perceptions.

was made on the basis of fitness for purpose (Noyes and Lewin, 2011b; Noyes et al., 2015). A key factor was that, while many of the more specialized methods also utilize thematic analysis, they tend to use forms of it that are not appropriate for the objectives in the current project. For example, in *meta-aggregation* (Munn and Jordan, 2011; Lockwood et al., 2017; McArthur et al., 2017), *thematic synthesis* (Thomas and Harden, 2008), *meta-ethnography* (Noblit and Hare, 1988; Mays et al., 2005a; Britten and Pope, 2011/2012), and *grounded theory synthesis* (Whittemore et al., 2014; Bryant, 2017), once initial coding has been applied to material extracted from the selected publications, the process becomes about discerning higher level themes, which normally involve greater levels of abstraction. Identifying higher level themes was not the main objective in the current project. Coding was used to identify features of the practices within the extracted material (see section "Synthesis")[6]. Those features could be broad (e.g., the general requirement to maintain a posture in a practice), or narrow (e.g., the specific requirement that the posture be symmetrical). The main objective was not to generate from the features higher level themes or groupings, but to explain how the experts refer to the features (whether broad or narrow) and to compare the features across the practices.

Basic Components and Reporting

The narrative synthesis method comprises four basic components: (a) selection of the publications for review; (b) critical appraisal – assessing the quality of the publications; (c) data extraction – extracting relevant material; and (d) synthesis – coding that material and performing any additional analyses (Popay et al., 2006). In the current project, critical appraisal is dealt with as part of the selection of publications. That leaves three components (selection, extraction, synthesis), which are described below. These have been designed specifically to meet the research objectives, having regard to existing principles and frameworks for narrative synthesis and evidence synthesis more generally.

The project is compliant with the ENTREQ reporting guidelines for qualitative evidence synthesis (Tong et al., 2012). **Supplementary Appendix A** details the section/s of the present evidence synthesis that satisfy each of the 21 items on the ENTREQ checklist.

Selection of Authors and Publications

Traditional accounts were selected using purposive sampling (Suri, 2011, 2014; Gough et al., 2012/2017; Patton, 2015). That involved the strategic identification of a sample of publications providing valuable insights into the practices. Purposive sampling was essential because comprehensive searching was not feasible (see above).

For each practice, the strategy for selecting publications involved two steps: (a) identifying a limited number of authors within the meditation tradition who have outstanding qualifications as experts in the practice and who write in clear English; and (b) identifying, by way of a structured process, samples of those authors' publications that would reveal their understandings of the practice. Those steps are described in detail below.

The procedure constituted a form of critical appraisal, in that publications were only selected if the author had outstanding qualifications as an expert in the relevant practice (Greenhalgh et al., 2005; McArthur et al., 2017). The rationale for this approach was that such authors are able to provide higher quality descriptions of the practices than authors who are less qualified. Publications by less qualified authors were excluded.

Selection of Authors

Candidate authors were identified from scoping reading of selected publications of a broad range of authors, and from general background reading. From the list of candidate authors for each practice one or more authors with outstanding qualifications as an expert in the practice was identified. Assessment of whether an author has outstanding qualifications was made on the basis of the following criteria:

- The author is recognized as an expert by other meditation experts or laypeople;
- They have been in dialogue with meditation teachers or practitioners, including those regarded as senior or advanced;
- They have academic qualifications or achievements (including publications) in relation to the meditation tradition or otherwise;
- They hold or have held positions in relevant organizations, such as meditation bodies;
- They have meditation teaching experience and expertise;
- They maintain a personal meditation practice; and
- They have other qualifications that are material to the assessment.

For an author to be assessed as having outstanding qualifications it was required that they have high ratings on a number of these criteria. Having high ratings on at least the first two was treated as essential. It was not strictly necessary for the author to have high ratings on each of the other criteria. Having exemplary ratings on some criteria could on balance be treated as sufficient even where the author had lower ratings on one or more others.

Alan Wallace stood out as having outstanding qualifications with respect to Shamatha. Five authors (Craig Pearson, Norman Rosenthal, Bob Roth, Jonathan Shear, Fred Travis) stood out with respect to TM, and two authors (Ainslie Meares, Pauline McKinnon) with respect to Stillness Meditation. In each case TW made the initial assessment, and OC and JW confirmed the decisions.

The next step was to consider whether it would be sufficient to rely on those authors, or whether others should also be included. That assessment was made having regard to rules about sample size (sometimes referred to as *stopping rules*) that are applicable in the context of an evidence synthesis involving purposive sampling. Suri (2011) explains that there are two rules that can be applied. One is *data saturation*, which in the present context

[6]In this paper the term *practice* includes both the meditation technique and experience.

would mean that the existing authors provide virtually all of the available insights and perspectives relating to the practices. The other is *data sufficiency*, which would entail that the existing authors provide insights and perspectives that are sufficient for the purposes of the evidence synthesis. Data sufficiency can take into account practical constraints, such as limitations on time and resources. Suri indicates that data saturation is rarely achieved. Data sufficiency appears to better reflect what is considered appropriate in practice.

The scoping reading for Shamatha gave the impression that Wallace's analysis is particularly rigorous and well informed. He provides clear and detailed descriptions of the Shamatha technique and experience, which integrate and contextualize traditional understandings with modern western perspectives and knowledge of other meditation practices. He also covers philosophical and historical aspects and has co-authored several scientific journal articles. Wallace discusses how key elements of his presentation of Shamatha are supported by other distinguished Buddhist practitioners. He makes what appear to be cogent arguments as to why alternative interpretations are problematic.

The scoping reading indicated that Wallace's publications include extremely detailed instructions for Shamatha and tend to each add some important facet of the technique or experience rather than merely repeating content. It was therefore clear that, in order to get a complete understanding, it was necessary to review all of Wallace's relevant publications. From the scoping reading it was evident that there were over 25 relevant publications by Wallace, including more than 15 books, and that the necessary detailed examination of those texts would involve a huge amount of work. It was not practicable to do the same level of reading and analysis with respect to other Shamatha authors. Having regard to the strengths of Wallace's analysis (see paragraph above), we determined that reviewing his publications in a comprehensive and in-depth manner would lead to a higher quality understanding than reviewing the accounts of multiple Shamatha authors at a more superficial level. Based on these considerations, it was determined that the selection of Wallace achieved data sufficiency in relation to Shamatha.

The decision to focus on Wallace provides a concrete example of the way in which our method deals with the practical problem of how to reasonably limit the publications for review when faced with a very large body of expert literature. A further strength of our method is that, if other researchers feel that additional Shamatha authors may contribute further insights, they can readily extend the work to those authors using a similar process.

The five TM authors provide a range of perspectives. Pearson contextualizes TM relative to historical reports of contentless experience; Shear focuses on philosophical aspects; Travis conducts empirical studies; Roth is a meditation teacher; and Rosenthal is a psychiatrist. It was expected that each author might therefore draw out unique aspects of the technique and experience. The high-level impression based on the scoping reading was that, while that is correct, the authors also present the technique and experience in broadly similar terms. Adding another author may have yielded some additional insight, but the broad similarity in the five authors' accounts suggested that these would be marginal. Consequently, it was concluded that the five authors together provide data sufficiency.

Data sufficiency with respect to Stillness Meditation was clearly achieved by the selection of Meares and McKinnon. Meares developed the practice, and McKinnon has taught it for over 35 years. Meares and McKinnon are responsible for all of the major publications concerning the practice.

Selection of Publications

The next step was to select publications of the authors identified above. Three of the TM authors (Pearson, Rosenthal, Roth) have recently published major works that appear to present their understandings of the practice in a consolidated form (Rosenthal, 2011/2012, 2016/2017; Pearson, 2013; Roth, 2018). For those authors those publications were therefore relied on alone[7]. Understandings of the other two TM authors (Shear, Travis), the Shamatha author (Wallace), and the Stillness Meditation authors (Meares, McKinnon) are spread across their publications. Relying only on their more recent materials would risk omitting important details. For that reason publications of those five authors were selected by applying eligibility criteria to lists of their full output.

The primary sources for the list/s of an author's publications were searches in online databases, and reference lists and citations from relevant publications or websites. The rationale was that those are the main sources recommended for evidence syntheses (Gough et al., 2012/2017, 2013). Full details of the searches are provided in **Supplementary Appendix B**.

The searches were designed to capture all relevant publications, meaning that iterative searches were not required (ENTREQ checklist item 3). Iterative searches involve searching for select literature, reading it, conducting further searches on the basis of that reading, and so on (Gough et al., 2012/2017). In most cases, searches were conducted in Medline, PubMed, PsycInfo, Embase, Web of Science, Scopus, and Google Scholar. Other databases, including Amazon, PhilPapers, Philosopher's Index, and Discovery (an internal University of Melbourne database) were also utilized where appropriate. Where possible, the author search field was narrowed using terms indexed in the databases, for example "wallace b alan."

Details of the reference lists and citations that were relied on in addition to the searches are provided in **Supplementary Appendix C**. The searches, reference lists and citations were conducted or reviewed (as applicable) in January or February 2018. The only publication that was selected for review after February 2018 was Wallace's (2018) book, *Fathoming the Mind*, which was released in October 2018. The justification for including that text was that it is a major work of more than 200 pages, and was released prior to 2019, when the analysis in the current project commenced. To the best of our knowledge, none of the eight authors published any other works that are commensurate in scale between March 2018 (the month

[7]One exception is that Pearson is a co-author of Travis and Pearson (2000), which we selected under the regime for Travis (see below). For simplicity, and since we are relying on Pearson (2013) for Pearson's understanding, in this paper we will treat Travis and Pearson (2000) as a Travis publication not a Pearson one.

following the searches) and March 2020 (the month in which the present paper was submitted for publication).

The eligibility criteria applied to each author's list comprised inclusion criteria, and, in some cases, exclusion criteria. Publications that satisfied all inclusion criteria for an author, and that did not satisfy any applicable exclusion criteria, were selected for inclusion in the three evidence syntheses. The effect of the criteria was to excise from the full set of publications for an author at least some of the publications that were: (a) not relevant – i.e., that did not address the technique or experience; and/or (b) likely to merely duplicate relevant content from other publications in the set. To duplicate content in this context means to repeat the same idea without adding anything conceptually. It does not require word-for-word repetition.

The resulting sample comprised a core set of publications setting out the main elements of the author's understanding of the practice, in some cases together with a small number of extraneous publications. The extraneous materials were mainly publications that were likely to merely duplicate the core content, but that had not been excised via the criteria. Where final samples contained some extraneous materials, that did not matter, since those publications could be identified as part of the extraction component (see section "Data Extraction" below).

The eligibility criteria included general criteria (see further below), which were the same for each author, and author-specific criteria. Author-specific criteria were utilized because they could incorporate particular features of an author's publications in order to excise extraneous materials more effectively. As an example, the scoping reading indicated that Shear had published a major work in 1990 that appeared to present his understanding of TM in a consolidated form (Shear, 1990b). On that basis it was decided that Shear's relevant publications from prior to 1990 would be unlikely to add anything to the understanding in his major work and later publications. An inclusion criterion that Shear's publications be from 1990 onward was therefore utilized. Since the other authors had not published equivalent works in 1990, for them that inclusion criterion was not suitable.

The general criteria – applying for all five authors – were that the publication was a book, book chapter or journal article (not including encyclopedia entries), in English, and non-fiction. The author-specific criteria are set out in **Supplementary Appendix C**. As an example, the main Wallace criterion was that the publication includes two or more paragraphs (whether together or apart) on Buddhist shamatha technique or experience. That criterion had the effect of excising from Wallace's full set of materials any publications that did not address the technique or experience, and that were therefore not relevant. It also excised any publications that contained minimal discussion (i.e., less than two paragraphs) about the technique or experience, on the basis that they likely merely duplicated content in the publications containing more detail.

As noted above, **Supplementary Appendix C** sets out the sources used to produce the author lists, and the author-specific eligibility criteria for each author. For ease of reading, it is structured as a step-by-step description of the process for selecting the publications of each of the five authors for whom the criteria were utilized. The general elements of that process are as described above, but the appendix provides the fine details, including:

- The author-specific criteria and the sources for the lists;
- Justifications for the criteria (in addition to those provided above); and
- Descriptions of how the criteria were applied at a practical level – for example, on the basis of citation, title, and abstract, or by reading the publication in full.

A flowchart summarizing the selection process for all three practices is presented at **Figure 1**. PRISMA-style flowcharts with additional detail (including qualifications) are provided at **Supplementary Appendix Figures D1–D3** of **Supplementary Appendix D** (ENTREQ checklist item 9; Tong et al., 2012, p. 6).

TW was responsible for the initial application of the eligibility criteria. For three of the five authors (Meares, McKinnon, Shear), the criteria could be applied in a manner that was straightforward, with no gray areas, for example by determining whether or not a text was published from a certain year onward. The only criterion for these authors that involved any appreciable subjective judgment was the Meares inclusion criterion that the publication refers to a practice that might be reasonably identified as Stillness Meditation. For that criterion, any gray area was removed by erring on the side of including all publications for which there was any doubt.

For the other two authors (Travis, Wallace), applying the criteria involved more scope for subjectivity, requiring for instance an assessment as to whether the main focus of the publication (or a specific portion of it) was the meditation technique and/or experience. To address that issue, guidelines were established for how to apply the criteria for those two authors (**Supplementary Appendix E**). In addition, for those authors OC acted as a second reviewer to test the reliability of the criteria. OC has no personal history with Shamatha, TM or Stillness Meditation. The criteria were applied by OC, independently of TW's assessment, to random samples of 20% of the publications on each of the Travis and Wallace lists (Booth et al., 2013, p. 130; Campbell et al., 2014, p. 5). The independent assessment yielded 100% agreement with TW's assessment, and on that basis the criteria and TW's application of them were considered sufficiently reliable.

Final Publications Selected

The publications selected for inclusion in the evidence syntheses on the basis of the process above are listed in **Supplementary Appendix Tables F1–F3** in **Supplementary Appendix F** for Shamatha, TM and Stillness Meditation, respectively. In most cases the entire publication was reviewed, but for a small number of books the review covered only the portion identified as relevant (see the three tables for details).

Figure 1 and **Table 1** show for each practice the total number of publications included in the evidence syntheses. **Table 1** additionally provides the number of books and the number of book chapters and journal articles. The totals for each practice are uneven, but that should not be taken to indicate that better coverage of one practice was obtained than for another. The evidence synthesis process was designed to ensure that excellent

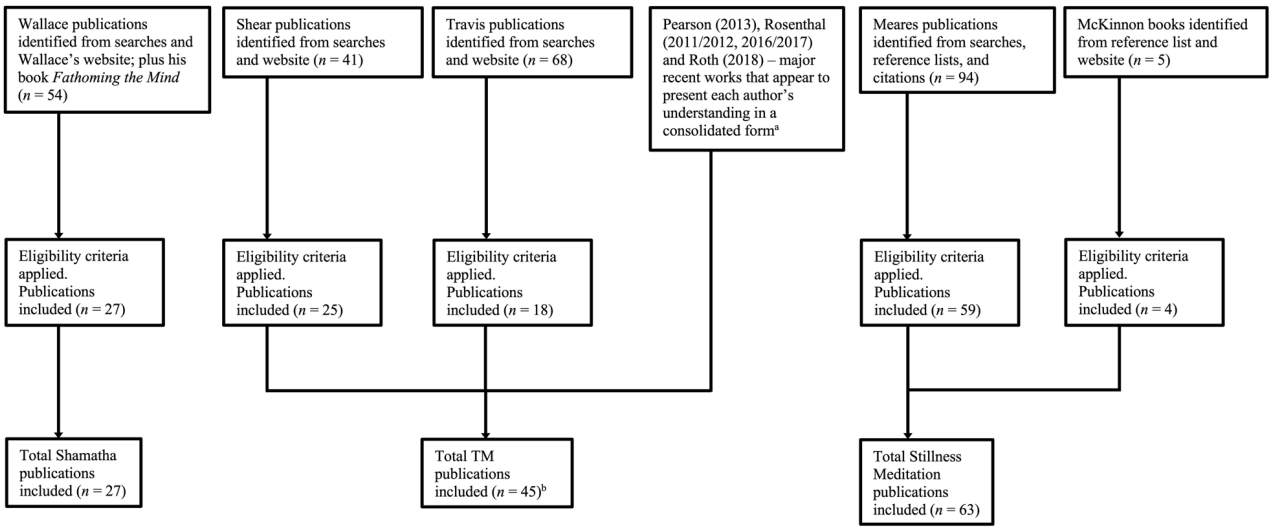

FIGURE 1 | Flowchart summarizing the process for selecting publications. For additional detail (including qualifications), see **Supplementary Appendix D**. [a]It was not necessary to apply eligibility criteria to these four publications. The purpose of the criteria was to identify samples of publications revealing authors' understandings of the practices. For these three authors the four publications already comprised an appropriate sample (see section "Selection of Publications"). [b]Two publications were selected for both Shear and Travis. These were only counted once in calculating the total TM publications.

TABLE 1 | Number of publications included in the evidence syntheses.

Practice	Books	Book chapters and journal articles	Total
Shamatha	17	10	27
TM	5	40	45
Stillness Meditation	27	36	63

coverage was achieved for all three practices. Notwithstanding the difference in the number of publications, the sections of the Shamatha, TM and Stillness Meditation extraction tables (see below) on the features of the goal-state/s are similar in length, at 29, 35 and 32 pages, respectively. Furthermore, although considerably fewer publications were reviewed for Shamatha, the Shamatha extraction table (83 pages) is substantially longer than the tables for TM and Stillness Meditation (51 and 60). That mainly reflects that there are three types of Shamatha meditation, and that the Shamatha publications contain extremely detailed instructions on how to perform the technique.

Data Extraction

Types of Data to Be Extracted

General approach

The next step in the process was to extract particular data from the selected publications. The data that were extracted included: (a) descriptions of what it is like to experience the goal-states or the interim-states fundamental in achieving the goal-states (Nagel, 1974); and (b) descriptions of the features of the techniques fundamental in achieving the goal-states. These two types of information will be together referred to as information relating to the techniques and experiences. We treated as descriptions of what it is like to have an experience both descriptions of a specific experience at a particular point in time, and descriptions that were more generalized.

Information not required included theoretical, philosophical, and metaphysical understandings. That information was extracted only if it was thought necessary or helpful to properly interpret or contextualize the data relating to the techniques and experiences.

Teacher-related aspects

In order to compare the three practices on an even footing, the evidence syntheses do not focus on features specific to meditation sessions being led or supported by a teacher. For example, a teacher in Stillness Meditation will typically use calming touch on the meditator's head and shoulders to provide a sense of safety and reassurance (Meares, 1979e, 1989; McKinnon, 1983/2016, 2011). Descriptions of the Stillness Meditation technique in the evidence syntheses do not refer to teacher-related aspects such as calming touch, but instead describe the technique as it would be performed by a meditator practising alone. According to Meares and McKinnon, the presence of a teacher normally leads to a deeper experience, but practising alone can still be effective (Meares, 1978/1986; McKinnon, 1983/2016, 2011). Key teacher-related aspects referred to in the traditional accounts of the three practices were still extracted, but this was done mainly for completeness and context.

Participant-based studies

The selected publications include certain participant-based academic empirical studies authored or co-authored by Shear, Travis or Wallace. Material in those studies was extracted if it indicated the expert's understanding of the technique or experience that was separate to the participant-based findings. Across the full set of selected publications for all eight experts,

material was also extracted if it was a participant-based finding about the experience of the goal-state/s, and the finding was from an academic empirical study and heavily relied on by the expert/s[8].

Extraction Process

The first step in the extraction procedure was to read the selected publications (or the selected portions) in full and to mark the material that was potentially relevant, adopting a broad interpretation of that phrase. The second step was to work through those sections in detail and copy or summarize the material relating to the techniques and experiences in a Microsoft Word table for each practice. The order in which the publications were reviewed for this step is described in **Supplementary Appendix G**. Most of the material in the tables was extracted verbatim rather than summarized.

It was not necessary to copy *all* of the material relating to the techniques and experiences in the sections that had been marked. Material was extracted only if it added something conceptually to any material already in the relevant table. In this way, conceptual duplication of points in the table was avoided. A conservative approach was taken concerning whether material in the publications added anything conceptually to material in the table. For example, material could be taken as adding something where it:

- Expanded on or qualified a description in the table; or
- Simply repeated the description, but through the repetition indicated that the feature:
  - was regarded as central to the practice rather than marginal;
  - was recognized by multiple experts; or
  - remained part of the practice at a later point in time.

Supplementary Tables S1–S3 in the supplementary material are the final extraction tables for Shamatha, TM and Stillness Meditation, respectively. The tables together comprise the database for the current project. The set of tables is preceded by a document headed "Database Contents List" that lists the contents of the three tables and provides page numbers.

TW was responsible for the data extraction, and for the coding of the extracted material as described below (see section "Synthesis"). He was guided by regular feedback from OC and JW. OC also performed an independent review of a sample of the extraction and coding (Centre for Reviews and Dissemination, 2009; Noyes and Lewin, 2011a; Booth et al., 2013). For each of the three practices, one book was selected at random from the first five books reviewed for the practice. That meant that three books were selected in total (Meares, 1978/1986; Rosenthal, 2011/2012; Wallace, 2011b). In each of the three books, 10 pages were randomly selected from the pages that TW had marked in his initial review as containing potentially relevant material. Another 10 pages in each book were randomly selected from pages that TW had not marked. The independent review involved examining the extraction and coding that had been undertaken in respect of the initial set of 10 pages, as well as confirming that the second set of 10 pages did not include material that should have been extracted and coded. OC did not identify any issues with the extraction or coding for the initial set, and she confirmed that the second set did not contain relevant material.

Synthesis

The final step in the process was to synthesize the extracted material. Synthesis is a form of analysis that involves generating new knowledge by forming connections within extracted material that have not been made before (Mays et al., 2005b; Suri, 2011, 2014; Gough et al., 2012/2017; Noyes et al., 2015). As referred to above, Popay et al. (2006) provide a series of synthesis techniques that the reviewer employing narrative synthesis can choose from and can tailor as appropriate for their extracted data. The critical requirement is that the technique/s be applied in a structured manner.

The technique selected for the current project was thematic analysis. This section describes the tailored form of thematic analysis that was utilized in the present evidence synthesis and how it was applied in a structured manner. The form of analysis used in the project involves several of the other techniques identified by Popay et al. (2006), including textual description, grouping of publications, tabulation, and translation of themes and concepts. It will be referred to in the project as a single technique, but it could alternatively be presented as multiple techniques.

Popay et al. (2006) provide a four component structure for the synthesis element, consisting of theory development, preliminary synthesis, detailed synthesis, and synthesis assessment. However, they emphasize that this is not prescriptive and that structuring will vary with individual syntheses (pp. 11, 12). In practice, reviewers tend to treat narrative synthesis as the second and third components, and either disregard the first and fourth, or address them separately, and without reference to the guidelines (e.g., Bailey et al., 2015; Madden et al., 2018).

A similar approach has been taken in the current project. On the basis that it is unnecessary and unhelpful for the purposes of the project, the first component (theory development) has been left out and no distinction has been drawn between the second and third components (the preliminary and detailed syntheses). The fourth component (synthesis assessment) is addressed in the "Discussion" section/s, independently of the guidelines.

Synthesis comprised both coding of the extracted material and the steps taken to compare the techniques and experiences across the three practices. To code the extracted material, the extraction tables for the three practices were each divided into two sections: "Techniques and Interim-States" and "Goal-state/s." As material was extracted, it was placed in one or both of those sections, as appropriate. Within those sections, the material was placed under one or more additional subject headings. For example, extracted material describing a goal-state as wakeful was placed in the "Wakefulness" section of the "Goal-state/s" part of the table. In that way it was coded as both "Wakefulness" and "Goal-state/s."

The codes "Techniques and interim-states" and "Goal-state/s" were developed deductively, meaning they were

[8]We focused on findings relating to the goal-state/s because *all* features of the goal-states needed to be captured, rather than merely features that were fundamental.

determined at the outset (ENTREQ checklist item 19). All other codes were developed inductively: They were created as required, based on the features referred to in the extracted material (ENTREQ checklist item 19; Popay et al., 2006; Thomas and Harden, 2008). Codes were applied to words, phrases, sentences, or paragraphs, as appropriate to capture the relevant feature (Gough et al., 2012/2017; Bryant, 2017). Coding was treated as provisional until the process was complete (Bryant, 2017). During the process, adjustments to the coding were made to ensure that it was consistent and precise, and that individual codes were appropriate in scope (Richards, 2006/2015; Thomas and Harden, 2008). The full coding is shown in the final extraction tables (**Supplementary Tables S1–S3**).

The feature silence/quietness was compared across the traditions by juxtaposing the database material coded silence/quietness for each practice (**Supplementary Tables S1–S3**, section "Silence, Quietness"). The steps for the comparison of the techniques and the other aspects of the experiences will be presented elsewhere (Woods et al., 2020a,b).

RESULTS

The database reveals that in each of the three practices the goal-state/s have a large number of experiential features, and that in each practice these overlap to various degrees (see **Supplementary Tables S1–S3**, section "Features"). Silence/quietness is one of many features that are reported or implied in all three traditions. Other examples are the meditator being conscious and awake, having no thoughts, perceptions, or mental images, and experiencing calm and rest.

In this section we report our findings regarding the feature silence/quietness. The extracted material for that feature is provided in the database, and for ease of reference it is also set out in **Tables 2–4**. Those three tables present the material for Shamatha, TM and Stillness Meditation, respectively.

There are four main findings regarding how the experts refer to silence/quietness. The first is that they frequently present the feature alongside other features of the goal-states. For example, Wallace (2011a, p. 249) refers to the Shamatha goal-state as "silent, luminous, [and] blissful." Pearson (2013, p. 175) describes the TM experience as involving "silence, peace, and joy." Meares (1978/1986, p. 24) indicates that in Stillness Meditation there is "quietness, and an ease." In these examples, silence/quietness is presented alongside the features luminosity, bliss/joy, and ease/peacefulness.

The second finding is that the experts often use terms like silence or quietness without elaboration as to their precise meaning. This point is also illustrated by the quotations in the paragraph above. For example, Pearson's (2013) reference to "silence, peace, and joy" indicates that those three qualities are features of the TM goal-state, but it does not provide further detail concerning those features. That leaves unresolved the precise nature of silence as a specific feature. In other words, what exactly does the word silence add to the description of the experience?

Other passages in the expert texts do provide elaboration as to the nature of the silence/quietness as a specific feature. Those passages are the subject of our third and fourth findings.

The third finding is that certain passages indicate a particular connection between the silence/quietness and the absence of concepts, mental activity/noise, thoughts, and disturbance, or between the silence/quietness and stillness. Wallace says that the Shamatha goal-state is "conceptually silent" (Wallace, 2009/2014, p. 93), and that the "conceptual mind is quiet" (Wallace, 2011a, p. 208). Pearson (2013, p. 51) quotes a TM meditator who describes the transition from an "active level" of awareness to the silence of the goal-state. Rosenthal (2011/2012, p. 18) describes the transition in TM by saying "all [the] mental noise quiets, and I welcome the silence." Elsewhere he says: "Thoughts may still come and go but sooner or later . . . silence . . . all thoughts have gone" (Rosenthal, 2016/2017, p. 35). Meares (1988, p. 74) discusses the movement into the Stillness Meditation goal-states in very similar terms: ". . . [Thoughts] fizzle out. A silence comes to our mind. Then a few more thoughts. Then silence again." He additionally associates quietness with the absence of disturbance in the experience (Meares, 1978/1986, p. xii, Meares, 1987a, p. 42, Meares, 1989, p. 122). For example, he notes that for a period of time he used the term "Mental Ataraxis" to describe the practice (see **Table 4**). He explains that *ataraxis* is a Greek term meaning "absence of disturbance," and he adds that Mental Ataraxis concerns "quiet of mind" (Meares, 1978/1986, p. xii). In describing the goal-states he says that there is "[n]othing to disturb the quiet within" (Meares, 1989, p. 122).

Numerous passages in the expert texts indicate that silence/quietness is closely related to stillness (see section "Introduction" above, and **Tables 2–4**). Sometimes the term stillness appears to be focused on the absence of thoughts. For example, Roth (2018, p. 164) quotes a TM meditator who says, "Thoughts will come and go, and it will be five minutes before I can get to [the] stillness. I go to this incredible place where I'm not even thinking anything." Other times the term stillness seems to be used in a broader manner that reflects both the absence of thoughts and other disturbances. Wallace (2011b, p. 62), for instance, indicates that in the Shamatha goal-state "the mind is quiescent . . . no turbulent thoughts or emotions arising . . . still." He also refers to the "silence, the stillness, the lack of perturbation" (p. 120) in the experience. Pearson (2013, p. 25) describes what is aimed for in TM as a "state of perfect stillness, beyond all perceptions, thoughts, and feelings." Meares (1977c, p. 131) says similarly that: "[Stillness Meditation] is characterized by stillness. There is an absence of intellectual activity, an absence of sensory experience and an absence of emotion." McKinnon (1983/2016, p. 218) explains that in the stillness "nothing disturbs [the meditator] at all."

The fourth and final finding is that the experts in each practice indicate that the silence/quietness is in some sense complete. As noted above, Wallace (2011b, p. 120) refers to the Shamatha goal-state as involving "sheer silence." The TM experts describe the silence in TM as deep, complete, absolute, infinite, and pure (see **Table 3**), and they refer to the goal-state as the quietest experience possible (Pearson, 2013, p. 49; Roth, 2018, p. 34). In Stillness Meditation there are references to a complete and

all-encompassing silence or quiet (see **Table 4**), and the goal-state experience is also described as "just quietness" (Meares, 1987/1991, p. 114, 1989, p. 115).

DISCUSSION

The current paper is an evidence synthesis examining silence/quietness as a specific feature of the goal-states in Shamatha, TM and Stillness Meditation. It is based on expert texts from within the three traditions. We have designed and presented a detailed evidence synthesis method that is appropriate for the research objectives. The method involves the production of the database comprising **Supplementary Tables S1–S3**. The database was produced by way of a detailed review of 135 traditional publications. It contains rich descriptions of the meditation techniques and experiences extracted from those texts. The descriptions have been organized – or coded – in the database to differentiate individual features. These include all the features of the goal-states referred to in the traditional accounts (**Supplementary Tables S1–S3**, section "Features"). Silence/quietness is one of the central features of the goal-states. Our findings concerning silence/quietness are based on the experts' references to that feature in the database (see **Tables 2–4**).

The paper is part of the Contentless Experience Project, a broader project that includes three evidence syntheses. The present evidence synthesis presents our findings concerning silence/quietness as a specific feature of the goal-states. The other two syntheses (Woods et al., 2020a,b) will provide our findings concerning features of the meditation techniques and interim-states, and the features of the goal-states other than silence/quietness.

Summary of the Findings

The evidence synthesis method and the database lead to four main findings concerning the feature silence/quietness. The first finding is that the experts in the three practices often refer to the silence/quietness alongside other features of the goal-states. Pearson (2013, p. 175), for example, describes the TM goal-state as involving "silence, peace, and joy."

The second finding is that frequently the experts do not elaborate as to the precise meaning of terms such as silence and quietness. Pearson's reference to "silence, peace, and joy," for instance, does not provide any detail concerning the meaning of the term silence.

The third finding is that the experts draw a particular connection between the silence/quietness and the absence of concepts, mental activity/noise, thoughts, and disturbance, and between the silence/quietness and stillness. In Shamatha the silence/quietness is linked to the absence of concepts, in TM it is linked to the absence of mental activity/noise and thoughts, and in Stillness Meditation it is linked to the absence of thoughts and any other disturbance. The silence/quietness is closely associated with stillness in each of the practices. The experts use the term stillness in a range of ways. In its broader usage it appears to reflect the absence of thoughts and the absence of other disturbances such as perceptions, mental images, and negative feelings.

The fourth finding is that the silence/quietness is reported as being in some sense complete. Terms such as sheer, deep, absolute, pure, and all-encompassing are used.

Silence/Quietness Reflects the Absence of All or Certain Types of Disturbance

In reflecting on the findings, we can begin by noting that in each practice the experts report or imply that the goal-states involve an absence of disturbance. In Stillness Meditation the term "absence of disturbance" is given a particular prominence, but the concept is also conveyed in the other two practices (**Supplementary Tables S1–S3**, section "… Absence of Disturbances"). Disturbances include (but are not limited to) thoughts, sounds, other perceptions, mental images, and negative feelings. Since there are no disturbances in the goal-states, meditators in the practices experience stillness in the broad sense of that term (see above).

From these observations, it is evident that in terms of the absence of disturbances the experiences in the three practices are at least broadly the same. The findings regarding silence/quietness (see above) indicate that the experts see that feature as reflecting at least the absence

TABLE 2 | Shamatha extracted material for the feature silence/quietness.

Expert text	Extracted material
Wallace, 2011b	"… the sheer silence, the stillness, the lack of perturbation …" – p. 120
	"… a quiet, percolating, radiating sense of serenity, joy that is very malleable." – p. 145
Wallace, 2009/2014	"… blissful, luminous, conceptually silent state …" – p. 93
Wallace, 2011a	"… a luminous, blissful, silent space of awareness …" – p. 40
	"… peaceful, luminous silence …" – p. 111
	"When the mind goes quiet, what remains is the substrate consciousness." – p. 196[a]
	"The conceptual mind is quiet …" – p. 208
	"… the silent, luminous, blissful substrate consciousness." – p. 249

[a]*Wallace uses the term substrate consciousness to refer to the state aimed for in Shamatha practice (**Supplementary Table S1**, section "Substrate Consciousness"). He indicates that substrate consciousness can also be accessed in sleep, death, coma, fainting, and hypnosis, but that the degree of attentional stability and vividness may differ.*

TABLE 3 | TM extracted material for the feature silence/quietness.

Expert text	Extracted material
Pearson, 2013	Quoting a meditator describing their first session: "... I experienced a silent, inner state of no thoughts, just pure awareness and nothing else ..." – p. 29
	"... a state of deep inner silence and peace ..." – p. 29
	"[The mind] can become calm, quiet, silent, while remaining awake. This is [pure consciousness]." – p. 44
	"Your mind is awake but silent and serene." – p. 44
	"[Pure consciousness] is the most simple and natural experience a person can have – the experience of awareness in its most quiet state." – p. 49
	"[Pure consciousness] is still, silent ..." – p. 50
	Quoting a meditator: "I will never forget the first experience I had of the [TM] technique ... The movement of my awareness from the active level ... to the field of silence within myself ... was like diving into a pond of pure joy." – p. 51
	Quoting a meditator: "[M]y mind settles down, thoughts become less and then suddenly all thought activity ceases and I slip into an unbounded ocean of awareness which is pure, quiet, unexcited ..." – p. 52
	Quoting a meditator: "... I sometimes reach a state of complete silence ..." – p. 52
	"... an inner sanctuary of infinite silence, peace, and joy." – p. 175
Roth, 2018	"... [D]eep within is a level that is calm yet alert; silent yet wide awake." – p. 17
	"It is your own quiet inner self ..." – p. 17
	"... the quietest, deepest level ..." – p. 34
	"... quiet, peaceful, transcendent state of awareness." – p. 37
Shear and Jevning, 1999a	"The experience would appear to be one of consciousness alone by itself – pure, silent, and empty of all 'phenomenal' objects." – p. 194
	"... silent and fully awake inside ..." – p. 195
	"... alert silence of pure consciousness ..." – p. 205
	"... simplest, non-active, completely silent state [of consciousness] ..." – p. 205
Shear, 2006b	"... *absolute, pure silence*." – p. xviii
Shear, 2006c	"... completely silent state ..." – p. 26
Rosenthal, 2016/2017	"... peace and quiet." – p. 31
	"What, then, are the usual elements of transcendence? That was the question I asked a group of students, at Loyola University's Stritch School of Medicine in Chicago, who had learned to meditate. They replied with gusto: stillness, quiet, no boundaries, no thoughts, and bliss. In short, they captured the essential spirit of the state." – p. 31
	"It is quiet there. Still. Peaceful. Thoughts may still come and go but sooner or later ... silence ... all thoughts have gone." – p. 35
Rosenthal, 2011/2012	"... I use the mantra in a way that allows my mind to settle into quietude." – p. 18
	"As I continue to meditate, all that mental noise quiets, and I welcome the silence." – p. 18
Travis and Pearson, 2000	Quoting a participant: "... [A] couple of times per week I experience deep, unbounded silence, during which I am completely aware and awake, but no thoughts are present." – p. 81
Arenander and Travis, 2004	"... complete silence ..." – p. 114
Travis et al., 2005	Quoting a meditator: "... I am completely still. It's absolute silence." – p. 128
	"It is being awake in the midst of silence." – p. 128
Travis, 2009	"This silent interiority of the mind has been called pure consciousness." – p. 28

of certain types of disturbance, and possibly the absence of all forms of disturbance. To explain this point it is necessary to consider the most relevant categories of disturbance in turn.

For each of the practices it is clear that terms such as silence and quietness reflect at least the absence of thoughts. Rosenthal (2016/2017, p. 35) describes the silence in TM where "all thoughts have gone," and Meares (1988, p. 74) says that in Stillness Meditation "[thoughts] fizzle out" and "[a] silence comes to ... mind." The Shamatha passages do not directly link the terms silence and quietness to the absence of thoughts, but they do link them to the absence of concepts. Thoughts involve concepts, and this implies that the terms also reflect the absence of thoughts.

In the passages in the database the experts do not expressly state that the term silence reflects the absence of sounds. However, the absence of sounds is reported in each practice, the term silence is conventionally understood as meaning or including the absence of noise[9], the experts give no indication that the conventional understanding is not applicable, and they refer to the silence as sheer, absolute, all-encompassing, and so on. On this basis it seems implied that in each practice the experts intend the term silence to extend to the absence of sounds.

A similar analysis and conclusion applies for the term quietness, except that for Stillness Meditation the indications that quietness reflects the absence of sounds are more explicit. Discussing that practice, Meares expressly links the term quietness to the absence of all disturbances. He explains that "absence of disturbance" concerns "quiet of mind" (Meares,

[9]One definition of the term silence in the Oxford English Dictionary is "the absence of all sound or noise" (Oxford, 2020). The Merriam-Webster Dictionary includes an almost identical definition ("absence of sound or noise") (Merriam-Webster, 2020).

TABLE 4 | Stillness Meditation extracted material for the feature silence/quietness.

Expert text	Extracted material
Meares, 1978/1986	"... [Stillness Meditation allows] the mind to come to a state of quiet and stillness." – p. ix Meares coined the term "Mental Ataraxis" to refer to the meditation, and to distinguish it from other forms of meditation (pp. xi-xii, 6). He explains: "[The Greek term] '*ataraxis*' simply means 'an absence of disturbance.' Mental Ataraxis concerns quiet of mind and peace of mind." – p. xii Meares later stopped using the term on the basis that it was confusing for some people (Meares, 1989, pp. 108–109).
	"[The experience] comes as quietness, and an ease, pervading everything – our thoughts, our feelings, our whole being." – pp. 24–25
Meares, 1989	"... [O]ur mind goes quiet of itself ..." – p. 46
	"Nothing to disturb the quiet within." – p. 122
	"When our mind is still, there is nothing. Just quietness. Just *being*." – p. 115
Meares, 1987/1991	"Let the mind run quiet. Just quiet." – p. 17 Meares pp. 21, 80, 115 makes similar comments.
	"... just quietness, a stillness of effortless tranquility." – p. 114
Meares, 1988	"The idea is just to let our mind be quiet ... It is just a quietness, a stillness of the mind. Thoughts may come ... Just let them be, and in a few moments they fizzle out. A silence comes to our mind. Then a few more thoughts. Then silence again. It is just a coming and going." – pp. 73–74
Meares, 1979b	Writing from the perspective of a notional patient in conversation with himself as Stillness Meditation teacher/therapist: "You harp on the silence [a]nd the stillness ..." – p. 79
Meares, 1984	"... The silent stillness [o]f the meditation ..." – p. 46
Meares, 1987a	"Ease is quietness of mind ..." – p. 25
	"... The storm whips up the waves, [b]ut deeper down the world is quiet." – p. 42
McKinnon, 1983/2016	"... silence and stillness ..." – p. 228
McKinnon, 2011	"... the experience of only stillness ... an all-encompassing silence." – p. 44
	"... quiet and silence ..." – p. 162
McKinnon, 1991	"*Only complete quiet...*" – p. 127
McKinnon, 2002/2008	"... completely still and silent ..." – p. 52

1978/1986, p. xii), and makes clear that, in that context, "absence of disturbance" refers to the absence of *all* disturbances. He also says that there is "[n]othing to disturb the quiet within" (Meares, 1989, p. 122), and that, "When [the] mind is still, there is nothing. Just quietness" (Meares, 1989, p. 115).

Since Meares treats the term quietness as reflecting the absence of all disturbances, he sees the term as reflecting not just the absence of thoughts and sounds, but the absence of other disturbances as well. As noted above, these other disturbances include non-auditory perceptions, mental images, and negative feelings. It is not clear from the passages in the database whether the Shamatha and TM experts ever intend the word quietness to reflect the absence of these other disturbances. It is also not clear whether the experts in any of the three practices ever intend the word silence to extend beyond the absence of thoughts and sounds in this manner.

Wallace's (2011b, p. 120) reference to the "silence, the stillness, the lack of perturbation" in the Shamatha goal-state provides an example of how the scope of terms such as silence and quietness can be unclear. The phrase "the stillness, the lack of perturbation" fits with Wallace's (2011b, p. 62) earlier reference to the mind being still, without "turbulent thoughts or emotions arising." In the framework that we have been discussing, the turbulent emotions constitute a form of disturbance other than thoughts and sounds. It appears that the word stillness is being used in the two passages in the broad sense (see above) covering the absence of all disturbances, including turbulent emotions. The scope of the term silence in the passage "the silence, the stillness, the lack of perturbation" is unclear. It could be interpreted as narrower in scope than the term stillness, reflecting only the absence of thoughts and sounds. Alternatively, the two terms could be treated as equal in scope, reflecting the absence of thoughts, sounds, *and* other disturbances, including turbulent emotions. That broader scope is also equivalent to Meares' broad usage of the term quietness (see above).

Based on the passages in the database, each of these interpretations seems reasonable. As noted above, the term silence is conventionally understood as meaning or including the absence of noise. The passages in the database provide no indication that it would be inappropriate to understand the term silence in this way. If someone reading Wallace's reference to silence (see above) conceived that term as being only about the absence of noise, they might interpret it as reflecting only the absence of thoughts and sounds. The reason for this is that thoughts and sounds can readily be understood as forms of noise, whereas it is harder to construe other disturbances such as non-auditory perceptions, mental images, and negative feelings in that way. Sounds, as we have been using that term, are auditory sense impressions from external sources. They clearly constitute noise. Thoughts can easily be conceived as a form of internal noise. Other disturbances could possibly be treated as noise in a metaphorical sense: As the meditator approaches the goal-state/s, the disturbance – or noise – is turned down, and in the goal-state/s it reaches zero. Clearly, though, treating these other disturbances as noise is more of a stretch.

Numerous passages in the database leave room for the term silence to be interpreted in a broader manner that extends beyond the absence of noise. In particular, they allow for the term to be interpreted as reflecting a complete calm or

absence of disturbance[10]. If the person reading Wallace's reference to silence had in mind this extended definition, they would likely see it as reflecting the absence of thoughts, sounds *and* other disturbances.

One further point is that the two interpretations can co-exist. The term silence could mean the absence of noise *and* the complete absence of disturbance. As such, when Wallace uses the word silence, at one level that may reflect simply that thoughts and sounds are absent, and at another it may reflect that there are no thoughts, sounds *or* other disturbances.

In summary, the analysis above provides the following insights. In each practice it is reported or implied that the goal-states involve an absence of disturbances including thoughts, sounds, other perceptions, mental images, and negative feelings. The terms silence and quietness reflect at least the absence of thoughts and sounds, and this fits neatly with a conception of silence/quietness as the absence of internal and external noise. For the most part, the experts do not clearly indicate that the terms silence and quietness can extend to the absence of disturbances other than thoughts and sounds, however they also do not rule this out. Interpreting the terms in that extended manner would fit with a conception of silence/quietness as complete calm or absence of disturbance.

In view of these conclusions, researchers seeking to understand silence/quietness in contentless experiences should keep in mind the potential for a single term to be used in different ways. In particular, the terms may reflect the absence of thoughts and sounds, the absence of thoughts, sounds and other disturbances, or they may have each of those meanings at the same time.

This conclusion fits with the observation that there is often a degree of flexibility in the terms the experts use to describe the goal-states. The terms tend not to be defined in a rigid and very specific manner. The flexibility seems important given that the goal-states are so unusual compared to ordinary waking experiences. They are said to involve an absence of concepts and an absence of subject-object duality, and can therefore be challenging to describe (see **Supplementary Tables S1–S3**, section "Features"). Wallace explicitly draws attention to the fact that a single term can have multiple meanings (see Wallace, 2011b, pp. xi–xii; **Supplementary Table S1**, section "The Term Nature of the Mind").

Silence/Quietness May Be a Unique Feature

Recognizing that the silence/quietness reflects the absence of all or certain types of disturbance is a major step toward understanding it. It is important, however, to appreciate that there can be more than one feature that reflects the absence of particular disturbances, and this does not necessarily mean that those features are identical. Each feature may still be unique.

As an example, we have noted above that the terms silence, quietness, and stillness may in some cases each be used to reflect the absence of all forms of disturbance. That indicates a substantial overlap between the features silence/quietness and stillness, but it does not necessarily mean that they are identical. Silence/quietness might be some combination of calm and the absence of noise, whereas stillness might combine calm and the absence of movement. Movement here refers to movements of the mind, such as fluctuations in thoughts or feelings (see, e.g., **Supplementary Table S1**, section "Stillness and Movement"). The absence of noise and the absence of movement are each implied by there being no disturbances, however it may be that experientially they are different.

The passages in the database in fact provide little detail as to whether or how the feature silence/quietness is unique. As explained above, the terms silence and quietness are frequently used without elaboration as to their precise meaning, and most of the elaboration that is provided is about the terms reflecting the absence of all or certain types of disturbance. The experts do not explicitly address how the silence/quietness is distinct from stillness. It may be that in some cases they intend the terms as synonyms, describing an identical experiential quality. In other cases, they may use the terms to refer to qualities that are overlapping but distinct.

To the extent that the experts are seeking to convey distinct qualities, they appear to mainly rely on the words silence, quietness, and stillness themselves. The words themselves may prompt in the reader some intuitive sense of the features silence/quietness and stillness, and how they may be different. The experts may consider that giving this intuitive impression is sufficient for the purposes of the texts. While the texts provide a great deal of detail about the experiences, they are not intended to provide exhaustive technical descriptions of every facet.

The experts may also consider that there is not much that can be said about the unique elements beyond what is conveyed using the terms themselves. As referred to above, the experts note that there are limitations when it comes to describing the goal-states in words.

Silence/Quietness Is Connected to the Other Features of the Goal-States

From the database as a whole it is evident that in each practice the feature silence/quietness is interconnected with all the other features of the goal-state/s. **Figure 2** is a diagram that illustrates how silence/quietness has closer connections with some features than with others.

The full diagram represents the goal-state/s in any one of the three practices. Since silence/quietness is the focus of this paper it is placed in the middle of the diagram, at the bottom. Working outward from silence/quietness there are four bands of features which will be explained below. The features shown in circles are examples of the features in each band, not the full set of features. The features in circles are reported or implied in each of the three practices.

[10]This extended definition fits with other conventional understandings of the terms silence and quietness. For example, one definition of silence in the Oxford English Dictionary is "complete quietness or stillness," and definitions of quietness include "calmness. . .", and the "absence of. . . disturbance" (Oxford, 2020).

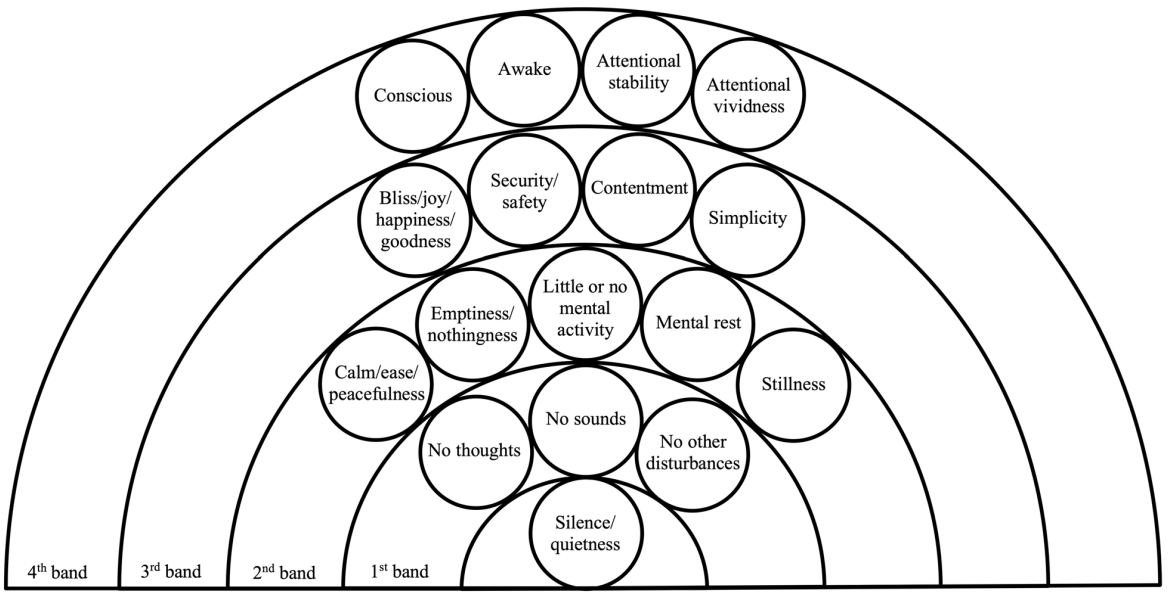

FIGURE 2 | Closeness of connections between silence/quietness and other features of the contentless experiences. For each of the four bands the features in circles are examples of the features in that band. The present paper explains how the experts in Shamatha, TM and Stillness Meditation refer to the feature silence/quietness. The section headed "Features" in each of **Supplementary Tables S1–S3** shows how the experts refer to the other features.

For clarity and simplicity, the features in circles are shown in the diagram as being distinct but connected. The reader should, however, bear in mind that an alternative way to represent the connections would be to show overlaps between the features. If that alternative approach was taken, the feature silence/quietness could, for example, be depicted as including the features in the first band (discussed below), or as otherwise overlapping with them to a large extent.

The experts themselves do not refer to there being four bands. We are dividing the features into four bands purely to illustrate the varying connections between the features.

A key conclusion from our earlier analysis was that silence/quietness can be conceived in different ways. The experts make clear that it reflects the absence of thoughts and sounds, and they leave scope for a broader conception in which it also reflects the absence of other disturbances. The features no thoughts and no sounds can be treated as central to – or intimately connected with – silence/quietness, and for this reason they are placed in the first band. On the broader conception of silence/quietness the feature no other disturbances is also central, so it is also in that band. The absence of other disturbances is represented as a single feature, but it could equally be presented as the component features no other perceptions, no mental images, and so on.

The features in the first band together represent the feature no disturbances. That feature appears equivalent or very nearly equivalent to the feature calm/ease/peacefulness. It also seems extremely close to the features emptiness/nothingness, little or no mental activity, mental rest, and stillness, where stillness is understood in the broad manner described earlier. These four features each reflect the absence of mental content such as thoughts, sounds, other perceptions, mental images, etc., but as explained above each may also have a unique experiential quality. In the diagram, the features calm/ease/peacefulness, emptiness/nothingness, little or no mental activity, mental rest, and stillness are in the second band. That indicates their extreme closeness to the features central to silence/quietness.

The third band represents features that may be slightly more removed from the central features but that are still closely connected to them. The examples in the diagram are bliss/joy/happiness/goodness, security/safety, contentment, and simplicity. Bliss/joy/happiness/goodness, for instance, appears different to the central features (i.e., the absence of disturbances), but it seems closely related to them, and in particular the absence of negative feelings. In Shamatha, for example, bliss or happiness is said to arise due to the mind no longer being "pummeled to death with afflictions, craving, hostility, and aversion" (Wallace, 2010, p. 32).

The fourth band represents features that are less closely connected to the central features. For this band, the examples are that the meditator is conscious (as opposed to not conscious), awake (as opposed to not awake), and has a degree of attentional stability and attentional vividness. These features have some connection with the absence of disturbances but it is not as close as for the other features above. For example, the feature conscious is connected to the absence of disturbances in that the meditator can only report the absence of disturbances because

they were conscious of it during the goal-state. That connection is not specific to the absence of disturbances, however. There is a similar connection between the feature conscious and all the other features of the goal-states.

The present paper examines silence/quietness as a specific feature of the goal-states – i.e., as one of the many features that make up the experience as a whole. It is also possible to treat the silence/quietness as the entire goal-state/s in each practice. For example, a meditator may say that they had an "experience of silence," and mean not just silence specifically, but rather all of the goal-state features, including silence, awakeness, bliss/joy/happiness/goodness, and so on. Researchers wishing to understand silence/quietness in this much broader sense would need to examine all of the goal-state features in detail. Our database contributes to this endeavour by identifying each of the goal-state features in the traditional accounts, and showing how the experts refer to them.

The Method Provides a Strong Evidence Base

The analysis above is grounded in our findings concerning how silence/quietness is referred to in the database. Readers can have confidence that the findings accurately reflect how the feature is conceived within the traditions because the database and findings have been generated using an appropriate scientific method. The database represents a stronger evidence base than traditional descriptions identified by researchers in an unsystematic and/or opaque manner.

The method is both rigorous and transparent. Rigour is ensured by relying only on experts with outstanding qualifications; using objective criteria to identify samples of those authors' publications that reveal their understandings of the practices; working through those publications systematically and in fine detail in order to extract relevant material; and fully coding the extracted text. Transparency is provided by documenting each element of the process, satisfying the ENTREQ reporting guidelines, and making the full method and database available.

In our analysis we conclude that certain aspects of the experts' understandings are unclear. For example, it is unclear exactly if and when the experts intend the words silence and quietness to extend to disturbances other than thoughts and sounds, and it is unclear precisely how silence/quietness differs from stillness. The discovery of these ambiguities represents a strength of our method. A more superficial approach would likely fail to recognize the fine distinctions to which they relate. Identifying the ambiguities helps to generate research questions that can be examined in future studies to provide greater clarity (see section "Future Research" below).

Limitations

There are three main limitations of the evidence synthesis.

Subjectivity

The method incorporates a series of structural elements designed to provide an objective basis for making decisions relating to the selection, extraction, and synthesis of expert texts or material within them. These include numerous rules applied by one of our team members and independent assessment by a second team member, for a sample of publications, to identify any issues with the first team member's decisions. A limitation of the method is that there remains a degree of subjectivity in how the rules are applied. As an example, our judgment that a description concerns what it is like to have an experience and should therefore be extracted may differ to the assessment of other researchers.

All forms of evidence synthesis involve a degree of subjectivity (Centre for Reviews and Dissemination, 2009; Gough et al., 2012/2017; Bryant, 2017). A strength of our approach is that it involves much less subjectivity than most existing analyses of traditional accounts. Since existing analyses tend not to use an explicit scientific method they generally do not include the explicit structural elements that we have utilized in order to reduce subjectivity.

We have aimed to be as transparent as possible. The transparency allows others to critique or audit the process and see if the findings replicate. If experts in or outside the traditions consider that any facet of the method or its application is problematic, they are free to argue that point.

Sample of Publications

The second limitation is that the method involves selecting and reviewing only a sample of the traditional publications for the three practices rather than all of them. As noted earlier, the large number of traditional publications for the three practices means that it is not feasible to review them all. Examining additional publications (outside the sample) might clarify some aspects of the goal-states. However, the sampling strategy was explicitly designed to ensure that the selected publications allow a deep understanding of how the experiences are described in each practice.

Reliability of the Traditional Accounts

The third limitation is that there are various issues concerning the reliability of the descriptions of meditation experiences in the database. The data and findings allow us to address our specific research question, namely, "How is the silence of the goal-states described in the traditional texts?" However, it cannot be simply assumed that the descriptions in the traditional publications reflect with a high degree of accuracy the experiences that meditators have in practice.

For example, the traditional descriptions are likely to be normative to some degree and can be influenced by doctrinal considerations (Dunne, 2015; Markovic and Thompson, 2016). In addition, while the selected authors have outstanding qualifications as experts in the practices, they do not necessarily have the expertise in phenomenology or science that may be required to obtain or provide highly accurate descriptions of experience. Reports are generally regarded as more reliable if they concern a specific experience at a particular point in time, and if there is little delay between the experience and the report (Hurlburt and Schwitzgebel, 2007, pp. 14, 16–17). In that circumstance the reports are much less vulnerable to biases and other limitations

of memory. Many of the descriptions in the database are generalized rather than specific, and do not indicate the delay. Some researchers may consider that the reliability of those descriptions is so questionable that they should be excluded altogether, rather than treated as indicating what it is like to have the experience.

The traditional accounts also have certain strengths when it comes to reliability. For instance, typically they take into consideration the expert's personal experience during meditation and the experience of large numbers of other meditators, such as students, patients, or peers of the expert. The experts will often describe a particular feature of the experience and then provide examples from individual meditators (quoted or paraphrased) to support those descriptions. In numerous cases the reports from the individual meditators relate to a specific experience at a particular point in time.

Lutz and Thompson (2003, p. 38) have argued that the practical methods used to become aware of experience in Buddhist shamatha and insight practices are "far more developed" than in the western tradition of phenomenology (see also Depraz et al., 2002, pp. 206, 224). Wallace says that experienced meditators can provide "detailed, accurate [and] objective" reports (Wallace and Hodel, 2008, p. 178), although the current scientific evidence for this claim is inconclusive (Abdoun et al., 2019). Shear (2007, p. 41) contends that attaining contentless experience in TM or any other practice "provides an optimum platform for [then] investigating . . . contents of mind," since the experience reduces internal noise and distortion.

All methods for examining experience have substantial limitations relating to reliability, even the popular *micro-phenomenology*, which claims to provide "great precision" (Petitmengin, 2006, pp. 230–231; Hurlburt and Schwitzgebel, 2007, pp. 186, 293, 2011b p. 208). Traditional accounts are a major source of information about meditation practices and meditation researchers generally agree that they have sufficient reliability to be of value (Studstill, 2005, pp. 52, 85; Lindahl et al., 2014; Sedlmeier et al., 2014, p. 620; Lutz et al., 2015; cf. Sharf, 1995). For this reason it makes sense to work out what the accounts have to say, while bearing in mind the reliability issues. Other methods should also be used, and any findings that converge are more likely to be credible (Hurlburt and Schwitzgebel, 2007, p. 186, 2011a; Millière et al., 2018, p. 18).

Future Research

A sensible next step in exploring silence/quietness as a feature of the goal-states in the three practices would be to conduct participant-based studies. Those studies could use interviews (e.g., Lindahl et al., 2014), questionnaires (e.g., Kok and Singer, 2017), micro-phenomenology (e.g., Przyrembel and Singer, 2018; Petitmengin et al., 2019), or some other method. The studies could focus on meditation experts, layperson meditators, or both.

The current paper suggests two research questions that could be examined in participant-based studies: Do meditators conceive silence/quietness as reflecting purely the absence of thoughts and sounds, or do they see it as extending to the absence of other disturbances? And, how do meditators distinguish between silence/quietness and other features such as stillness?

One impediment to the participant-based research is that achieving the Shamatha goal-state is said to be extremely rare (Wallace, 1998/2005, p. 219, 2006a, p. 147). For Shamatha, researchers may be better off focusing on silence/quietness in advanced interim-states. In those states meditators are also said to be largely undisturbed (**Supplementary Table S1**, section "The Ten Stages").

Another option for future research is to use evidence synthesis or participant-based studies to investigate silence/quietness as a feature of contentless experiences in other practices. The method and database presented in this paper could easily be extended to another tradition.

CONCLUSION

The current paper is the first evidence synthesis based on expert texts to examine the experience of silence in Shamatha, TM and Stillness Meditation. Evidence synthesis is a robust and transparent scientific method. It was used in the present paper to generate a database containing descriptions of the meditation techniques and experiences extracted from the expert texts. The database runs to nearly 200 pages and is based on a detailed review of 135 publications. It has been coded – or organized – to identify individual features of the techniques and experiences, including silence/quietness and each other feature of the goal-states referred to in the expert texts.

Based on the database we made the following findings concerning the feature silence/quietness: (a) The experts frequently present it alongside other features; (b) The terms silence and quietness are often used without elaboration as to their precise meaning; (c) The experts suggest that it has a particular connection to stillness, and the absence of concepts, mental activity/noise, thoughts, and disturbance; and (d) They indicate that it is in some sense complete.

Analysis of the findings led to the following additional insights. The terms silence and quietness reflect the absence of thoughts and sounds. In general, the experts do not clearly indicate that the terms can extend to the absence of other disturbances, but they leave room for that interpretation. It is not clear from the expert texts exactly how the feature silence/quietness is distinct from other features such as stillness that may also reflect the absence of disturbances. As a separate matter, the absence of disturbances can be treated as central to silence/quietness, but silence/quietness is also connected to the other features of the goal-states in varying degrees.

As shown by the findings and insights above, the evidence synthesis identifies fine distinctions and areas of ambiguity within the expert texts. These lead to new research questions which can be investigated in participant-based studies or other text-based studies with the aim of achieving greater clarity. The findings, insights, and paths for future research in this paper

demonstrate the value of investigating silence/quietness using evidence synthesis.

DATA AVAILABILITY STATEMENT

All datasets generated for this study are included in the article/**Supplementary Material**.

AUTHOR CONTRIBUTIONS

TW wrote the first draft of the manuscript and compiled the database. All authors contributed to the conception and design of the project, and to manuscript revision.

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SUPPLEMENTARY MATERIAL

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Consciousness Without Content: A Look at Evidence and Prospects

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Many traditions in the East have proposed that consciousness without content is possible and could be achieved with mental training. However, it is not clear whether such a state is possible given that intentionality is a critical property of mentality and consciousness in many theories of consciousness. A prominent recent attempt to account for such states of "minimal phenomenal experience" is the ascending reticular arousal system (ARAS) model, which proposes a specific type of non-conceptual representational content to address such a state. Consciousness without content can also be understood by studying related or similar states of minimal phenomenal experience and this paper discusses such findings from such states including dreamless sleep experience and their implications. One way to argue for the need for proposing consciousness without content is to locate a property of consciousness that would necessitate postulating it. A continuous state of consciousness without content may be needed to understand continuity of conscious experience. Finally, I discuss the implications of consciousness without content for current theories of consciousness.

Keywords: consciousness, *Turiya* state, continuity of conscious experience, dreamless sleep, minimal phenomenal experience

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INTRODUCTION

Multiple contemplative traditions report exceptional experiences and these experiences pose critical questions for the study of consciousness (Thompson, 2014; Metzinger, 2019). These exceptional experiences have been used to characterize and define states of consciousness. One of the earliest writings on states of consciousness comes from the Upanishads (Olivelle, 1998; Thompson, 2014). Verse 7 of the Mandukya Upanishad mentions four states of consciousness. Three states of consciousness are familiar, which are wakefulness, dreaming, and sleep. The most interesting and unusual is the fourth state called *Turiya*. *Turiya* is defined as follows: "They consider the fourth quarter as perceiving neither what is inside nor what is outside, nor even both together; not as a mass of perception, neither as perceiving nor as not perceiving; as unseen; as beyond the reach of ordinary transaction; as ungraspable; as without distinguishing marks; as unthinkable; as indescribable; as one whose essence is the perception of itself alone; as the cessation of the visible world; as tranquil; as auspicious; as without a second. That is the self (atman), and it is that which should be perceived (Olivelle, 1998, p. 475)." *Turiya* is also mentioned in other Upanishads

as well; for example, in Brihadaranyaka Upanishad, chapter 5.14.3 (Olivelle, 1998). *Turiya* is not simply another state of consciousness but is considered the basis of all the other three states of consciousness. Given this conceptualization, the possibility of *Turiya* has important implications for theories of consciousness (Metzinger, 2019).

A variation of the concept of *Turiya* can be found in Kashmir Shaivism (Lakshmanjoo, 2015, 2017). According to this, there is a junction between each of three states, wakefulness, dreaming, and deep sleep. *Turiya* can be experienced in these junctions with practice. Some minor Upanishads and Kashmir Shaivism also propose a fifth state of consciousness called *Turyatita*, which is a state beyond *Turiya*. Kashmir Shaivism also talks of seven states of *Turiya* or bliss (Lakshmanjoo, 2017) in terms of progressive steps achieved through practice. These include *nijananda* (the bliss of your own self), *nirananda* (devoid of limited bliss), *prananda* (the bliss of breathing), *brahmānanda* (the bliss which is all-pervading), *mahananda* (the great bliss), *cidānanda* (the bliss of consciousness), and *jagadānanda* (universal bliss).

Buddhists also talk about different states or planes of consciousness. They mention four planes of consciousness, in which the fourth plane is called *Lokuttara*, which is unintentional consciousness (*nirvana*). *Nirvana* is a pure conscious state (Rao and Paranjpe, 2015). In later schools like *Vajrayana*, Buddha Nature (ultimate reality) is defined as permanence, bliss, purity, and self (Takasaki, 1966). The state of consciousness without content is problematic because such states are described as being non-intentional. Recent attempts to understand such states characterize non-dual consciousness in terms of multiple dimensions, which include presence or being, emptiness, non-representational reflexivity, bliss, luminosity, continuity, and singularity (Josipovic, 2019; Josipovic and Miskovic, 2020).

On a first pass, the definition of *Turiya* as given in the Upanishads or *samadhi* or *nirvana* seems formidable and difficult to capture by empirical methods. It is also possible that pure consciousness is conflated with absorption states like *samadhi* (Joispovic and Miskovic, 2020). So, the first question ignoring the difficulties posed by the definition is whether *Turiya* exists. If it does not exist (as defined?), then how do we understand the *Turiya* experience and how do we explain it? This paper will discuss one such prominent attempt, which is the ascending reticular arousal system (ARAS) model by Metzinger (2019).

If a state of consciousness without content (*Turiya* or *Nirvana*) does exist, then how do we study it? This paper sympathetically explores the possibility of consciousness without content and discusses possible ways to attack this problem. One possibility is to link it to states of consciousness or minimal phenomenal experience that are close in nature, study them, and interpolate (Baars, 2013; Windt, 2015). The second possibility is to argue for a need to postulate consciousness without content to explain specific properties of consciousness. In this paper, I will focus on the continuity of conscious experience and whether this necessitates postulation of consciousness without content, primarily based on Buddhist theories of consciousness. Finally, I will discuss current scientific theories in the context of consciousness without content.

A MODEL OF MINIMAL PHENOMENAL EXPERIENCE (MPE)

The nature of consciousness and its phenomenal properties have also been investigated in western philosophy (Tye, 1997). For example, Metzinger (2019) quotes from Moore (1903) regarding transparency: "the moment we try to fix our attention upon consciousness and to see what, distinctly, it is, it seems to vanish: it seems as if we had before us a mere emptiness. When we try to introspect the sensation of blue, all we can see is the blue: the other element is as if it were diaphanous (Moore, 1903, p. 450)." The argument is that we can access only content but not content-carrying vehicle properties. Consciousness without content is not possible and consciousness is a second-order process. The second-order meta-awareness is generally not noticed but can be noticed through attention.

Based on phenomenological reports and analysis, Metzinger (2019, 2020) postulates certain phenomenological constraints for the minimal phenomenal experience (MPE). They are tonic alertness, absence of intentional content or content of "absence," self-luminosity, introspective availability, epistemicity, and transparency. A state of full absorption is mostly characterized by wakefulness and self-luminosity. Lucid dreamless sleep is also somewhat similar to the state of full absorption, which is discussed in the next section.

Metzinger (2019) defines the minimal form of experience as: "constituted by the content of a predictive model serving to control and regulate the global signal of the ARAS, which in turn determines the brain's general level of activation (pp. 1)." The model argues that this minimal phenomenal experience appears to be empty because it models a hidden cause of the ARAS signal, which is non-intentional vehicle property. The choice of the ARAS is due to its strength and its non-representational nature and this system needs to be controlled to obtain optimal level of arousal. While the ARAS signal itself is continuous, the ARAS model is discrete. In Metzinger (2020), the minimal phenomenal experience is defined in terms of a representation of tonic alertness maintained by the cingulo-opercular network (Sadaghiani and D'Esposito, 2015).

The model in essence argues that content-less consciousness is an illusion and the pure consciousness state actually has non-conceptual representational content. To be more specific, the model argues that the non-conceptual content is "empty" or "non-representational." The "content-less" phenomenal state actually carries an abstract form of intentional content. Metzinger (2019, 2020) raises questions about taking the phenomenological reports as they are in terms of no-content. If it is the case that there is no sense of self or time, how could one remember that one was in such a state sans content or remember the duration or onset of such a state? In addition, it points to the fact that the experience and its report could be affected by the expectations and theories associated with such experiences in various contemplative traditions.

STATES CLOSE TO CONSCIOUSNESS WITHOUT CONTENT

Irrespective of whether the state of consciousness without content is actually without content or a special content (Metzinger, 2019), it is important to study such a state or reported experiences of such a state. Whether truly consciousness without content is possible or not, some have suggested focusing on states with minimal content as a way to get closer to reported experiences of such non-content states (Baars, 2013). Such suggestions include experiences based on repetition including Ganzfeld experiences and near threshold attending (Baars, 2013).

One possible way to study them would be to study neural measures associated with such a state with meditators who claim to experience such states (Hinterberger et al., 2014). In this electroencephalogram (EEG) study with experienced meditators, participants were asked to perform different types of meditation, which included thoughtless emptiness, focused attention, and open monitoring. Results showed that thoughtless emptiness is characterized not just by reduction in power of high frequencies but also low frequencies in EEG. In a more recent study (Winter et al., 2020) with a single experienced Buddhist meditator, conscious state without content was reported toward the end of the meditation session. EEG results showed a reduction in alpha power and increase in theta power during the self-reported content-free awareness period compared to the rest. The functional connectivity results showed decreases in the posterior default mode network and increases in connectivity in the dorsal anterior network. A direct comparison of the EEG results from the two studies show that the spectral analysis results do not confirm with each indicating the potential difficulties with studying such a state using EEG at present.

Some neural areas or systems have been proposed to underlie MPE states (Baars, 2013; Hinterberger et al., 2014; Josipovic, 2019). One proposal is the central precuneus network (Josipovic, 2014, 2019), which shows increased connectivity between central precuneus and the dorsolateral prefrontal cortex and could underlie nondual awareness. Another neural measure that has been proposed for minimal phenomenal experience is larger theta-alpha power perhaps accompanied by much reduced power in beta or gamma frequency ranges (Baars, 2013). Studies on sensory deprivation have also been used to study MPE states (Ben-Soussan et al., 2019) and insula has been proposed an important area for such states. However, there is very little conclusive evidence for neural mechanisms that underlie such states at the current juncture. It is also not clear whether these states have anything in common, which can also be discerned from the different neural substrates proposed in different studies (Baars, 2013; Hinterberger et al., 2014; Josipovic, 2014).

Dreamless Sleep Experience

Windt (2015) proposes that "dreamless sleep experience can be described as pure temporal experience (pp. 35)" and could be considered a minimal phenomenal experience. In this state of dreamless sleep experience, there is experience of time but without any intentional content. The nature of dreamless sleep has been debated among different Indian philosophical systems (Thompson, 2014; Windt, 2015). Different Indian philosophical systems allow or disallow cognitive states without content. For example, the *Nyaya* does not allow objectless cognitive states but *Advaita* does. A state of consciousness without content or a pure temporal experience without content is possible according to *Advaita*. Given that pure self or consciousness is always present, *Advaita* argues that consciousness is present during dreamless sleep.

During such a dreamless sleep experience, the experience is that of a no-self and no intentional content. Windt (2015) argues that this experience can be understood as a phenomenal "now." Using Husserl's notion of retention (Husserl, 1991), Thompson (2015) argues that the recognition of absence of self and intentional content can possibly be based on retentional aspects of the "now." While acknowledging, the possibility of dreamless sleep experience as a MPE, Metzinger (2019) points out potential issues with the characterization of dreamless sleep experience. These include contentlessness, atemporality, and epistemicity. The notion of an empty phenomenal now is not clear and phenomenology of the experience of consciousness without content is that of a lack of sense of time. In addition, Windt (2015) account does not take into account "passive, non-agentive knowing," which captures the notion of "witnessing sleep." These considerations pointed by Metzinger (2019) are critically important for not just dreamless sleep experience but also other MPE states, both in terms of similarities and differences.

CONTINUITY OF CONSCIOUS EXPERIENCE

One important debate about conscious perception is whether it is continuous or discrete (VanRullen and Koch, 2003; Dainton, 2014; Herzog et al., 2016; Fekete et al., 2018; White, 2018). It has been argued that conscious perception is discrete and the continuity of experience is as such an illusion (VanRullen and Koch, 2003; Herzog et al., 2016). Models of time perception, more specifically cinematic models assume discrete frames and imply that continuity of temporal experience is an illusion (Dainton, 2014).

Discrete models of perception generally assume that unconscious integrative processes occur over time and once the integration is complete, this results in all at once in conscious perception. This has been postulated to take around 100–500 ms. It has been argued that the conscious percept is an attractor in phase space (Herzog et al., 2016). Studies on attention have argued that attentional sampling is discrete (around 7–8 Hz) and this is a possible factor that underlies the discreteness of perception (VanRullen and Koch, 2003; VanRullen, 2016).

Arguments have been raised against the discrete model of mind or conscious perception (Spivey and Dale, 2006; Fekete et al., 2018; White, 2018). The proponents of continuous-time models of perception argue that the putative evidence for discrete perception is also consistent with continuous-time models of perception. Occasionally, the

duration of the stimulus needed to consciously perceive a stimulus is conflated with the duration or timing of conscious experience (Thompson, 2014, p. 46–48).

White (2018) questions the boundaries of discrete temporal windows of momentary awareness, given that we already know that different perceptual modalities have different temporal resolutions. A gap of 30 ms may be required to segregate two flashes in foveal vision but a gap of 2–5 ms is enough to segregate two tones. In addition to temporal resolution differences across modalities, such differences also exist for different features within modalities. A classic example is the trade-off between peripheral and central vision in terms of spatio-temporal resolution. Moreover, integration of visual-auditory information themselves involve different timescales and our perceptual system can tolerate small asynchronies between the two (sounds and sight), still representing them as co-synchronous even with offsets around 50–100 ms to produce a unified audio-visual experience. White (2018) also considers the ability of such frames to explain feelings of flow, succession, and persistence of experiences beyond and within these frames. Would these problems be addressed by proposing a fourth state that is content less, non-representational, and continuous that underlie our experience?

The answer to the question of continuity (apparent or real) may have implications for the notion of consciousness without content. Different Indian systems argue for or against the continuity of consciousness (Waldron, 2003; Thompson, 2015). Many early Buddhist (Theravada and some Mahayana) theories argue for discrete moments of experience (Collins, 1982; Waldron, 2003; Thompson, 2015). However, for Buddhists, the discrete theories of consciousness do pose a problem in explaining other aspects of mind and consciousness. To quote from Evan Thompson, "How consciousness manages to function coherently, given that it is gappy. If consciousness is strictly momentary, in the sense that there is no consciousness whatsoever that persists during the gaps, then what accounts for its coherent functioning, not only from moment to moment but also across longer stretches of time? For example, what accounts for longer-lasting traits of consciousness, such as the attentional stability arising from meditation practice? Why do not the gaps between moments of awareness disrupt these continuities? (pp. 58)."

Different solutions have been proposed by different schools of Indian thought (Waldron, 2003; Thompson, 2014). The Theravada school distinguishes between active consciousness versus passive consciousness. Active consciousness is about the differing contents of experience. Here, passive consciousness is the basis of continuity of individual; "Life-continuum" or "factor of existence (*bhavanga*)." The passive exists only in the gaps between active (Waldron, 2003).

The Yogacara school argues for a underlying more base consciousness, which is continuously present at all time – *Alaya-vijnana* (store consciousness). The *alaya-vijnana* is the basis for cognitive awareness (which is probably discrete). This *alaya-vijnana* has no "I" or perspectivalness and it is the ego consciousness that brings in the "I (Waldron, 2003; Thompson, 2014)."

Sometimes *bhavanga* and *alaya-vijnana* have been interpreted as an unconscious base, which makes consciousness possible (Waldron, 2003; Rao and Paranjpe, 2015). If *bhavanga* or *alaya-vijnana* is interpreted as unconscious (but still presumably part of the mind) but continuous, then it is not clear what provides the continuity of conscious experience and it seems to simply move the problem of continuity of consciousness to continuity of non-consciousness. In addition, the term awareness or consciousness is explicitly used in many Buddhist texts in discussing *bhavanga* or *alaya-vijnana*. *Alaya-vijnana* is translated as store-house consciousness and need not be interpreted as an unconscious process (Kalupahana, 1992).

Generally, Buddhist theories of time assume time to be discrete (Collins, 1982; Waldron, 2003; Thompson, 2014). Theravada assumes that *bhavanga* itself is discrete and made of finer moments than consciousness with content. This stance implies that even *bhavanga* is gappy. It has been argued with consistent meditative practice that this momentariness may become perceivable. However, even if this is true then those who meditate should report a somewhat choppy consciousness without content experience. This is not usually reported even though loss of self and time are reported (Ataria et al., 2015).

Hierarchical theories of time perception assume time scales generally in the 30–100 ms range to a few seconds range (Pöppel, 1997). If *bhavanga* is made of moments and then is at a scale much smaller than 30 ms range, then these moments could be even of the order of less than 1 ms. From what we know of neuronal firings and their time scales, the discrete frames for a *bhavanga* would require neurons firing rates that would be difficult given their physical limitations. Of course, one can argue that *bhavanga* as fine discrete moments is not based on neuronal activations or new finer mechanisms would emerge but at this point there are no clear possible mechanisms available at such a fine temporal scale. The hierarchical nature of time perception itself can possibly achieved with nested, synchronized activity of populations of neurons oscillating at different frequencies, which are coupled and interact with each other (Roux and Uhlhaas, 2014).

Buddhist theories, in general, do use the metaphor of the stream of consciousness and especially describe *alaya-vijnana* as stream. Some have used *citta-santāna* or mind-stream as a synonym or alternative for *alaya-vijnana* (Lusthaus, 2013). For example, Kalupahana (1992) says "Instead of being a completely distinct category, *alaya-vijnana* merely represents the normal flow of the stream of consciousness uninterrupted by the appearance of reflective self-awareness. It is no more than the unbroken stream of consciousness called the life-process referred to by the Buddha. It is the cognitive process, containing both emotive and conative aspects of human experience, but without the enlarged egoistic emotions and dogmatic graspings characteristic of the next two transformations."

Representational theories of consciousness like the global workspace theory (Baars, 2013) are generally not concerned with properties of conscious experience like continuity. The ARAS model postulated to handle MPEs is a special

representational model and *prima facie*, it appears that is not concerned with explaining specific phenomenological aspects like continuity of conscious experience (Metzinger, 2019). In addition, while the ARAS signal is continuous, the ARAS model itself is not continuous.

CONSCIOUSNESS WITHOUT CONTENT AND THEORIES OF CONSCIOUSNESS

A prominent cognitive theory of consciousness is the global workspace theory (Baars, 2013). The global workspace theory, at its core, is a representational or functionalist theory. What one is conscious of is what is globally broadcasted in the brain or mind. If this is the case, and if consciousness is present without content, then this would imply that nothing is broadcast. This seems to go against global work space workspace theory and representationalist theories, in general (unless the no-content is made into a special non-intentional, non-conceptual content as in the ARAS model). Even if somehow workspace itself is represented and there is no other content, this would still be semantic content (Josipovic, 2019). The maintenance of any content in the global workspace would still need attention and monitoring.

While Baars (Baars, 2013; Josipovic and Baars, 2015) seems to be sympathetic to the possibility of consciousness without content, the implications of consciousness without content for global workspace needs to be explored in detail. It appears that *alaya-vijnana* or *bhavanga* awareness cannot be easily accommodated by purely content-based theories of consciousness, since processes operating on content are what makes cognitive or access consciousness possible.

How would other theories of consciousness address the possibility of consciousness without content? For example, consciousness has been conceptualized as a meaning-making process or producing information (Marchetti, 2018). Marchetti (2018) focusing on the content of conscious experience say that "the content of CI coincides with its form." Given this conceptualization, it is not clear how consciousness without concept can be conceptualized. One could argue for the notion of "pure attention" as a process that does not have content but holds the system in a state of readiness within this theoretical framework (Marchetti, 2018). This is somewhat akin to the proposal of tonic alertness as a possible representational substrate for minimal phenomenal experience (Metzinger, 2020).

Integrated information theory (IIT) is another prominent theory that has been proposed to understand consciousness (Tononi, 2004; Tononi et al., 2016). Tononi et al. (2016) state "Similarly, IIT predicts that the cerebral cortex as a whole may support experience even if it is almost silent, a state which may perhaps be reached through meditative practices designed to achieve 'naked awareness' without content (pp. 460)." They also state "States of naked awareness could be compared with states of unawareness that occur, for example, during deep sleep or anesthesia, when the cause-effect repertoires of cortical neurons, regardless of the level of neuronal activity, are disrupted as a result of bistability (pp. 460)."

Dimensional models of consciousness (Berkovich-Ohana and Glicksohn, 2014; Paoletti and Ben-Soussan, 2019, 2020) also try to account for consciousness without content and how they can be achieved. In these dimensional models, time and emotion constitute two dimensions. The third dimension varies: access, varying from low accessibility to high accessibility (Berkovich-Ohana and Glicksohn, 2014) or motivation/self-determination (Paoletti and Ben-Soussan, 2020). The time axis goes from past to future and the emotion axis goes from reward to punishment. They intersect at a point which represent "present" in the time axis and zero emotion in the time axis. Defined in terms of access to awareness (Berkovich-Ohana and Glicksohn, 2014), the third axis goes from minimum access to maximum access or no-access to maximum access. In terms of self-determination (Paoletti and Ben-Soussan, 2019, 2020), the focus is on a particular form of intentionality to act and being aware. The origin or intersection of the all three dimensions possibly represents the state of consciousness without content, which they call the "place of pre-existence" (Paoletti and Ben-Soussan, 2019). It has been argued that such a state of no-self and lack of content is achieved through meditation or possibly sensory deprivation.

How would predictive processing theories handle consciousness without content? Some recent attempts have been made to understand meditation and meditative experience in the context of the predictive processing approach (Lutz et al., 2019; Pagnoni, 2019). Focused attention meditation can be conceived as a way to minimize prediction error through the processes of focusing attention and eliminating distractions with practice (Lutz et al., 2019). If we regard the mind as a hierarchical predictive control system (Jordan, 2003; Kumar and Srinivasan, 2012, 2014), then perhaps one is in a state of effortless perception in which prediction errors at all hierarchical levels are zero. This would include the ability to predict not signals from external environment but interoceptive signals from the body itself, which would need the ability to control the body as well. The ability to control both the body and mind is possible only through interactions with environment, which may partially address the dark room problem (Friston et al., 2012). If consciousness without content is possible, then it is not necessary to have a dark room *per se* to have absence of content in experience. If it is so, predictive processing theories may need to explain how it is that we have conscious experience, when there is no content (or minimal content) about which predictive inference needs to be made. Of course, it has been argued that the content is a special type of content, which gives rise to the phenomenological experience of no content (Metzinger, 2020). A speculative solution to this would be continuous-time models of perception, which can realize hierarchical predictive inference (Fekete et al., 2018) and may involve prediction of the vehicle (*bhavanga* or *alaya-vijnana*) alongside content of consciousness. That is predictive inference not just about the content of experience but also the dynamical structure of experience embedded possibly on a base consciousness.

One of the phenomenal aspects that is very rarely considered in most of these models or theories of consciousness, is *Ananda* or bliss. As discussed earlier, the Kashmir Shaivists talk of

seven different states of bliss associated with *Turiya* (Lakshmanjoo, 2017). Since emotions or feelings are thought to be intentional mental states, it is not clear why there should be a reported experience of bliss, if there is no content. Consistent with this argument, bliss is not a phenomenal constraint for MPE according to Metzinger (2019). In the spherical models of consciousness (Berkovich-Ohana and Glicksohn, 2014; Paoletti and Ben-Soussan, 2019), the putative point in the three dimensional space representing a state of consciousness without content has zero emotion (neither pleasant nor unpleasant). It is not clear why this point is associated with reports of bliss. Proposers of nondual awareness do include bliss as one of the dimensions of such an awareness (Josipovic, 2019). The term *Brahman*, the underlying reality according to the Upanishads is generally characterized as *sacchidananda* (*sat* – existence or truth, *cit* – consciousness, and *ananda* – bliss). It could be important to consider how *ananda* is linked to consciousness without content or MPEs, in general.

CONCLUSIONS

The presence or absence of content-less state of consciousness has important implications for theories of consciousness (Metzinger, 2019). Many current conceptions of consciousness do not consider a content-less state of consciousness as a possibility and would need to be significantly altered if such a state is possible. We need novel paradigms to study and theorize about such states of consciousness without content or minimal phenomenal experience. A thorough understanding of the phenomenal properties of consciousness and its links to functional or neurophysiological aspects would enable us build a comprehensive theory of consciousness (Josipovic and Miskovic, 2020; Metzinger, 2020). The current paper suggests that focusing on the continuity of conscious experience may necessitate proposing consciousness without content a theoretical necessity. Such states of consciousness have been reported for a long time among practitioners in various contemplative traditions and there is a need to take them seriously to eventually understand consciousness. It also seems to be the case that realizing such an experiential state seem to change one's life in a significant manner. Hence there is also a need to measure the impact of having experienced such a state in day to day life of those practitioners.

AUTHOR CONTRIBUTIONS

The author confirms being the sole contributor of this work and has approved it for publication.

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Molecules of Silence: Effects of Meditation on Gene Expression and Epigenetics

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Many studies have consistently demonstrated an epigenetic link between environmental stimuli and physiological as well as cognitive responses. Epigenetic mechanisms represent a way to regulate gene activity in real time without modifying the DNA sequence, thus allowing the genome to adapt its functions to changing environmental contexts. Factors such as lifestyle, behavior, and the practice of sitting and moving mindful activities have been shown to be important means of environmental enrichment. Such practices, which include mindfulness meditation, Vipassana, Yoga, Tai Chi, and Quadrato Motor Training, have been reported to positively impact well-being. In fact, they can be considered emotional and attentional regulatory activities, which, by inducing a state of greater inner silence, allow the development of increased self-awareness. Inner silence can therefore be considered a powerful tool to counteract the negative effects of overabundant environmental noise, thanks to its power to relieve stress-related symptoms. Since all these positive outcomes rely on physiological and biochemical activities, the molecular and epigenetic mechanisms influenced by different mindful practices have recently started to be investigated. Here, we review some of the findings that could allow us to uncover the mechanisms by which specific practices influence well-being.

Keywords: meditation, silence, epigenetics, epigenetic marks, gene-expression, mindfulness

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INTRODUCTION

According to the most recent definition given by Cavalli and Heard (2019), epigenetics refers to "the study of molecules and mechanisms that perpetuate alternative gene activity states in the context of the same DNA sequence" (Cavalli and Heard, 2019, p. 489). The activity of genomes is deeply impacted by environmental and lifestyle factors that interface with the genetic information. Epigenetic mechanisms do not change the DNA sequence; instead, they generate different and interchangeable structural states that modify gene activity. These mechanisms include interdependent modifications of DNA and of chromatin, the histone protein structure that compacts DNA in the cell nucleus. These modifications can be grouped into three main categories: DNA methylation, modifications of histones, and small non-coding RNAs. Placement of these epigenetic marks is spatially and temporally controlled and exerts gene-expression regulatory

functions. For instance, the addition of methyl groups to cytosines causes the condensation of chromatin, which renders the DNA unavailable to the transcriptional machinery leading to gene silencing. Similarly, acetylation and deacetylation of histones loosen and tighten chromatin, respectively, thus creating "open" or "closed" domains of gene activity along the genome. Finally, microRNAs can control the stability and access of mRNAs to the translation machinery, with an impact on protein production (Cavalli and Heard, 2019).

Mindful practices have long been suggested to promote well-being by producing a state of body relaxation and inner silence, i.e., a state of quiet mind and emotions characterized by the absence of recurring thoughts, images, and emotional fluctuations (Ben-Soussan et al., 2019). Inner silence therefore counteracts the negative effects of the increasing environmental noise reported by the World Health Organization (2011). Consequently, a wide variety of mindful practices stemming from oriental traditions have been introduced in western societies following the impelling demand to increase self-awareness, improve health, and ameliorate the quality of daily life. These practices include a spectrum of meditations, both sitting (i.e., mindfulness meditation, Vipassana, breathing attention) and moving (Yoga, Tai Chi, and Quadrato Motor Training), all of which share the common goal of achieving a state of silence of mind, with positive repercussions on emotional regulation and health. The evidence for their effectiveness is growing and promising mind–body practices are emerging as complementary to more conventional therapeutic interventions. In fact, a considerable amount of literature suggests that mind–body activities can alleviate stress-dependent symptoms of various diseases including psychological disorders (e.g., mood and anxiety disorders), inflammatory diseases, aging, and cancer (Abbott and Lavretsky, 2013; Bower et al., 2015; Chételat et al., 2018). However, although it is likely that related outcomes might be mediated by changes in the levels of some humoral, immune, and neurological factors, the molecular mechanisms underlying the benefits of mind–body interventions remain poorly understood. The analysis of human peripheral tissues (e.g., blood and saliva) has started to show that various types of meditation can reduce levels of the stress hormone cortisol and of reactive oxygen species (ROS), as well as stimulate anti-inflammatory cytokines, endorphins, and neurotrophins (Kasala et al., 2014; Pascoe et al., 2017). In addition, some authors have traced the effect of meditation on such effector molecules back to expression changes of the corresponding genes and, more recently, to specific mechanisms that regulate gene expression (Buric et al., 2017; Kaliman, 2019). The above observations raise the intriguing idea that mindful practices influence the body by means of epigenetics. However, at present, because of the relative novelty of the field, a unifying view of the molecular pathways underlying the benefits conveyed by meditation and a direct correlation between inner silence and specific epigenetic signatures is still lacking. In the current mini-review, we intend to give a summary of the most recent advances in the field of molecular and epigenetic effects of inner silence-inducing activities.

EPIGENETICS, STRESS, AND THE IMPORTANCE OF MINDFUL ACTIVITIES

During the past 15 years, many studies have correlated alterations of epigenetic marks with conditions of physiological and psychological stress (Szyf, 2012; Provençal et al., 2013; Turecki and Meaney, 2016). Altered profiles of whole-genome DNA methylation were found in brain specimens associated with early-life adverse experiences and in different conditions, such as post-traumatic stress disorder (PTSD; Roth et al., 2011; Roth and Sweatt, 2011) and altered parental care (Weaver et al., 2004; Naumova et al., 2012) in animal models, and mood disorders in humans (McGowan and Kato, 2008). In addition, alterations of histone acetylation profiles and of small non-coding RNAs activity have been found in depression (reviewed in Misztak et al., 2018; Yuan et al., 2018, respectively). Genes affected by differential epigenetic regulation range from modulators of the immune response (i.e., cytokines; Provençal et al., 2013) and glucocorticoids in the hypothalamic–pituitary–adrenal (HPA) axis (Tyrka et al., 2016; Argentieri et al., 2017) to neurotrophins such as brain-derived neurotrophic factor (BDNF) and nerve growth factor (NGF) involved in neuroplasticity, learning, and memory (Roth and Sweatt, 2011).

One key feature of epigenetic information is its potential reversibility. For example, interventions aimed at improving life conditions and behavior (i.e., education, exercise, diet, sleep) were associated with changes in DNA methylation profiles (Naumova et al., 2012; Quach et al., 2017). Early studies of environmental enrichment in rodents (i.e., a combination of multisensory/cognitive stimulation and increased physical activity that enhances social interactions and explorative behavior in mice) showed positive association with improved social behavior and coping with stress, elicited by increased histone acetylation in the hippocampus and neocortex as well as increased production of BDNF (Baroncelli et al., 2010). Moreover, environmental enrichment was associated with decreased DNA methylation at glucocorticoid receptor gene promoter (Gapp et al., 2016) and microRNA-mediated up-regulation of BDNF (McCreary et al., 2016).

In humans, in addition to the beneficial effects of an appropriate lifestyle as reported above, mental and emotional health can be ameliorated by the experience of inner silence, which induces a state of equanimity and leads to improved attention and increased relaxation. To this end, many types of meditation techniques that help reach awareness and reflectivity have been proven to be highly effective. It is therefore of great relevance to investigate whether these practices could reproduce in humans the epigenetic effects elicited by environmental enrichment in rodents and, more importantly, whether it would be possible to identify a specific epigenetic signature for the state of inner silence. In fact, identification of meditation-induced epigenetic marks on the genome may provide critical information on epigenetically modified genes

and pathways underlying the association between meditation and mental/emotional health amelioration and may help uncover new targets for therapeutic intervention.

Molecular and Epigenetic Effects of Movement Meditations

Yoga, Tai Chi, and Qigong

Yoga, Tai Chi, and Qigong can improve attention, self-control, and mindfulness by helping to achieve inner silence through movement. Several studies have addressed the physiological effects of these practices at the molecular level.

Yoga was shown to improve the redox state of the body by reducing ROS levels, known to cause inflammation and accelerated aging (Dada et al., 2015; Mohammad et al., 2019). Moreover, Yoga can help cope with stress conditions as shown by reduction of serum cortisol *via* the HPA axis (Tolahunase et al., 2017). However, some authors consider the Cortisol Awakening Response (CAR) a more appropriate measure of stress resilience. In the study by Cahn et al. (2017), CAR appeared significantly increased after training. Importantly BDNF, a central regulator of neuroplasticity, was also found to increase following practice both in healthy (Cahn et al., 2017; Tolahunase et al., 2017) and depressed (Naveen et al., 2013, 2016) subjects. Since BDNF can cross the blood–brain barrier, it is possible to assume that peripheral BDNF levels may reflect those in the brain (Cattaneo et al., 2016). These results suggest that Yoga may counteract neurodegenerative processes triggered by various types of stress by reducing cellular aging and preserving neuroplasticity in the brain. Finally, reduced plasma cortisol levels and increased BDNF were associated with cardiovascular health (Pal et al., 2014). Similarly, the practice of Tai Chi and Qigong was shown to improve immune function by reducing plasma inflammatory cytokines (Campo et al., 2015). Moreover, increased blood levels of endorphins and reduced levels of adrenocorticotropic hormone (ACTH) and cortisol (Ryu et al., 1996; Lee et al., 2004) indicate a positive impact on the HPA axis.

Genome-wide approaches to gene activity, using both plasma and blood samples, have started to be employed to elucidate the effects of mind–body activities (reviewed in Buric et al., 2017) on gene modulation. The first microarray analysis of global mRNAs was carried out in a cross-sectional pilot study of Qigong long-term practitioners. Results showed modulation of several sets of genes having common functions, related to enhanced immunity, lower cellular metabolism, and delayed cell death (Li et al., 2005). Subsequent longitudinal observations revealed that Yoga was able to induce rapid gene expression changes in PBMCs (peripheral blood mononuclear cells, Qu et al., 2013). Similarly, differential expression of genes related to type I interferon response and inflammation was reported following daily Yoga in a population of breast cancer survivors (Bower et al., 2014). In addition, a number of microarray studies revealed transcription profile changes following Tai Chi, involving pathways of inflammation, antiviral response, energy and adrenergic activation, in PBMCs (Irwin et al., 2014, 2015; Kinney et al., 2019).

While differential gene expression and protein levels appear, in most cases, correlated and coherent with the observed biological effects, the mechanisms involved are mostly unknown. However, the involvement of epigenetic regulation seems to be the most likely scenario. Nevertheless, research on epigenetic profiles following mindful movement practices is rare, with only two published studies involving Yoga and Tai Chi practitioners. DNA methylation occurs predominantly at CpG sites located at promoter regions that are known to undergo age-related changes (Fraga et al., 2005; Hannum et al., 2013). The first cross-sectional study, by Ren et al. (2012), analyzed the epigenetic effects of Tai Chi on the methylation of 66 sites using saliva samples from experienced practitioners. They observed that 6 CpG sites on different chromosomes showed significant differences between the trainees and controls. Interestingly, these authors reported that the age-related methylation trend at those CpGs was slower in the Tai Chi group *vs* the controls. Since the age-related decline of DNA methylation reflects the gradual deterioration of important regulatory functions of the genome, the authors speculated that the practice of Tai Chi might protect against the age-related decay of the epigenome. Subsequently, a similar cross-sectional study was conducted by Harkess et al. (2016) who focused on the CpG methylation levels of candidate genes involved in immune function, namely, TNF, IL-6, and CRP, in blood samples of chronically stressed women practicing Yoga compared to a waitlist group. Their main result was that Yoga was associated with hypomethylation of the TNF gene while IL-6 and CRP appeared unaffected. Interestingly, the same result was observed when the waitlist group that later participated in the Yoga intervention was analyzed. However, because of the pilot approach of these studies, further research is required to validate the link between DNA methylation and these practices.

Quadrato Motor Training

Here, we treat Quadrato Motor Training (QMT) as a separate case because its unique feature, to the best of our knowledge not present in other movement meditations (i.e., Aikido; Ben-Soussan et al., 2019), is the requirement for second-by-second response inhibition. QMT is a specifically structured walking meditation, developed with the purpose of balancing the three fundamental components of the human being – body, cognition, and emotion (Dotan Ben-Soussan et al., 2013; Paoletti et al., 2017). QMT consists of a set of recorded oral instructions that guide the individual to move within the corners of a 50 × 50 cm square drawn on the floor, by making 12 possible movements. QMT was shown to increase attention, reflectivity and creativity, and these outcomes were correlated with enhanced neuroplasticity as detailed below (Dotan Ben-Soussan et al., 2013; Ben-Soussan et al., 2014). Reflectivity is the capacity to exercise introspection consciously and requires suspension from the habitual thought, inward attention, and receptivity toward the experience (Depraz et al., 2000). Each step taken in the QMT square is followed by a time of waiting for the next recorded instruction, obliging the subject to suspend the tendency for habitual movement (response inhibition). Therefore, the practice requires and reinforces a state of sustained divided attention between the cognitive processing and the motor response, to take the correct direction at each step. During the period of silent waiting between two movements,

this unique type of attention brings a state of awareness into the experience of movement itself. Therefore, QMT can be conceived as a form of "mindful movement" (Ben-Soussan et al., 2014, 2019; De Fano et al., 2019; Diamond and Ling, 2019).

Electrophysiological and magnetic resonance studies have suggested that QMT can improve reflectivity and creativity by stimulating neuroplasticity processes leading to increased inter- and intra-hemispheric connectivity (Dotan Ben-Soussan et al., 2013; Ben-Soussan et al., 2014, 2015a; Lasaponara et al., 2017; Piervincenzi et al., 2017). Subsequent studies have suggested a link between the QMT-driven neuroplasticity processes and changes in the salivary levels of proBDNF and proNGF (Ben-Soussan et al., 2015b; Venditti et al., 2015; Caserta et al., 2019). In fact, proNGF was found to decrease following 1 month of practice in both adults and children, in association with an improvement of cognitive and metacognitive functions, such as creativity (Venditti et al., 2015). A parallel pilot study reported increased proBDNF following 3 months of practice, and this variation was correlated with an increase in white matter volume in several brain areas, including the corpus callosum, suggesting improved inter-hemispheric connectivity (Ben-Soussan et al., 2015b). A more recent study comparing levels of proBDNF and proNGF showed significantly correlated increases of both neurotrophins after 3 months of practice (Caserta et al., 2019). It is conceivable that these changes represent the link between the cognitive and psychological outcomes and the ongoing QMT-driven increased neuroplasticity. Further studies are now being carried out to answer the question whether these changes reflect differential expression and/or variations of DNA methylation of the corresponding genes.

Effects of Sitting Meditations

There are multiple approaches to meditation, including Transcendental Meditation (TM), Zen meditation, Vipassana, Buddhist meditation, Sudarshan Kriya (SK), Kirtan Kriya (KK), Pranayama, and others. Notwithstanding this variety, they share the common goal of achieving mindfulness, a state of moment-to-moment non-judgmental awareness of the actual experience, possibly reached through a state of inner silence.

The abovementioned meditations have been widely studied from the molecular point of view. They influence the levels of several metabolites and biomarkers like hormones and neurotransmitters, as well as immune and neuroendocrine factors affected by stress and relevant to disease development and progression (Daube and Jakobsche, 2015; Robert-McComb et al., 2015; Twal et al., 2016; Household et al., 2017). For example, TM, SK, and Zen meditation were shown to influence levels of cortisol, serotonin, melatonin, epinephrine and norepinephrine, gamma amino butyric acid (GABA), glutamate, and dehydroepiandrosterone (DHEA; reviewed in Kasala et al., 2014). Nevertheless, although several imaging studies demonstrated that meditation promotes neurogenesis in brain areas involved in cognitive and emotional functions (Tang and Posner, 2014; Lee et al., 2018), studies of neurotrophin levels following meditation are scarce. One report shows increased serum BDNF levels, related to antidepressant activity in subjects practicing SK (Pan et al., 2006). Another study reports on increased salivary NGF following Pranayama (Balasubramanian et al., 2015).

Cross-sectional and longitudinal studies of SK, Pranayama, and KK, using mostly blood samples, in both healthy and clinical populations, found transcriptional changes in common pathways involved in oxidative stress, cell death, aging, cell cycle regulation, and immune response (Sharma et al., 2008; Kumar and Balkrishna, 2009; Black et al., 2013). One interesting case study involving two lifelong expert meditators, able to achieve higher states of consciousness, again revealed differential expression of genes involved in metabolism and cell cycle regulation, immune response, stress response, and cell death (Ravnik-Glavač et al., 2012).

Few epigenetic studies involving experienced meditators were conducted to evaluate possible changes in genome-wide DNA methylation profiling at CpG sites. In the first study, Chaix et al. (2017), using PBMCs, analyzed 353 CpG sites whose methylation level is highly correlated with chronological age across tissues and cell types and represent a measure of epigenetic age (DNAm age; Hovarth, 2013). The deviation between the DNAm age and the chronological age provides information regarding the epigenetic aging rate of an individual (Chen et al., 2016). The study, focused on subjects practicing mindfulness and compassion meditation, revealed that the epigenetic aging rate in meditators is significantly decreased as a function of the practice duration (Chaix et al., 2017). In a follow up of this study, the same authors showed that short meditation interventions can influence the methylome of experienced meditators rapidly, at genes associated with immune metabolism and aging (Chaix et al., 2020). The second methylomic approach, by García-Campayo et al. (2018), compared the methylation profiles obtained from circulating lymphocytes of experienced meditators with more than 10 years of experience with those of meditation-naïve subjects, and identified 64 differentially methylated regions, corresponding to 43 genes involved in glucose homeostasis, lipid metabolism, protein folding, neurotransmission, and modulation of inflammatory pathways.

Effects of Multiple-Meditation Protocols: Mindfulness-Based Stress Reduction

Following the introduction of meditation in Western countries, many combined protocols of mindful practices have been developed and introduced in several clinical contexts. The first ones were the Relaxation Response (RR, Wallace et al., 1971) and the Mindfulness-Based Stress Reduction (MBSR, Kabat-Zinn, 1982). This latter is an 8-week integrated approach, an amalgam of mindfulness meditation, concentrative meditation, breathing exercises, Yoga, autogenic training, and Buddhist philosophy. In recent years many such protocols, combining different techniques to be applied for defined periods of time to various clinical settings, have been developed under various acronyms, such as Mindful Awareness Practices (MAP; Bower et al., 2014), Mindfulness-Based Movement (MBM; Robert-McComb et al., 2015) and more generally standardized as Mindfulness-Based

TABLE 1 | Side-by-side summary of the effects of different meditations.

	Moving meditations				**Sitting meditations**		**Multiple meditation protocols**
	Yoga	**Tai Chi**	**Qigong**	**QMT**	**TM/SK/KK Pranayama**	**Mindfulness**	**MBSR**
Epigenetics	↓ DNAmet at CpGs of TNF gene CS, Blood Harkess et al., 2016	Slower age-related DNAmet at CpGs. CS Saliva Ren et al., 2012	N/A	N/A	N/A	↓ DNAm age at CpGs ≠ DMR L, CS PBMCs Lymphocytes Chaix et al., 2017, 2020; García-Campayo et al., 2018	↓HDAC 2,3, 9 ↑DNA met at FKBP5 gene L, CS PBMCs, Kaliman et al., 2014; Bishop et al., 2018
Differential gene expression (Pathways affected)	Inflammation pathways L PBMCs Qu et al., 2013; Bower et al., 2014	Inflammation pathways, antiviral response L PBMCs Irwin et al., 2014, 2015; Kinney et al., 2019	↑Immunity, ↓Cell metabolism, delayed cell death, CS PBMCs Li et al., 2005	N/A	Oxidative stress, cell death, aging, cell cycle, immune response L, CS Blood Sharma et al., 2008; Kumar and Balkrishna, 2009; Black et al., 2013	N/A	Inflammation pathways, metabolism, oxidative stress, DNA damage L, CS Creswell et al., 2012; Ho et al., 2016
Biomolecules	↓ROS levels ↓Cortisol ↓Inflammation markers CS Blood Reviewed in: Dada et al., 2015; Mohammad et al., 2019	↓Inflammatory cytokines ↓Cortisol L Saliva Campo et al., 2015	↓ACTH ↓Cortisol ↑Endorphins CS, L Plasma Ryu et al., 1996; Lee et al., 2004	N/A	↓Cortisol ↑DHEA ↑Serotonin ↑Melatonin ↓Epinephrine ↓Norepinephrine L, CS Various fluids Reviewed in: Daube and Jakobsche, 2015 Kasala et al., 2014	Markers of inflammation, Markers of stress, Cytokines L, CS Various fluids Reviewed in Black and Slavich, 2016	Markers of inflammation, Markers of stress, Cytokines L, CS Various fluids Reviewed in Black and Slavich, 2016
Neurotrophins	↑BDNF L Serum Naveen et al., 2013, 2016; Cahn et al., 2017; Tolahunase et al., 2017	N/A	N/A	↑BDNF (3 mo.) ↓NGF (1 mo.) ↑NGF (3 mo.) L Saliva Ben-Soussan et al., 2015b; Venditti et al., 2015; Caserta et al., 2019	↑BDNF ↑NGF CS, L Saliva, Serum Pan et al., 2006 (SK/KK) Balasubramanian et al., 2015 (Pranayama)	N/A	↑BDNF CS Serum Dada et al., 2018; Gagrani et al., 2018

MBSR, Mindfulness-based stress reduction; QMT, Quadrato Motor Training; TM, Transcendental Meditation; SK, Sudarshan Kriya; KK, Kirtan Kriya; L, Longitudinal; CS, Cross-sectional; DMR, Differentially methylated regions; HDAC, Histone deacetylase; PBMC, Peripheral blood mononuclear cell; ROS, Reactive oxygen species.

Interventions (MBI; Black and Slavich, 2016). All protocols have become the subject of psychological, physiological, and molecular investigations (Black and Slavich, 2016). Neurotrophins were studied in only a few cases (i.e., BDNF; Dada et al., 2018; Gagrani et al., 2018). Transcriptomic analyses were performed in several longitudinal and mixed design studies in both healthy and clinical populations combining diverse MBI activities (Dusek et al., 2008; Bhasin et al., 2013; Bower et al., 2014; Kuo et al., 2015; Epel et al., 2016). Results showed that, in both long and short-term practitioners, differential transcription occurs in genes involved in metabolism, inflammatory processes, oxidative stress, and DNA damage response. In most cases, these results were correlated with reduced stress and fatigue, decreased depression symptoms, and improved immune response. A few studies dedicated to the transcriptomic analysis of subjects involved in MBSR protocols obtained similar results (Creswell et al., 2012; Ho et al., 2016).

MBSR was also the subject of two epigenetic studies, one focused on histone acetylation levels following the last day-long session of the MBSR program (Kaliman et al., 2014), and the other focused on the CpG methylation of two specific genes (SLC6A4 and FKBP5) as potential biomarkers for depression (Bishop et al., 2018). Kaliman and collaborators showed lower expression of histone deacetylase genes (HDAC 2, 3, and 9) in PBMCs, as well as alterations of global histone H4 acetylation levels, and proposed that the reduction of HDAC expression may represent a potential therapeutic effect of MBSR in depression. Bishop and colleagues reported hypomethylation of the FKBP5 gene in subjects with PTSD responding to the MBSR intervention compared to non-responders who, in contrast, showed increased methylation. These authors speculated that FKBP5 methylation could be a predictive biomarker of the response to MBSR in PTSD.

CONCLUSION AND PERSPECTIVES

Growing evidence suggests that epigenetic changes are a key mechanism by which a stressful environment acts on the genome, causing stable changes in gene expression and in behavior that can mediate maladaptive responses. On the other end, the voluntary practice of meditation can be considered a form of environmental enrichment, equivalent to positive external stimulation. Hence, it appears fundamental to understand whether meditation can elicit epigenetic events able to prevent disease and promote health. Relevant examples of stress-related targets of epigenetic deregulation are genes involved in glucocorticoid signaling, serotonergic signaling, and neurotrophins. Surprisingly, meditation practices seem to act on the same gene targets, such as FKBP5, SLC6A4, and BDNF, and promote endocrinal, neuronal, and behavioral functions. This suggests that the achievement of a state of inner silence through the practice of meditation can prevent or reverse the detrimental effects of a stressful environment (see **Table 1**). However, it is unclear whether stress and meditation act antagonistically on shared epigenetic mechanisms and, because of the relative novelty of the field, molecular and epigenetic evidence of the effects of mindful activities is still not sufficient to demonstrate a cause–effect relationship. It is conceivable that, by improving the immune system, metabolism, and stress–response pathways, and by promoting neuroplasticity, meditations of several kinds could affect mechanisms of energy saving, promote homeostasis, and potentiate the reciprocal mind and body's relaxation abilities, with a positive impact on psychology.

We are still far from identifying specific epigenetic markers associated with the state of inner silence, but the pioneering studies conducted so far suggest that this possibility deserves to be further explored. More epigenetics-focused studies will be necessary to understand the mechanistic details of meditative techniques. An increased, thorough understanding of these techniques and their molecular and epigenetic bases will bring us closer to the possibility of introducing them as non-pharmacological approaches to stress-related diseases and psychological disorders.

AUTHOR CONTRIBUTIONS

SV wrote the manuscript. MZ, AR, VV, MC, and LV read and revised the manuscript. All authors contributed to the article and approved the submitted version.

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Reflections on Inner and Outer Silence and Consciousness Without Contents According to the Sphere Model of Consciousness

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In the current hypothesis paper, we propose that focusing attention on silence can be used as a paradigm conceptually similar to sensory deprivation, to study consciousness without content. We briefly overview recent influential models of consciousness and consider how they assess the relationship between consciousness and contents. After discussing the strengths and weaknesses of current models, we suggest an extension based on the Sphere Model of Consciousness (SMC) and introduce new definitions for identification and self-awareness as states of consciousness. We further compare Paoletti's theoretical model for the development of self with other influential models, highlighting similarities and differences. We conclude with a discussion of how attentional focus on silence can be empirically tested.

Keywords: consciousness without content, Sphere Model of Consciousness, silence, default mode network, insula

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INTRODUCTION

Several recent theoretical models have aimed to clarify the idea of consciousness in itself, independent of its contents. Examples include the examination of *metacognitive consciousness* (Raffone and Srinivasan, 2009), consciousness with minimal content (Metzinger, 2018), and *consciousness-as-such* (Josipovic, 2019). In this context, we recently presented the Sphere Model of Consciousness (SMC; Paoletti, 2002a,b, 2008; Paoletti and Selvaggio, 2011; Paoletti and Ben Soussan, 2019), which attempts to represent the phenomenology of consciousness using the geometrical properties of the sphere. In the present hypothesis paper, we propose that focusing attention on silence can be used as a paradigm similar to sensory deprivation, to study consciousness without content. Our hypotheses, elaborated below, are based on the SMC.

Our hypothesis, that attention to silence creates a paradigm similar to sensory deprivation, is based on a specific notion of environment. The concept of environment can be defined in various ways. Here, we refer to both internal and external aspects of the environment, as follows: the internal environment encompasses intrinsic determinants, namely the person's psychological, neurological, and physiological mechanisms, while the external environment comprises extrinsic determinants, such as perceptual deprivation (Glicksohn, 1991; Ben-Soussan et al., 2019). Internal and external environments do not act independently on the individual but rather work together

to shape thoughts, feelings, and behaviors (De Fano et al., 2019). More specifically, we will explore the difference between internal intentional acts, such as meditation, and external perceptual deprivation, keeping in mind that structured external environments can also facilitate better internal communication (Paoletti and Selvaggio, 2013; Paoletti et al., 2017). We aim to explore the difference between internal intentional acts and external deprivation, using silence as an example of an intentionally achieved internal environment supporting a state of consciousness-as-such or consciousness without content.

We begin with a brief review of perspectives on the relationship between consciousness and content, as presented in recent studies. After considering the strengths and weaknesses of current models, specifically in relation to the isolation of consciousness from its contents, we suggest an extension based on the SMC. As suggested by one of our reviewer, these definitions are briefly compared with those used in other hierarchical models, including Maslow's hierarchy of needs (Maslow and Lewis, 1987), Wilber's Integral Theory (Wilber, 1979, 2000), and Drigas and Pappas' Consciousness-Intelligence-Knowledge Pyramid (Drigas and Pappas, 2017), as well Paoletti's theoretical model of the development of the self (Paoletti et al. 2016). We further introduce new definitions for *identification* and *self-awareness* as states of consciousness.

DIFFERENTIATING BETWEEN CONSCIOUSNESS AND ITS CONTENT

How Current Models Address the Differentiation Between Consciousness and Content

Three of the most recent models of consciousness, proposed by Raffone and Srinivasan (2009), Metzinger (2018), and Josipovic (2019), vary in their views on the content of consciousness and on how it can be differentiated from consciousness itself.

Raffone and Srinivasan (2009) suggested that access to consciousness is determined by selective endogenous attention, which produces a "working access bias" to the stimuli relevant for the response (target) in a given situation and consequent stimulus-response mapping. They also proposed that several dynamic links in the adaptive coding networks [e.g., in the dorsolateral prefrontal cortex, anterior prefrontal cortex, and anterior cingulate cortex (ACC)] could connect to enable access to consciousness. This processing of information is then modulated by body state and environment. Raffone and Srinivasan further proposed a classification of three orders of consciousness processes in relation to perception. With Baars's Global Workspace Theory[1] (GWT; Baars, 1983, 1998, 2002; Baars et al., 2003) as a starting point, they suggested that in the first order of consciousness processes, each cluster of neurons which constitutes a core of the global workspace (GW) in the adaptive coding networks relates to a single perceptual object, while a larger set of backstage neurons operating at the unconscious level support and modulate conscious perception. Thus, phenomenal consciousness of a given object is implicit or contextual, while the specific characteristics of the object of consciousness are mediated by the cores of the GW. When the cores dedicated to the specific object decays, the previously backstage networks supporting it emerge in consciousness, resulting in first person phenomenal awareness of subjective states perceived as "I." This second order contains the introspective experiences of self-perception. This "I" will then be considered simultaneously in relation to body states and the environment, through the production of neuronal connections between adaptive networks and neural markers of transient body states. Finally, the third order of consciousness refers to the possibility that adaptive neuronal networks act non-referentially, that is, only recursively as consciousness of being conscious.

Raffone and Srinivasan (2009) also argue that in metacognitive processes, alpha coherence[2] has a decisive role in guiding the dynamics of neuronal populations with adaptive coding properties in the prefrontal cortex. Based on the above, they conclude that "awareness of being aware" can be understood only as an "intuitive awareness" based on meditation (Sumedho, 2004). While Raffone and Srinivasan provide an insightful depiction of consciousness dynamics referred to in Open Monitoring (OMM) and Focused Attention Meditation (FAM), they note that the same processes are potentially observable in a wide range of cognitive settings and experiential contexts other than meditation. As such, Raffone and Srinivasan's model raises challenges in isolating contents from consciousness. More specifically, if metacognitive awareness is a process of "intuitive awareness" underlying other processes observable solely by expert meditation practitioners, and in a wide range of settings and contexts, it is difficult to isolate metacognitive processes from contents in consciousness.

Metzinger's *Ascending Reticular Arousal System* (ARAS) model (Metzinger, 2018) differs considerably from that of Raffone and Srinivasan (2009), addressing what he calls Minimal Phenomenal Experience (MPE). In Metzinger's view, the MPE models the global state of arousal in the brain. According to this view, consciousness-as-such must be related to a mechanism underlying any kind of content, and it is believed to be the general state of arousal in the brain. The general state of arousal appears as a representation when its reflexivity is not activated and appears as non-representational when its reflexivity is activated. The state of arousal becomes the signature of consciousness

[1]Bernard Baars' GWT (Baars, 1983, 1998, 2002; Baars et al., 2003) is one of the most influential theories of human consciousness. According to this view, contents are categorized in conscious and unconscious perceptions. Conscious perception which gives access to brain resources, in terms of wide broadcasting of information in brain areas. In contrast, unconscious perception involves brain sources in an unconnected or modular way. According to the GWT, consciousness provides a gateway to unconscious knowledge resources in the brain. To exemplify the functional properties of the GW, Baars (1998) used a theater metaphor, referring to it as a useful first approximation (Baars and Franklin, 2007).

[2]Alpha coherence is an electrophysiological measure of functional connectivity, characterized by synchrony relationships between the activities of two neuronal populations. Studies further report higher frontal alpha coherence, slower breath rate, lower sympathetic activity, and higher parasympathetic activity during transcending, compared to periods of undirected thoughts (Travis, 2001; Travis et al., 2002). Enhanced alpha coherence was further found to be related to both increased cognitive flexibility and fine motor control and performance (Babiloni et al., 2011; Ben-Soussan et al., 2013).

when its reflexivity is activated, and the individual perceives it in a state of "content-less wakefulness," like it occurs in lucid dreams. This model bonds consciousness without contents to level of arousal with tautology as a potential side effect: that is to say that consciousness requires arousal and arousal can be a content in itself for the brain (Josipovic, 2019).

Finally, according to Josipovic (2019), consciousness-as-such or nondual awareness is viewed as the foundation of consciousness, independent of any other phenomenal content: an empty awareness that is non-conceptual and without subject-object structuring. In Josipovic's view, determining roles are played by a dynamic functional network with a main node in the central area of the precuneus and a main axis with a node in the dorso-lateral prefrontal cortex. Josipovic notes that the precuneus is the most connected hub in the cortex, involved in perceptual, motor, affective, and cognitive functions. *Nondual awareness* is believed to function as a background framework that, when included in the GW, unifies contents. Thus, Josipovic hypothesizes that the neural distinction between *consciousness-as-such* and content is that neural activity related to the former is reduced to precuneus and neighboring areas when *nondual awareness* is isolated from all contents, accompanied by synchronized activity within low gamma (40–60 Hz) or high gamma (above 100 Hz) ranges. Finally, Josipovic emphasizes that the signature of consciousness-as-such lies not in the difference between conscious and unconscious contents but in dynamic brain patterns common to both. Josipovic's model also delineates a specified research protocol addressing changes in the dynamics and scope of the central precuneus network, aiming to specify the neuronal population related to "nondual awareness" and, more specifically, to its different dimensions (see Josipovic, 2019 for further detail).

The three models summarized above provide detailed frameworks for investigating the correlates of consciousness in itself, but there is room to address additional variables in empirical research, such as settings thought to observe differences, for example, between expert and non-expert meditation practitioners and between conditions intentionally sought or outwardly imposed. Both conscious and unconscious experiential contents are thought to be generated through mutual interactions between perceptual, affective, and cognitive processes (Metcalfe and Son, 2012; Vandekerckhove et al., 2014; Barrett, 2017; Josipovic, 2019). We can explore the possibility of setting constraints on the three types of processes and investigating each one separately to learn about its relationship with consciousness. We begin below with the perceptual level, proposing that perceptual deprivation (here defined as a homogeneous perceptual field) can be used to isolate consciousness in itself from contents. We then discuss silence as a means of achieving perceptual deprivation.

Perceptual Deprivation (or Saturation) as a Means of Isolating Consciousness in Itself From Contents

The concepts of absorption and transcendence are by no means new; they have been discussed in the philosophies of both Eastern and Western traditions (e.g., Odin, 1981; Solomon, 1985, for reviews) and investigated scientifically for over 40 years. More specifically, perceptual deprivation has long been used to elicit the state of absorption (Tellegen and Atkinson, 1974). Notwithstanding ambiguity associated with research on absorption (Roche and McConkey, 1990), it has proven beneficial in recent research using mindfulness to study altered states of consciousness (Lau et al., 2006).

It has been proposed that absorption, as experienced by meditation practitioners, can be studied as a means of differentiating consciousness in itself from (other) phenomenal contents (Josipovic, 2014). In this regard, absorption is considered both a trait and a state (Ben-Soussan et al., 2019). As a trait, absorption involves the ability to highly focus attention (Tellegen and Atkinson, 1974) and is related to meditation, empathy, and hypnotic ability (Lau et al., 2006). State of absorption has been assessed using questions like "I was not distracted but was able to become completely absorbed in what I was experiencing" (Hall et al., 2016).

Individuals who score highly on trait absorption, an "inherently interactive" trait (Tellegen, 1981), tend to experience states of absorption given suitable circumstances (Glicksohn, 1987, 2004). Suitable circumstances are, for instance, altered immersive sensory environments, such as sensory homogenization (e.g., ganzfeld, or any visual condition without temporal or spatial contrast, like an unclouded sky; Baars, 2013). These immersive sensory environments facilitate the induction of altered states of consciousness (Glicksohn, 1991) similar to meditation (Benson, 2001; Lindahl et al., 2014). As such, exposure to an immersive environment, such as whole-body perceptual deprivation, should elicit experiences of absorption (Glicksohn and Berkovich-Ohana, 2012).

Considering the immersive nature of such altered environments, we propose the term perceptual *saturation*, rather than *deprivation*. Saturation could be a more fitting naming for what has been called *sensory overload* (Vollenwieder and Geyer, 2001). In fact, also Vaitl et al. (2005) defined these types of environments as *restricted stimulation*. Over the years, a correlation between sensory overload and difficulty in distinguishing self from non-self in both healthy altered states of consciousness and psychopathological cases has been reported (Scharfetter, 1981; Vollenweider, 1998; Vollenwieder and Geyer, 2001; Jamieson, 2007).

Glicksohn et al. (2017) and Ben-Soussan et al. (2019) conducted a series of studies with the OVO Whole-Body Perceptual Deprivation (OVO-WBPD) chamber, which is an altered sensory environment in the form of a human-sized egg (*Uovo* in Italian literally means egg). Based on the SMC, detailed below, the OVO-WBPD was specifically built with the aim of facilitating an immersive experience and an increased state of presence (Paoletti, 2002a). The electrophysiological fingerprint of the transition into an absorption state induced by the OVO-WBPD chamber was enhanced delta and beta activity, left lateralized to the inferior frontal region, peaking at the insula (Ben-Soussan et al., 2019). The insula plays a role in the experience of bodily self-awareness, sense of action, and sense of body possession (Craig, 2009), in addition to transmitting homeostatic information that enables sensory

integration (Williamson et al., 2001; Xue et al., 2010). As such, these results suggest enhanced effort to regulate the embodied self, based on interoception, when multi-sensory integration normally provided by the external visual field is impeded. The involvement of the insula suggests that absorption can be experienced when information simultaneously saturates the whole spectrum of perception, due to the immersive homogenous environment.

We can interpret the OVO-WBPD experiment as a constraint on content creation at the perceptual level. Constraining a specific level in this manner might allow us to observe, in greater detail, the process of achieving consciousness without contents. In the following section, we propose that silence can be used as a kind of perceptual saturation, intentionally sought by meditation practitioners.

SILENCE AS "PERCEPTUAL SATURATION"

Silence is frequently associated with contemplative practices and meditation, but it is not often discussed in neuroscientific studies on the neuronal effects of meditation. This may be due to the fact that silence, as opposed to noise, is difficult to define in positive terms. Indeed, silence is usually discussed in the scientific literature with reference to its absence, as in investigations of noise pollution damage (Wagner et al., 2004; WHO, 2011). Such research has shown that excessive noise has a direct negative impact on learning (Sanz et al., 1993; Wagner et al., 2004; WHO, 2011) and produces sleep disturbances with negative effects on insight production (Wagner et al., 2004).

Silence can be thought of as non-phenomenal or as an empty phenomenon. For example, when Radin et al. (2011) investigated attention, they used silence as a negative indicator, looking at how sound led meditation practitioners to distraction. In this sense, the construct of silence is comparable to that of consciousness without content: silence is identified only in contrast to its interruption, just as consciousness is considered only in terms of the contents that cancel its vacuity.

A method used in many traditional practices, called *listening to silence* (Teschner, 1981; Davies and Turner, 2002; Stratton, 2015), allows us to consider this construct from a different perspective. We can then ask which cognitive and/or physiological resources are required to draw attention to something that seemingly cannot be the object of attention, or cannot be defined, and hypothesize that those resources are similar to those involved in sensory saturation.

Neurally speaking, silence could work like an immersive sensory environment, but one that is intentionally sought by the practitioner. The importance of intentionality here is central because sensory and perceptual deprivation has been reported as a positive or aversive experience (Hebb, 1955; Feinstein et al., 2018; Ben-Soussan et al., 2019) depending on its intention. For example, while isolating participants against their own will can be considered white torture (Brown, 2007; Mausfeld, 2009), over the centuries, people have voluntarily utilized isolation as means of getting reconnected to themselves and achieve higher states of consciousness (Ustinova, 2009, 2017). This could mean that intention, or at least the perception of self-determining the experience, namely the way one choses to interpret the event and voluntarily orient it to his/her aims, has a decisive role in the experience of sensory deprivation. In the context of meditative traditions centered on "listening to silence" (Teschner, 1981; Davies and Turner, 2002; Stratton, 2015), we consider more the intentional use of silence, than only physical silence. Particularly relevant in this context is the work of Scholl et al. (2010), indicating that a special neuronal network is dedicated to silence. Accordingly, like the immersive sensory environment, silence could elicit an observable process involving a hypothesized network dedicated to listening to silence with noticeable differences between external silent sensory immersive environments and intentionally sought silence. Indeed, according to the SMC, intentionality is a decisive factor in reaching a state of consciousness without content.

To advance our exploration of the neural mechanisms underlying attention to silence, considered here as a kind of sensory saturation that challenges the brain to integrate perceptions, we present a phenomenological matrix that aims to represent consciousness through the SMC (Paoletti, 2002a,b, 2008; Paoletti and Ben-Soussan, 2019). The sphere represents a matrix in which the experiences of consciousness can be effectively placed both statically and dynamically. It is therefore a good basis for describing, phenomenologically, the consciousness-related experiences of contemplative practice and meditation practitioners. Most importantly, the geometric form of the sphere is suitable for describing consciousness without content, taking into account the characteristics of phenomenal experiences. After presenting the SMC, we use it to elaborate on the specific relationships between silence and consciousness without content.

THE SPHERE MODEL OF CONSCIOUSNESS

The description of consciousness within the space of a matrix is based on the *space-state* concept (Fell, 2004; Werner, 2009; Berkovich-Ohana and Glicksohn, 2014), which has been employed to describe consciousness as a system and define its dimensions and dynamics. In the current paper, we adopt the SMC as a framework.

The Sphere as an Icon of Consciousness

In describing consciousness without content, in a certain sense, we are faced with the need to represent the unrepresentable or express the inexpressible. A primary feature of the sphere is its emptiness. The classic geometrical definition describes it as a set of points equidistant from a center (Hilbert et al., 1952), but if we open up a ping pong or tennis ball, we see that this center is invisible. This invisible center can be conceptualized as the heart of consciousness, equidistant from all stressors (see **Figure 1**).

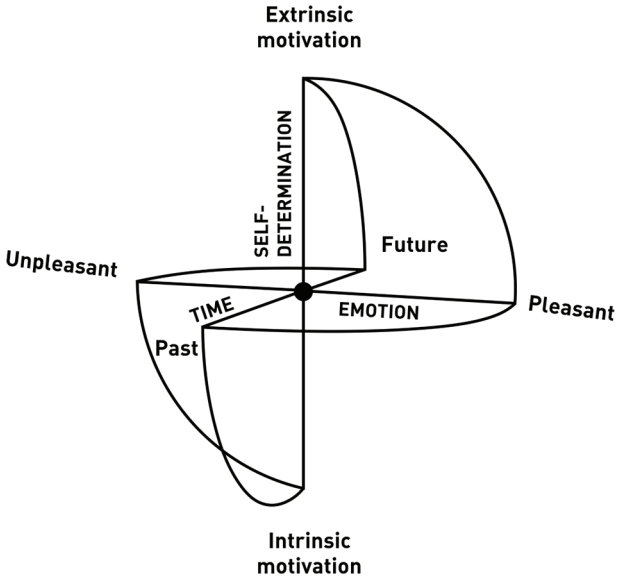

FIGURE 1 | The Sphere Model of Consciousness (SMC), axes, and polarities. Adapted from Paoletti and Ben-Soussan (2019).

Recalling the discussion of immersive environments and absorption above, we can hypothesize that when consciousness, through attention, expands and becomes able to be in connection with all contents without any of them prevail, the contents vanish due to lack of differentiation, as in the case of the ganzfeld homogeneous perceptual field[3] (Wackermann et al., 2002; Miskovic et al., 2019). This, in turn, leads to the experience of "loss of self" (Avant, 1965). When consciousness is guided by expanded attention due to sensory saturation (e.g., perceptual deprivation; Leckart et al., 1970) to the point of dissolving identification with specific content and even the distinction between self and non-self (Vollenwieder and Geyer, 2001), the specific content vanishes, and the subject could enter a state of consciousness without contents. As we saw, sensory deprivation or saturation could be experienced in opposite ways, i.e., as white torture (Brown, 2007; Mausfeld, 2009), or to achieve higher states of consciousness (Vaitl et al., 2005; Ustinova, 2009, 2017). According to the SMC, the opportunity to enter a state of consciousness without content through sensory saturation is assumed to be determined by intentionality, represented in the model with the vertical axis (see **Figure 1**). This could mean that intentionality is a necessary element for experiencing consciousness without content. In the SMC, when the consciousness is intentionally expanded to all contents in a state of non-attachment, the center of the sphere, which represents the meeting point of the three axes, becomes what we have called the *place of pre-existence* (Paoletti and Ben-Soussan, 2019). This name is based on the hypothesis that, in the central place, when there is intentional non-identification with any content, perception can be experienced without the usual filters created by memories. This makes it possible to reprocess subjective autobiographical memories and implies that we can emerge from a state of absorption with a more neutral relationship with our own memories, without losing them. Accordingly, Vaitl et al. (2005) observed that after participation in a restricted stimulation compared with rest condition, autobiographical life episodes were retrieved more intensely and recalled more pleasantly.

The term place of pre-existence indicates the receptive and originally undifferentiated character of consciousness, with respect to all stimuli within and outside the individual. This is the geometrical place in the matrix where we situate the possibility of consciousness-as-such, which we parallel here with silence. In the model, the three ideal axes represent three lines of force passing through the central point, such that the intersection divides the axes into two sections (**Figure 1**).

As a mathematical metaphor, the sphere constitutes an ideal paradigmatic model. One of its fundamental characteristics is that all the points are "umbilical," or locally spherical. This means that the normal curvature is the same in all directions, and each tangent vector represents a main direction. Hence, the logic of the sphere is a logic of equitable redistribution of forces (Hilbert et al., 1952). Every pressure that reaches the sphere from one of the six directions of space, which in the model represent the polarizations of time, emotion, and self-determination, is redistributed on the whole structure without creating deformations. This continues provided that the center of the sphere remains "empty," or that consciousness is not drawn back to identification with specific content.

The Center of the Sphere

To fully understand the function of the center of the geometrical matrix of the SMC, it is necessary to note that the model is (at least) three-dimensional (3D) and dynamic, and that the intersection point between the axes represents the phenomenological coordinates of experience at a given moment. If self-determination (third axis) does not participate, the intersection will be defined only by the first two axes, time, and emotion. When there is no voluntary activation of the self-determination axis, the intersection point can be "decentralized." Thus, one is conditioned by memories and feeling; or, in other words, those things that capture your memories and feelings determine who you are. Visually, when the experience of consciousness is characterized by identification with one of the polarities of time and emotion, this can be represented as a shift of the center point and consequent deformation of the axes. For example, if a practitioner's mind is projected to a future unpleasant experience, it would be placed in the model in an intermediate point between the future unpolarity and pleasant polarity (see **Figure 2**).

When the characteristics of the state of consciousness produced by the relation between time and emotion are in equilibrium with each other, but the dimension of self-determination is not intentionally manifested, we will have a graphic localization in the center of the sphere. This is referred to in the model as "flat life" or "bidimensional consciousness" (see **Figure 3**, Paoletti and Ben-Soussan, 2019). The center, in this case,

[3]It is important to note that the alpha activity remained enhanced in the Ganzfeld despite no indication of diminished brain arousal (Miskovic et al., 2019).

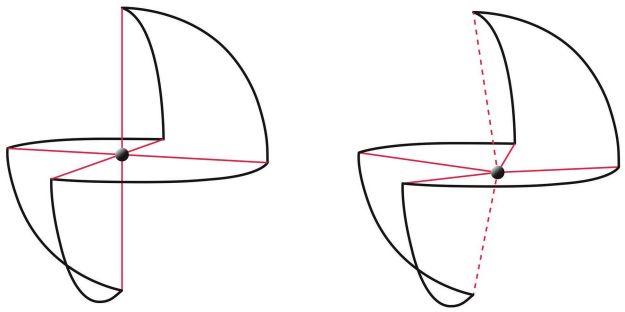

FIGURE 2 | (A) The centered condition, in which all three axes intersect at the center of the sphere. **(B)** A decentered condition, in which the intersection is only between the time and emotion axes, and there is not intentional self-determination. The dotted lines depict the state of no voluntary activation of the self-determination axis.

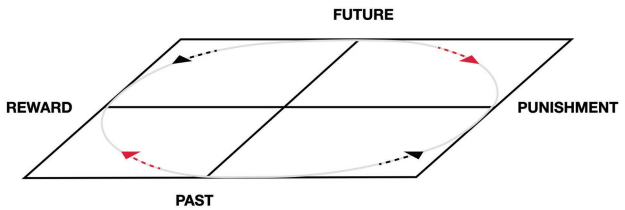

FIGURE 3 | The "flat life," the intersection of the two axes—time and emotion—produces a two-dimensional (2D) and circular life, or a "flat life," in which the repetition of experience cycles is determined by the interaction between emotional memories and projective experiences; that is, a circuit that moves between dependence and the need for gratification. Adapted from Paoletti and Ben-Soussan (2019).

represents the intermediate point between the axes, but it does not yet represent the non-dual state of consciousness (Josipovic, 2014; Vieten et al., 2018) discussed in "Silence and Consciousness without Content" section. For example, if the state is characterized by equilibrium, but the equilibrium is not reached intentionally, the center will represent the present moment and/or the emotional balance but not the non-dual state. Any experience of the present implies attention toward some references, and the references are placeable along the axes. Only when the axis of self-determination is inserted and a balance is created between all the polarities of experience will the subject experiences a non-dual awareness. Thus, we can have a two-dimensional (2D) center, which is not necessarily the same as the 3D center that represents the place of pre-existence. The state at the center of the sphere, when it is experienced as the place of preexistence, would be not characterized by the absence of contents, but by the equidistant presence of all contents, with none prevailing in its relationship with self-perception.

The Axes

Each axis in the SMC represents the unfolding and polarity of an aspect of experience, with an equilibrium point in the center of the sphere, and a graduated scale indicating distance from the

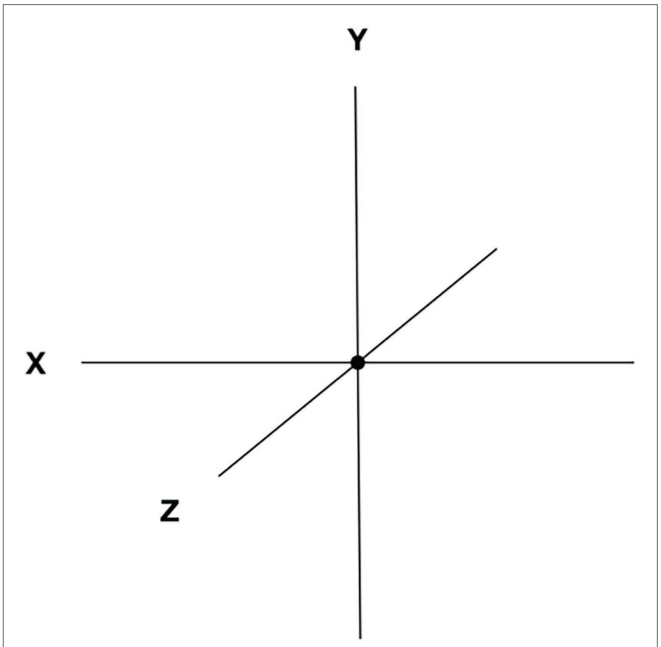

FIGURE 4 | The three ideal axes represent three lines of force passing through the central ideal point, such that the intersection divides each axis into two sections.

center (**Figure 4**). With respect to the spatial coordinates, the back-front axis, called the *time axis*, represents the temporal unfolding of past to future; the right-left axis, *emotion axis*, represents the emotional polarities of unpleasant and pleasant; and the vertical axis, *awareness-self-determination axis*, represents the dimensions of value and aspiration (see **Figure 1**). From a phenomenal point of view, the axes do not necessarily represent a linear continuum. For example, while we are used to thinking of past, present, and future on a linear continuum, from a psychological point of view, past and future are both projections from the central point representing the present time (Bar, 2011; Wittmann, 2015).

The proposed correspondence between spatial coordinates and dimensions of experience is based on the assumption that sensorimotor circuits are the substrate of higher order cognitive processes (Rizzolatti and Sinigaglia, 2006). We can assume, therefore, that representations of space are the basis for more complex mental elaborations. As such, the SMC, as a matrix representing consciousness phenomena, is structured on the spatial directions, which parallel the coordinates of mental contents. The central point of the sphere represents the space of consciousness as characterized by the dimensions signified by the axes.

Time (Past-Future) and Emotion (Unpleasant-Pleasant) Axes

Autobiographical memory is composed of a stratification of perceptions, through molecular processes that have only been investigated partially (Bonhoeffer and Yuste, 2002; Malenka and Bear, 2004; Marie et al., 2005; Kim and Linden, 2007). Molecular research suggests that memory formation is modulated by several mood-related neurotransmitters, such as dopamine, serotonin, acetylcholine, and endocannabinoids (Marie et al., 2005).

Parallel to the graphic representation of the SMC, these processes can be metaphorically represented by the encounter between the time and emotion axes.

We know, however, that memories necessarily record a subjective, partial view of experience, and that perception itself is constantly mediated by interpretation (Gazzaniga, 1985; Baars, 1998, 2002). This is supported by the temporal gap between sensory perception and consciousness of a stimulus, which in some cases can reach up to half a second (Libet, 1985; Dennet, 1989; Berry et al., 1999). We also know that memories are incessantly used by the brain for predictive activity, leading to the idea of the "proactive mind" (Bar, 2011), and that this activity influences sensory perception (Bjork, 1975; Schacter and Addis, 2007; Gazzaniga, 2012). Perception is a receptive rather than a passive process: if the stratification of memories constitutes the past in the SMC, projection represents the future (Farb et al., 2007; Wittmann, 2015). As an experience becomes more distant in time and space, it becomes increasingly abstract and subject to further elaboration. This greater level of abstraction comes with greater variability of interpretation (Johnson et al., 1988; Mather et al., 1997; Schacter and Slotnick, 2004; Loftus, 2005).

Turning to the emotion axis, many interpretative models proposed in the literature converge in claiming that emotional experience requires an omnipresent interpretative function, cognitive in nature. For example, according to Lambie and Marcel (2002), each emotional state is determined by the combination of two factors: readiness for action and evaluative description. Readiness for action refers to the ways in which brain and body systems are activated in response to stimuli. Evaluative description comprises self-representation of the ways one has been influenced by an event. This interpretative process, in the case of the emotions, exists through polarization. The emotions are pleasant or unpleasant and, from the psychological point of view, are associated with the reward/punishment dynamic and related brain networks (Carver and White, 1994; Delgado et al., 2000; Paoletti and Ben-Soussan, 2019).

The link between silence voluntarily reached through training, by traversing emotions and time, has been addressed by Vago and Zeidan (2016, p.13): "A sense of peace and quiet in the mind is proposed to arise through mental training in concentration, non-conceptuality, and discernment, in contrast to the untrained frenetic restlessness of mental time travel that is characteristic of daily activity in the postmodern setting." The primary contribution of the current model is in the emphasis on the third axis, discussed below.

The Awareness-Self-Determination Axis

In the SMC, the ability to become self-determined is characterized with respect to two possible polarities, intrinsic motivation and extrinsic motivation (Deci, 1971; Moller et al., 2006; Paoletti and Ben-Soussan, 2019). At the two extremes of the axis are the concepts of *aspiration* (extrinsic motivation), conceptualized as the intentional pursuit of a pre-determined goal, and *values* (intrinsic motivation), conceptualized as "sacred values" (Berns et al., 2012) that the brain processes independently from the reward/punishment mechanism (Delgado et al., 2000). Aspiration denotes the most extreme form of extrinsic motivation and values the extreme form of intrinsic motivation.

Neuroimaging studies suggest that intrinsic motivation recruits the salience and central executive networks, while suppressing the default mode network (DMN; see Di Domenico and Ryan, 2017 for a recent review; **Figure 5**). The DMN is typically active during task-free resting states. It is thought to represent neural processing related to mind-wandering (Raichle et al., 2001; Buckner et al., 2008) and demonstrates decreased activity during effortful, goal-directed tasks (Greicius et al., 2003; Fox et al., 2005). The salience network, associated with the anterior insula (AI) and dorsal ACC, is believed to support the detection of subjectively important events and the mobilization of attentional and working memory resources in the service of goal-directed behavior (Menon and Uddin, 2010; Murayama et al., 2010; Menon, 2015). See **Figure 3**. For example, Murayama et al. (2015) found increased activity within the ACC and bilateral insula in response to free-choice cues, as compared to forced-choice cues. Regarding the comparison between intrinsic (such as "writing an enjoyable article") and extrinsic motivation (e.g., "writing an extra-credit article"), increased activity within insular regions was found when participants imagined the enactment of intrinsically motivating activities (Lee et al., 2012; Lee and Reeve, 2013).

Depraz et al. (2000) have described the subtle dynamic of "the act" of becoming more self-aware as necessarily intentional. They described three interdependent phases each of one characterized by intention: first, suspension from the habitual act of mind and body, then redirection of attention inwardly, and finally receptivity toward the experience. In the SMC, we hypothesize that self-determination is positively correlated with awareness (Paoletti and Ben-Soussan, 2019), as awareness improves adaptive decision-making, with positive effects on

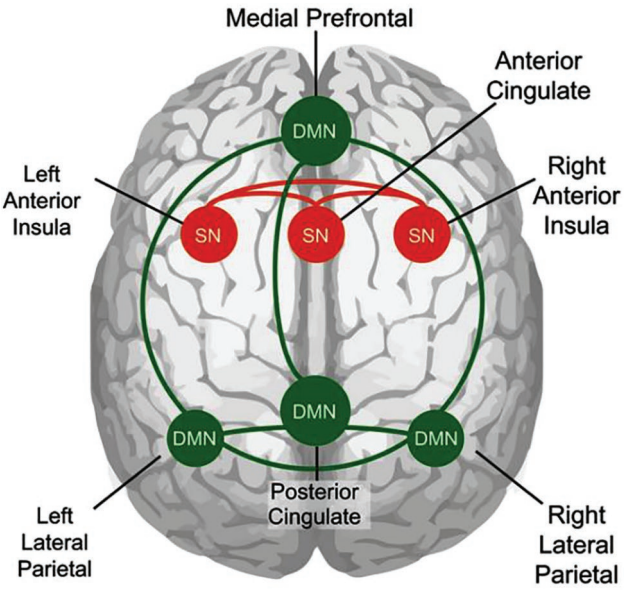

FIGURE 5 | Node connections of the default mode network (DMN; shown in green) and the salience network (SN; shown in orange). Illustration of node connections used in this study. Adapted from van Ettinger-Veenstra et al. (2019).

self-determination (Karoly, 1993). Regarding adaptivity and self-awareness, Seth and Baars (2005) claim that conscious events are highly informative, rapidly adaptive, internally coherent, and reportable. On this basis, they infer that a greater degree of consciousness corresponds to a better decision-making process, as every process of consciousness is in itself rich in information. We posit that there is a circular relationship between awareness and decision-making: while a greater degree of consciousness leads to better decision-making, it is also true that stronger motivation for decision-making improves awareness of the object of motivation. In this sense, awareness and self-determination are connected.

Self-Awareness and Identification According to the Sphere Model of Consciousness

Having described the SMC in general, we can now discuss the significance of saturation in its context. An immersive environment, such as homogenization, can be interpreted as pressure equally exerted all around the sphere, pushing the self toward its center. In this respect, an "immersion" into silence is a means of saturation. The relationship between the center of the sphere and the axes is represented in the SMC by level of self-awareness, as explained below.

Minimal Self, Narrative Self, and Overcoming of the Self

Neurophysiological research has often adopted the binary distinction between *Minimal self* and *Narrative self*. First proposed by James (1890/1950), the categories of Minimal and Narrative Selves were then redefined for the purposes of neuroscientific research by Gallagher (2000), with the former denoting the self as "I," the knowing subject, a temporary presence, and the latter depicting the self as "me," the object that is known, the concept of self and autobiographical identity. The Minimal Self has a short temporal extension and is endowed with a sense of action, property, and first person non-conceptual content, while the Narrative Self involves personal identity and continuity through time and includes conceptual content. In our previous papers on the SMC, we specified the addition of a third state, called Overcoming of the Self (see **Figure 7**, Paoletti and Ben-Soussan, 2019; Paoletti et al., 2020), in which all sense of self disappears. In the model, the Minimal Self is depicted as a circle close to the center, contained by a larger circumference that represents the Narrative Self.

We refer to the distinction between Minimal Self and Narrative Self because of its recurrent use in studies about neural correlates of the self. State and type of self are believed to have specific neural correlates. When the space of consciousness is completely occupied by contents placeable along the axes of the SMC, we have a state called "identification" with those contents. Neural activity in networks related to the Minimal Self or Narrative Self can indicate which kind of self-perception one is experiencing. Current research has indicated several neural correlates of the two types of self and suggested that they are hierarchically structured. Narrative Self is dependent on Minimal Self and not vice versa (for a review, see Berkovich-Ohana and Glicksohn, 2014). Meanwhile, Overcoming of the Self, which is parallel to consciousness without contents, has only recently been the subject of neuroscientific studies (Hinterberger et al., 2014; Winter et al., 2019). It can further be compared with self-transcendence, absorption, and non-dual states (Josipovic, 2014; Vieten et al., 2018), which are discussed in "Silence and Consciousness without Content" section.

To consider the SMC in the context of other hierarchical models, we compare it to Maslow's hierarchy of needs (Maslow and Lewis, 1987), Wilber's Integral Theory (Wilber, 1979, 2000), and Drigas and Pappas' Consciousness-Intelligence-Knowledge Pyramid (Drigas and Pappas, 2017). As specified in our previous paper about the SMC (Paoletti and Ben-Soussan, 2019), in which we suggested neural correlates for the model, we limited our discussion to the concepts of Minimal and Narrative Selves and introduced the aforementioned dimension of Overcoming of the Self. Neural correlates for the two dimensions of Minimal Self and Narrative Self have been proposed and addressed in a vast body of literature. However, as suggested before, the complete SMC includes an evolutive representation for seven levels of the self (Paoletti et al., 2016; Paoletti and Ben-Soussan, 2019; **Figure 6**).

In the theoretical model of the development of the self, we have a tripartite structure that can be represented in the form of an hourglass, with the immanent dimension at the base and the transcendent dimension at the top. The central tipping point is the representational self. Different needs and aspirations also correspond to different levels of the self. At the base, in the hereditary self, the dimension of the basic needs is decisive (as in Maslow's hierarchy); at the top, the ideal self is motivated by aspirations that transcend the individual and are oriented toward collectivity.

Once again, the model is dynamic. The immanent dimension in the SMC coincides, in the model, with the intersection of the

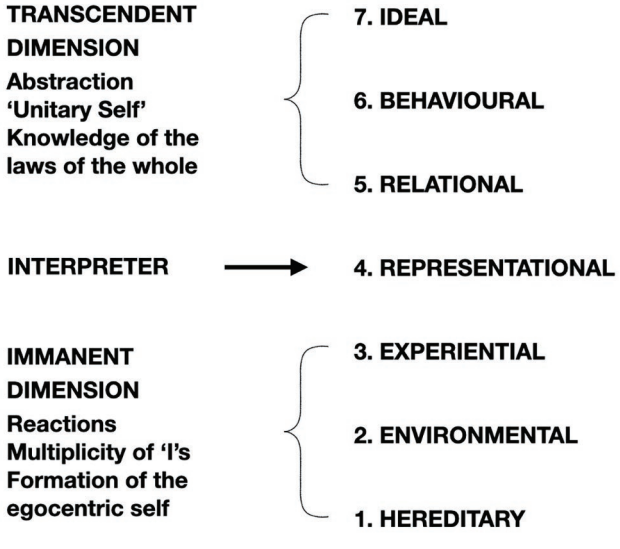

FIGURE 6 | The theoretical model of development of the self, with the overall trisection and the seven levels of the self. Adapted from Paoletti et al. (2016).

two axes – time and emotion – which produces a 2D and circular life or a "flat life" (see **Figure 3**). In the flat life, the repetition of experience cycles is determined by the interaction between emotional memories and projective experiences; that is, a circuit that moves between dependence and the need for gratification.

The insertion of the third axis results in a different interpretative capacity (Paoletti and Ben-Soussan, 2019). The idea of aspiration, or intentionality aimed at the pursuit of a predetermined result, enables the implementation of interpretative capacity (Deci, 1971). In the SMC, the level of interpretation is represented in the relation between the center and the periphery. The dimension of the transcendent self is a global relation between the center and the whole space of the sphere.

Similarly, in Wilber's theory of the self (Wilber, 1979), a higher-order structure is assumed to emerge through a differentiation of the preceding, lower-order level at each stage of psychological development. The emergent structure is considered more complex and, therefore, more unified. The higher-order structure is introduced to consciousness and eventually the self identifies with it. For example, as the body emerged from its fusion with the material world, consciousness became a body-self, identified with the body. As language emerged in awareness, the self began to shift from a solely biological body-self to a syntactical ego and eventually identified itself with language and operated as a syntactical self. While the detection of levels of self based on abstraction ability is similar to Paoletti's model, the definition of the levels is different. For example, in his model, language is not considered as a distinct level in the development of the self. In addition, the distinctive feature of the more developed self is not greater complexity but rather unitarity. The feature of unitarity is considered a result of development in Paoletti's model, while in Wilber's theory, the self seems to be originally intended as a unit able to identify with different "levels, lines, and states" (Wilber, 2000).

Many models related to the current model are 2D. For example, while Maslow's hierarchy of needs is a theory of human motivation (Maslow and Lewis, 1987), and not a model of consciousness but of needs, it is highly relevant to the SMC. The SMC is 3D, taking three axes into consideration simultaneously, including basic needs and higher motivations. As previously described (Paoletti and Selvaggio, 2011) in the SMC, the six directions designated by the three axes unfold to eight fields of life, namely body, family, career, friendship, spirituality, relationships, finance, and collectivity. The first four are located in the lower part of the sphere, while their respective counterparts are located in the upper part (Paoletti and Selvaggio, 2011, see **Figure 8**). Here too, geometry is significant – the lower four are related to more basic needs, while the upper four are related to values (Paoletti, 2005). Similarly, in Maslow's model, there are at least five sets of goals, namely physiological, safety, love, esteem, and self-actualization, which are proposed to be basic needs that can be simultaneously expressed or satisfied. According to Maslow, the appearance of one need usually rests on the prior satisfaction of another, more pre-potent need. The lower needs in Maslow's model, which are "instinctive" in nature, are similar to the lower part of the sphere in the SMC.

Thus, in the flat life condition, while we agree with Maslow on many aspects that classifications of motivation should be based also upon conscious goals rather than on drives (Maslow and Lewis, 1987; Paoletti, 2005; Paoletti and Ben-Soussan, 2019). Thus, the transition to a spherical life, which is accompanied by a change of focus from needs to values (Paoletti, 2005), is further accompanied by an intentional shift away from DMN activity and toward clear goal state, represented by the center of the sphere (Paoletti, 2002a,b; Paoletti and Ben-Soussan, 2019; Paoletti et al., 2020).

Similar to the SMC, based on knowledge, intelligence, and learning theories, and especially on Gardner's theory of multiple intelligences and Maslow's approach to transcendence, Drigas and Pappas (2017) proposed an eight-layer pyramid of knowledge. In their model, the individual must master each layer in order to reach transcendence, which involves greater

FIGURE 7 | Minimal Self, Narrative Self, and Overcoming of the Self in the SMC. Adapted from Paoletti and Ben-Soussan (2019).

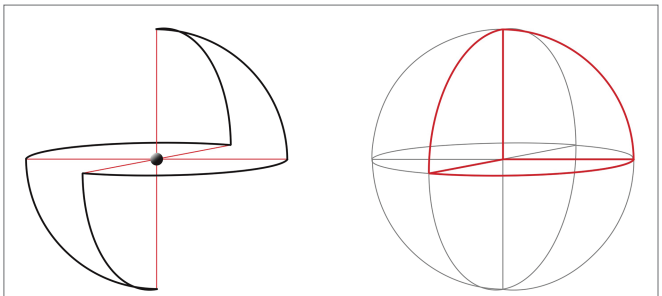

FIGURE 8 | The eight fields of life: body, family, career, friendship, spirituality, relationships, finance, and collectivity. The first four are located in the lower part of the sphere, while their respective counterparts are located in the upper part. Adapted from Paoletti and Selvaggio (2011).

freedom from biological and social conditioning. Each increase in level of the pyramid involves a higher state of self-organization, awareness, and consciousness, alongside reduced entropy. Drigas and Pappas define consciousness as a monitoring, regulation, and adaptation process that enables individuals to move from one layer to the next. In this context, the sphere could be regarded as a two converging pyramids or a clepsydra. In this sense, climbing the pyramid can be regarded as moving toward the center of the sphere. Yet, while for Drigas and Pappas, the individual has to conquer all the levels (including stimuli, data, information, knowledge, expertise and discrimination, self-actualization, and universal knowledge) in order to reach transcendence, it should be noted that some traditions, such as the Vedas, claim that self-transcendence and state of one's essence and being would actually lead to universal – complete knowledge (Alexander et al., 1987). In this sense, Drigas and Pappas' theory may be different from the SMC, as we distinguish between consciousness and intelligence. In this respect, it could be related to theories of consciousness and information processing, such as Baars and Franklin's LIDA (Baars and Franklin, 2007), for which specific neural correlates are suggested.

Self-Awareness and Silence

According to the SMC, self-awareness is expressed as a relationship between contents placed along the axes and the concentric circles of the selves. The highest degree of self-awareness would be represented as an equal relationship between the periphery of the sphere, or the extremes of the axes, and the center, where we place consciousness-as-such. We assume, in the SMC, that an equal relationship between consciousness and contents can be reached only intentionally. From a subjective, phenomenal point of view, this state of self-awareness could manifest itself as intentionally sought silence, encompassing all the external and internal stimuli. As we have seen above, sensory and perceptual deprivation has been reported as a positive or aversive experience (Hebb, 1955; Feinstein et al., 2018; Ben-Soussan et al., 2019). For example, while isolating participants against their own will can be considered white torture (Brown, 2007; Mausfeld, 2009), over the centuries, people have utilized isolation as means of getting reconnected to themselves and achieve higher states of consciousness (Ustinova, 2009, 2017). Similar to sensory deprivation, silence can be experienced as a positive or negative experience, depending on the interpretation and valance they give to it. For example, teaching the positive aspects of silence (e.g., ranging from silence the classroom to silence during meditation) can provide people the information on the beneficial effects of silence, therefore increasing the probability that they may voluntarily choose to take this path daily, dependent on their current situation. Thus, willingly staying in silence as it occurs in many meditation practices is actually advantageous for mental and physical well-being (Vago and Zeidan, 2016), emphasizing further the importance of education and the third axis.

In the three phases, process proposed by Depraz et al. (2000) of the act of becoming receptive toward experience is characterized by what they call *letting-come*, and what we defined as *being in the waiting* (Ben-Soussan et al., 2014; Paoletti and Ben-Soussan, 2019). Letting-come is defined by Depraz et al. (2000) as a "gesture," which produces a state of void of content lacking of any immediate discrimination. In this sense, just as silence is not the absence of sound in "listening to silence" meditative practices (Teschner, 1981; Davies and Turner, 2002; Stratton, 2015), the state at the center of the sphere, when it is experienced as the place of pre-existence, would be not characterized by the absence of contents, but by the equidistant presence of all contents, with none prevailing in its relationship with self-perception. Similarly, the axis of time can be regarded as going inward from (1) the narrative (past/future projected DMN) state to (2) awareness of the present moment (Minimal Self), and then (3) beyond time in the Overcoming of the Self (Wittmann, 2015, 2020; Paoletti and Ben Soussan, 2019; Paoletti et al., 2020), which could possibly be accompanied by observing the unfolding of time from one present time to *n* presents.

Identification and Absorption: The Importance of the Third Axis

In the context of meditative practice, Minimal Self-related networks are more active in relation to the experience of here and now (Farb et al., 2007; Berkovich-Ohana and Glicksohn, 2017), while those related to the Narrative Self are more active in relation to mental rumination, mind-wandering, and DMN activation (Hamilton et al., 2011; Hasenkamp and Barsalou, 2012; for a review, see Fox et al., 2015). During mind-wandering, the spotlight of attention is narrow and unintentional due to increased engagement with one mental object (Farb et al., 2012; Lutz et al., 2015; Vago and Zeidan, 2016). Similarly, when we identify with only one of the physical, affective, or abstract thought dimensions, or when these dimensions are in conflict, processes of transcendence and integration of information that we see as the basis for both meditative practices and creative abilities do not occur (Horan, 2009). We propose that this state of conflict can be denoted "identification" (Paoletti, 2008; Paoletti and Selvaggio, 2011).

In terms of the SMC, identification is described as an imbalance along one of the axes. Attention is identified, from time to time, with elements of the past or the future, with emotional experiences, or with aspirations or values, but it is usually not divided between these and something else (Paoletti, 2008; Paoletti and Selvaggio, 2011). For example, in a recent study by (van Elk et al., 2019), participants were presented with awe-eliciting, positive and neutral videos, while they were instructed to get fully absorbed in the scenery or to count the number of perspective changes. In line with previous studies using passive or low-demand tasks, it was expected that the absorption condition would be associated with increased activity in regions comprising the DMN. In contrast, the analytical compared to the absorption condition was expected to result in an increased activation of the frontoparietal attention network. In line with their hypothesis, van Elk et al. (2019) found stronger activation in the DMN in the absorption condition. Nevertheless, this was less the case when participants were watching awe videos, suggesting that while watching awe videos, participants were deeply immersed in the videos and that levels of self-reflective thought were reduced. In contrast, the insula and other key regions of the fronto-parietal network were most strongly activated

in the analytical condition when participants were watching awe videos compared to positive and neutral videos. In this respect, the sense of self is characterized by the element with which the subject identifies. In the state of identification, there is not a distinct perception of oneself and the element toward which attention is directed. Similarly, in "listening to silence," attention must not be led away by noise; rather, the practitioner is required to encompass noise in paying attention to silence. Thus, the division of attention between the element and oneself can hypothetically be the path to self-awareness, as defined above: an intentionally sought equal relationship between self-perception (the center of the sphere) and the phenomenal element of experience placed along the axes.

Many meditation techniques involve observing the experiential field by allowing thoughts and sensations to arise and pass without clinging to them (Cahn and Polich, 2006), thus deactivating the DMN (Brewer et al., 2011; Hasenkamp and Barsalou, 2012; Tomasino et al., 2012; Garrison et al., 2015). Study findings further suggest that awareness of subjective or phenomenal aspects of experience in the present moment involves neuronal populations with responses marking transient body states, in particular the somatic and interoceptive insular cortices (Damasio, 1999; Craig, 2004; Critchley et al., 2004; Farb et al., 2007).

Somatic marker or momentary self-awareness areas have also been implicated in OMM or mindfulness-based meditation (Lutz et al., 2008b). Using EEG, Travis et al. (2010) found that cortical midline circuits activated during Transcendental Meditation (TM) practice overlap with those of the DMN (Raichle et al., 2001). Travis et al. concluded that since activation in these default mode brain areas was higher during TM compared to rest (with eyes closed), the experience of contentless thought with continued self-awareness during TM practice could be different from autobiographical or mind-wandering thoughts (Travis, 2014).

As noted above, similar to the SMC's place of pre-existence in the center of the sphere, several theoretical descriptions (Vago and Zeidan, 2016) and empirical investigations (Josipovic, 2014; Vieten et al., 2018) of subjective experiences of non-duality (a sense of oneness or a perceived dissolution of the distinction between the observer and the contents of observation) have emerged in recent years. These states are thought to occur when the silent background awareness encountered in meditation becomes sufficiently stabilized and integrated with the daily waking experience, so that the habitual reified dualities between subject and object, self and other, and in-group and out-group dissipate. It is hypothesized that these states lead to a more spacious and compassionate way of being (Josipovic, 2016).

Identification has rarely been examined, as it is very elusive: the moment you voluntarily pay attention to yourself (thus hypothetically activating the third axis), you are no longer completely identified. Thus, while both identification and absorption are focused on a specific perceptual, imaginative, or ideational experience, perhaps the awareness axis gives the absorption experience its three-dimensionality. Taking pain as an example, we consider what happens when we are identified, and when we voluntarily add an additional perspective.

Pain is a conscious experience that can be considered an interpretation of nociceptive input influenced by memories, as well as emotional, pathological, genetic, and cognitive factors. It is thus more than just a qualitative experience or set of experiences (Mordeniz, 2016). Beyond its immediate unpleasantness, emotions experienced in the anticipation of pain and in response to its meanings and perceived future consequences are related to the DMN and salience network (Kucyi et al., 2014; van Ettinger-Veenstra et al., 2019). The overlap between the patterns of cerebral activity associated with feelings of pain, emotions, and motivational states in the ACC and insula is consistent with their contribution to basic aspects of self-representation, self-regulation, and consciousness (Wiech et al., 2008). Salomons et al. (2004) showed that perceived control over pain decreased pain-related responses in the ACC and insula. In accordance, the placebo effect, which is closely related to self-determination and interpretation of stimuli, has been found to decrease pain intensity and cerebral responses to pain in brain areas including the ACC and insula (Petrovic et al., 2002; Wager et al., 2004; Bingel et al., 2006; Wiech et al., 2008). In addition, the insula and adjacent areas are activated when individuals view or become aware of the delight, pain, or disgust of others, as when they experience these emotions first-hand, and this activation is modulated by individual empathic tendencies (Agnati et al., 2013).

In this context, it is important to note that the brain network governing meditation has been studied using a variety of meditation practices and techniques eliciting different mental processes, such as silence and attention to one's body and empathy, which are all linked to increased insular activity (for a review, see Tomasino et al., 2012). Recent studies have also shown that meditation inhibits or relieves pain and reduces pain-related neural activity in the ACC, insula, secondary somatosensory cortex, and thalamus (Nakata et al., 2014). It was further found that expert meditators, as compared to novices, report equal pain intensity but less unpleasantness. This difference was associated with enhanced activity in the insula and the anterior mid-cingulate among experts, while experiencing pain (Lutz et al., 2013). The authors have suggested that cultivating experiential openness downregulates anticipatory representation of aversive events and increases the recruitment of attentional resources during pain, which is associated with faster neural habituation.

Cognitive modulations of pain are related to activation of prefrontal brain areas (DLPFC, VLPFC, and ACC), which modulate activation in pain-associated regions in the cortex (ACC, SI, SII/insula, and thalamus). Affect labeling, or putting feelings into words, has long been thought to help manage negative emotional experiences. Relative to other forms of encoding, affect labeling diminishes the response of the amygdala and other limbic regions and produces increased activity in the right ventrolateral prefrontal cortex (RVLPFC), a region associated with the symbolic processing of emotional information and with top-down inhibitory processes (Lieberman et al., 2007; Burklund et al., 2014). Together, these results suggest that putting feelings into words might activate the RVLPFC, which in turn might dampen the response of the amygdala, thus helping to alleviate emotional distress. These results suggest that detaching one's self from being identified completely in

a specific situation (e.g., anxiety about current situation, emotional or physical pain), through intentional affect labeling, can diminish emotional reactivity.

In addition, while many mediation practices decrease DMN activation, as noted above, nondirective meditation, which permits mind-wandering, involves extensive activation of brain areas associated with episodic memories and emotional processing, than during concentrative practice or rest conditions (Xu et al., 2017). In relation to this, one should keep in mind that the DMN is further related to many positive attributes of consciousness and cognition, such as creativity and imagination (Agnati et al., 2013; Berkovich-Ohana and Glicksohn, 2017).

SILENCE, DIVIDED ATTENTION, AND REGENERATION OF MEMORIES

We now return to silence as a means of reaching the state of consciousness without contents, or, perhaps more accurately, "with all contents." Scholl et al. (2010) have shown that a specific set of neurons is dedicated to silence, distinct from those that deal with sound. Silence cannot, therefore, be conceptualized solely as a cancellation or deletion of sound. This coincides with a fundamental principle of meditative technique, requiring practitioners to move away from rather than eliminate internal chatter, in order to move toward a non-sound, or silence. The effort of moving away from internal chatter while moving toward silence can be seen as a voluntary effort (Tomasino et al., 2012) to divide attention (Meck and MacDonald, 2007; Paoletti and Selvaggio, 2011; Wyart et al., 2015).

Silence also stimulates processes of neurogenesis in the hippocampus, which have in turn been tied to regeneration of memories and creation of new associations (Kirste et al., 2015). Silence can, therefore, be seen as the entrance into a state of neutrality with respect to stressors, stimuli or previous memories. The stressors do not disappear: silence is not the absence of stimuli, but a greater space that allows inner distance and thus better management of stimuli. In this sense, silence represents a state of preparation for emptiness (Teschner, 1981; Davies and Turner, 2002; Stratton, 2015). The state of emptiness is an indefinitely larger space, which can be reached through sensory saturation (Scharfetter, 1981; Vollenweider, 1998; Vollenwieder and Geyer, 2001; Jamieson, 2007). Thus, emptiness is not the absence of references but the equidistant presence of all references, which can be better managed in a wider space.

Self-report and other psychological studies have shown that meditative practice induces increased awareness of perception and body awareness. However, phenomenological studies indicate that meditative practices lead to the experience of complete absence of an essential self or a total Overcoming of the Self. This state might coincide with the central void of the sphere discussed above, and therefore, with consciousness without content. Much is still to be discussed and examined from neuronal and physiological viewpoints, uniting different terminologies, ranging from the possible connection between silence, transcendence, and absorption to the differential effects of identification on the three axes and their neuronal correlates.

SILENCE AND CONSCIOUSNESS WITHOUT CONTENT

We conceptualized silence in meditation as a means of sensory saturation thought to induce experiences of consciousness without content, or silent consciousness (Baars, 2013). We assume that this state can be achieved in meditative practices that provide for sensory expansion. Such is the indefinite expansion of the senses, as described in Patanjali's Yoga Sutra with the concept of *pratyahara*. According to some, it indicates a kind of coercive control over the senses, but it can be understood instead as training in detachment from sensory perception, or non-attachment to the object of perception, which differs from its inhibition. This detachment would coincide with the practice of widespread attention, the "letting-come" of Depraz et al. (2000), the physiological correlates of which can be viewed as widespread endogenous attention in the open field (Raffone and Srinivasan, 2009; Srinivasan et al., 2009), leading to a form of sensory saturation subserved by the insula (Ben-Soussan et al., 2019; Paoletti and Ben-Soussan, 2019).

It is possible that these experiences of self-transcendence, defined by some as the extent to which individuals conceive themselves as integral parts of the universe as a whole, induce a transformation from a body/ego-based self-identity to a world/universe-centered experience of self, not limited to the self-narrative of the individual practitioner (Vieten et al., 2018). During peak states and deep meditative states, the self becomes one with the universe and experiences positive self-dissolution, the feeling of unity of the three time perspectives (or "timelessness"; Vaitl et al., 2005; Studerus et al., 2011; Wittmann, 2015).

CONCLUDING REMARKS AND FUTURE PERSPECTIVES

In the current hypothesis paper, we offered a synopsis of data suggesting a mechanism by which silence might enhance change in consciousness. Some of the key regions active in compassion meditation, including the insula, are involved in developing stronger than usual self and agency. Thus, combining knowledge regarding the importance of the insula in emotional modulation, embodiment, and neuroesthetics (Di Dio et al., 2007), with recent studies on time, space, and the insula (Wittmann, 2015; Ben-Soussan et al., 2019), we suggest that being immersed in silence, similarly to being immersed in a state of absorption, can activate the insula (among other areas). This will induce a shift toward the center of the sphere, which will in turn lead to alterations in the perception of time (Glicksohn et al., 2017), sense of unity, and non-duality (Wittmann, 2015), and eventually to enhanced empathy (Lutz et al., 2008a; Singer et al., 2009), which are reported in many contemplative techniques. Future research should examine the SMC with respect to different practices using both neuronal correlates of the different states they produce, as well as some physiological markers, such as heart rate variability and other parasympathetic measures (Travis and Wallace, 1999; Travis and Pearson, 2000), as well as in relation to augmented and virtual reality (Kiourexidou et al., 2015).

In addition, similarly to sensory deprivation, which has been found to be beneficial for memory functions, creativity, perception and signal detection, social cognition, and the readiness to change one's attitudes on social phenomena inducing increased motivation to change critical and maladaptive behavior patterns (for a review, see Vaitl et al., 2005); the importance of voluntarily entering into a state of silence, as an educational conceptual space, can and should be studied also in educational settings, in relation to the functions mentions above, as well as logics and mathematics (Stefaneas and Vandoulakis, 2014).

In the current paper, we focused mostly on the difference between intentional removal of content through an internal mental action (e.g., meditation) versus externally depriving (or saturating) perception. Future studies should also examine the differential theoretical and empirical effects of visual, auditory, and kinesthetic stimulation (such as photic stimulation and yantras, binaural beat, massage, and movement meditation, respectively), and their possible role in shifting position within the SMC (Paoletti et al., 2020). Finally, in line with Maslow's claim that for some people, one level is more important than others (e.g., self-esteem more than love; Maslow and Lewis, 1987), future studies should examine the relationship between location inside the sphere, personality, and the main fields visited inside the sphere (career, family, and friends). This could be particularly interesting when taking into consideration personality traits such as introversion and extraversion – which are closely related to silence (Cassidy and MacDonald, 2007; Cain, 2013) – and their neural correlates (Stenberg, 1992; Leshem et al., 2019).

AUTHOR CONTRIBUTIONS

PP is the creator of the Sphere Model of Consciousness and contributed the parts related to the neuopsychological applications of his model (e.g., place of pre-existence) and the importance of silence in them. TB-S contributed the parts mostly related to neural correlates and the differentiation between absorption and identification. All authors contributed to the article and approved the submitted version.

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Nondual Awareness and Minimal Phenomenal Experience

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Minimal phenomenal experiences (MPEs) have recently gained attention in the fields of neuroscience and philosophy of mind. They can be thought of as episodes of greatly reduced or even absent phenomenal content together with a reduced level of arousal. It has also been proposed that MPEs are cases of consciousness-as-such. Here, we present a different perspective, that consciousness-as-such is first and foremost a type of awareness, that is, non-conceptual, non-propositional, and nondual, in other words, non-representational. This awareness is a unique kind and cannot be adequately specified by the two-dimensional model of consciousness as the arousal level plus the phenomenal content or by their mental representations. Thus, we suggest that to understand consciousness-as-such, and by extension consciousness in general, more accurately, we need to research it as a unique kind.

Keywords: nondual awareness, minimal phenomenal experience, consciousness, meditation, lucid NREM sleep, consciousness-as-such

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INTRODUCTION

We have previously proposed that the impasse in today's scientific understanding of consciousness would be helped by understanding consciousness itself or nondual awareness (NDA), a basic aspect of consciousness that is different from all other phenomenal contents and functions of consciousness and from global states of arousal (Josipovic, 2014, 2019; Josipovic and Baars, 2015). Attempts to include this topic within the realm of contemporary scientific and philosophical discourse, which have been halting in the past (Forman, 1998; Shear and Jevning, 1999; Travis and Pearson, 2000), have recently gained renewed traction in both neuroscience and philosophy of mind (Baars, 2013; Tononi and Koch, 2015; Windt, 2015; Dor-Ziderman et al., 2016; Milliere et al., 2018; Koch, 2019; Metzinger, 2019, 2020; Miskovic et al., 2019). In particular, it has been proposed that so-called minimal phenomenal experiences (MPEs) or full absorption states are examples of consciousness-as-such (Metzinger, 2019).

Consciousness-as-such has been present as a central concern in most Asian contemplative traditions and philosophies, where a great variety of terms have been created to point to it, such as pure consciousness, pure awareness, NDA, rigpa, timeless or choiceless awareness, being-awareness-bliss, the Self, the fourth, Atman-Brahman, Buddha-nature, clear light, Shiva-Shakti, etc. (Rabjam, 2007; Radhakrishnan and Moore, 2014). These are primarily concerned with phenomenal descriptions but may also contain elements of ontological and metaphysical inferences and various pedagogical, ethical, or soteriological concerns, which we will not discuss here.

Two main ways of seeing consciousness-as-such have emerged in these traditions. According to one, it is a state of full absorption with maximally reduced phenomenal content (Sansk. Samadhi), akin to a deep dreamless sleep, but not entirely unconscious, and without any knowable properties (Nikhilananda, 1990). According to the other, it is an awareness which is in itself empty of other phenomenal content and conceptual processes including those that reify it, yet it inherently knows itself to be aware (Rabjam, 2001). In the contemporary scientific and philosophical discourse, these two views are often conflated, sometimes under one term of MPE (Metzinger, 2019).

Here we argue that the two should not be conflated, and that the latter view, which understands consciousness-as-such as a unique kind of awareness, is more accurate and useful for guiding contemporary discourse on consciousness. Specifically, we show that the two-dimensional model of consciousness as the arousal level plus the experiential content does not adequately specify consciousness-as-such. In line with our previous work (Josipovic, 2014, 2019), we advance the perspective that consciousness-as-such is first and foremost a type of awareness, that is non-conceptual, non-propositional, and nondual, in other words, non-representational. This awareness is a unique kind, and cannot be reduced to a level of arousal and phenomenal content, or to their mental representations and representational models.

The term MPE, as originally used, refers to episodes of greatly reduced or minimal phenomenal content, accompanied by reduced levels of arousal (Windt, 2015). At times, the term has been greatly stretched to include many types of contemplative experiences with differing amounts and complexity of phenomenal contents and levels of arousal, and with different properties of NDA, so that the term has lost much of its original meaning, and appears to overlap and confound with the term NDA (Metzinger, 2020). We will stay with the original meaning of the term MPE, as referring to episodes of reduced or minimal phenomenal content and reduced arousal. During such MPE there may, or may not, be an explicitly present NDA, which indicates that the term NDA refers to something essentially different from such MPE.

Episodes of explicitly present NDA that is isolated from other phenomenal content, such as those that can occur with contemplative practice or in lucidity during deep sleep, can be regarded as episodes of MPE since no phenomenal content is present other than awareness itself (Josipovic, 2019). However, since NDA, as we will see, can be present with any amount of phenomenal content, the term MPE does not best capture what NDA actually is, a type of awareness. Furthermore, MPE has at times been equated with full absorption (Sansk. Samadhi), a term borrowed from contemplative traditions where it most often indicates a greatly reduced level of arousal accompanied by minimal or no phenomenal content (Aranya, 1984; Metzinger, 2020). However, there is often no clarity in the traditional accounts as to whether full absorption entails the presence of NDA or not and whether that awareness, if present, is self-recognized or not (Srinivasan, 2020). Hence, there is a frequent misunderstanding that a mere absorption with a lack of most content, also known as mental silence, is the same as NDA. Likewise, in the full waking state, a mere presence without noticeable thoughts or emotions is often mistaken for NDA (Rabjam and Thondup, 2002). These and other similar types of conflations and misunderstandings are based, at least in part, on the reluctance to view NDA as a unique kind, one that is not specified by the level of arousal or the amount of phenomenal content.

What makes consciousness-as-such or NDA a unique kind is that it is aware, and inherently knows itself to be aware, without relying on mental representations (Josipovic, 2019). The two most common fixed beliefs that make this difficult to understand are that all knowing has to be mediated mental representations, also known as strong representationalism, and that being a unique kind necessarily implies naive essentialism and substance dualism. The first belief has been argued against extensively by most nondual contemplative traditions, especially the Buddhist ones (Rabjam, 2007; Dunne, 2015; Josipovic, 2019), as well as, by the phenomenologists, as this well-known quote indicates: "The pre-reflective self-awareness of an experience is not mediated by foreign elements such as concepts and classificatory criteria, nor by any internal difference or distance. It is an immediate and direct self-acquaintance which is characterized by being completely and absolutely irrelational (and consequently best described as a purely immanent self-presence)" (Frank, as quoted in Zahavi, 1998). The second belief is based on a limited interpretation that being a unique kind is due only to conceptual categorization. It also conflates phenomenological and ontological levels of discourse. The claim that differentiating awareness and phenomenal contents creates an artificial duality (Bayne et al., 2016) does not apply to NDA, which, as we will see, though distinct, co-occurs with phenomena nondually (Rabjam, 2001; Josipovic, 2019).

Below, we give some examples and outline the main properties of experiences of reduced and minimal phenomenal content, and those of NDA, and then discuss their main differences. We show that NDA and MPE should be treated as distinct and not be conflated and that only NDA can truly be considered to be consciousness-as-such.

MINIMAL PHENOMENAL EXPERIENCE

Experiences of reduced phenomenal content can occur in several situations: naturally, when transitioning to and from sleep or under special circumstances, such as when waking from anesthesia, in some minimally conscious states and near-death experiences, during sensory deprivation, under the influence of mind-altering substances, and during meditation and related practices (Windt, 2015; Dor-Ziderman et al., 2016; Milliere et al., 2018; Metzinger, 2019, 2020; Miskovic et al., 2019). These experiences can have varying degrees of arousal or wakefulness, from low levels of arousal akin to deep sleep to high levels of hyper-arousal accompanying some altered states. Likewise, the amount and type of phenomenal content can vary greatly, and reductions or even absences of the perception of time, space, body, and self-have been reported (Dor-Ziderman et al., 2016; Metzinger, 2020). Additionally, the

degree of consciousness can also vary, from a complete absence in various types of blackouts on one end of the spectrum, which may preclude such events from being regarded as phenomenal experiences altogether, to a vivid presence of self-knowing luminous awareness, regarded in some cases as instances of consciousness directly encountering itself (Josipovic, 2019).

More recently, Windt (2015) introduced the term MPE to refer to a special class of phenomenal experience with reduced content, in which content is reduced to what can arguably be regarded as some minimum that satisfies specific, albeit differing, constraints and lacks all perspectival structures (see also Forman, 1998 and Metzinger, 2019). While such MPEs are characterized by absence of most phenomenal content, including any egoic self-consciousness, one is not simply unconscious as in deep sleep (Windt et al., 2016). However, what exactly is left in such experiences is not entirely clear, neither in the traditional accounts, nor in the contemporary discourse (Srinivasan, 2020). This becomes especially problematic when the term MPE is stretched and applied to a broad range of experiences with varying degrees of phenomenal content and levels of arousal, so that the term itself loses its intended meaning (Metzinger, 2020). Therefore, presently we will stay with the original meaning of the term as stated above, so that MPE here refers to experiences of greatly reduced or minimal phenomenal content that are also accompanied with lowered levels of arousal, such as those occurring during initial stages of lucidity in deep sleep or during the full absorption in meditation. Importantly, whether NDA is explicitly present in MPEs or not is orthogonal to such MPEs.

While describing all or even most types of experiences of reduced or minimal phenomenal content is outside of the scope of this paper, below we describe briefly a few cases related to sleep and to meditation practice, as the most obvious examples of either naturally occurring or induced types, with reduced or minimal phenomenal content. Their common characteristic is that they can be specified by the amount of residual phenomenal content and by the level of arousal. In contrast, as we will see, NDA, whether explicitly present or not in these experiences, is independent from both the amount and complexity of phenomenal content, and from the level of arousal, and is not specified by them.

Reduced and Minimal Phenomenal Content in Sleep

The transformations of consciousness that are naturally observed across distinct sleep stages, including both non-rapid eye movement (NREM) and REM sleep, provide the most readily available opportunity for studying phenomenal experiences with reduced or even minimal content. An early reference to this phenomenon can be found in the writings of the psychoanalyst, Lewin (1946), who drew attention to what he called the blank dream. These were dreams corresponding to an experience of the empty visual screen onto which the manifested elements of the dream are projected. While the screen itself is not usually seen as a distinct element (attention being captivated by the dream narrative unfolding in dream space), not so in blank dreams where the screen appears alone.

The psychoanalytic discovery of the blank dream went mostly unnoticed by mainstream psychologists conducting experimental research on sleep and dreaming. As often happens, however, a related phenomenon was independently noted about three decades later, when it was discovered that around 30% of dreams in carefully collected diaries were lacking in any content (Cohen, 1972) – so-called "white dreams" (Fazekas et al., 2019). This finding has been supported by research using the serial awakening paradigm, wherein participants were woken up at regular 15–30 min intervals (Siclari et al., 2013). By comparison, another 20% of the awakenings were followed by descriptions in which there was no sense of any kind of dreaming having taken place, only a vacuity, while the remainder consisted of narrative rich dreams. Using early night-serial awakenings, Noreika et al. (2009) found that the frequency of white dreams was close to 40% during Stages 2 and 3 of NREM sleep. Fragmentary instances of white dreaming can also sometimes be reported during sedation with general anesthetics in cases where participants were no longer responsive to behavioral commands (Noreika et al., 2011).

While it is certainly plausible that many white dreams reflect memory failures rather than genuine contentless experiences *per se* (Siclari et al., 2017), others have argued that (a) white dreams do indeed contain some content, but that (b) the content is of a weak perceptual quality that lies between the vividness of a typical dream and the experience of deep, dreamless sleep (Fazekas et al., 2019). Support for this hypothesis comes from an EEG study (Siclari et al., 2017) which reported that, compared to no dreaming and dreams with recalled content, white dreams are associated with intermediate power in high frequency oscillations recorded from sensory "hot zones." Reduced neural activity in posterior regions may correspond to perceptual representations occupying the low quality end of the spectrum of conscious experiences, characterized by diminished vividness, greater ambiguity, and less stability (Fazekas et al., 2019).

Lucidity in Dreamless Sleep

Whether white dreams are best accounted for by degraded perceptual content or by the near absence of content altogether remains unclear, but the latter possibility is attested to by imageless lucid dreaming (Windt, 2015). These are dreams in which a minimal form of presence is maintained (although this presence can be completely disembodied), in the apparent absence of any sensory images. One account describes this state as one in which "no symbols are encountered, visual or otherwise… all awareness of the self as body or special entity leaves… characterized by peace, silence…" (Magallón, 1991; see also LaBerge and DeGracia, 2000; Bogzaran, 2003).

Since spontaneous or state induced MPEs are transient and highly unstable events, their recognition by untrained observers is extremely difficult and rare. Not surprisingly, advanced meditators, who have developed the requisite stability of attention, have provided us the largest amount of data on these conscious states. For example, sleep yoga practices developed in the context of the Tibetan Buddhist tradition allow the dedicated practitioner the ability to enter into "clear

light sleep" - a form of dreamless sleep that is characterized not by mental blankness and sluggishness, but a high degree of clarity, described as: "…there is no film and no projection. Sleep yoga is imageless. The practice is the direct recognition of awareness by awareness, light illuminating light itself. It is luminosity without images of any kind" (Wangyal, 1998, p.). Such episodes can be regarded as episodes of NDA co-occurring with minimal phenomenal content, though not all lucidity in deep sleep is necessarily NDA.

Meditative Absorption States

Meditative absorption states are reported as states of progressive decrease of phenomenal content and arousal that are induced through applying various cognitive strategies, mainly involving attention regulation, working memory, and reward prediction (Lutz et al., 2008; Josipovic, 2010; Josipovic et al., 2012). Different meditation techniques and different stages of the same technique can rely predominantly on one or the other function, such as top-down voluntary sustained attention, bottom-up involuntary salience-driven attention, open monitoring and vigilance, or some combination of these. Different degrees of effort are applied, usually decreasing with developing skill levels, though some techniques insist on a minimal effort from the start (Wallace, 2006; Travis and Shear, 2010). The overall approach to practice can be categorized as being primarily aimed at either the loss of object in the self, the loss of self in object, or the loss of both self and object, though if followed far enough, most end up in some type of MPE, irrespective of how it may be interpreted after the fact (Guenther, 1977; Dunne, 2015).

Meditative absorption states have been mapped based on the altered states of consciousness they induce or based on the disappearance or appearance of other phenomenal contents (Lama, 1980; Aranya, 1984). For example, altered states resulting from the traditional mindfulness practice have been categorized into four lower absorption states (Pali: jhana) and described primarily as pervasive sensory-affective states of pleasure, joy, contentment, and peace, while the four higher jhanas are described as more refined mental states of boundlessness of space, consciousness, no-thingness, and neither perception nor non-perception (Shankman, 2008). The end point of this practice is an absorption state described as temporary cessation of all perception, feeling, and consciousness. Whether any phenomenal content remains in such a state has been debated (Sharf, 2013; Srinivasan, 2020). In the Tibetan practices of six yogas, the progressive absorption stages are characterized by the appearance of different inner light visions and the cessation of corresponding conceptual mentation. The end point is conceived of as passing beyond cessation, to the isolated clear light of awareness, free of any other phenomenal content (Tsongkhapa, 1996; Varela, 1997). This then is an episode of isolated NDA, and, similar to types of lucidity during deep sleep, it can be regarded as a MPE with explicitly present NDA.

While these two examples of full absorption come from closely related traditions, differences in reported absorption experiences are due to more than differences in their respective philosophical outlooks. They have also to do with the differences in methods of practice. In mindfulness, the sustained attention applied at the beginning of practice is increasingly replaced with open monitoring without any breath regulation, so that as jhanas unfold one allows them to arise and subside of their own accord and merely follows them. In the six yogas, one uses sustained attention throughout, while focusing precisely on points in the core of one's body and applying a breath retention technique.

Most absorption states generated through meditation practice can be experienced in a more dualistic, or in a more unitary way. Within the ordinary subject-object dualistic structure of experience, the meditator as a subject observes the state of reduced phenomenal content as an object upon which he or she is meditating. For example, one can do mindfulness practice while perpetuating a dualistic subject-object split through conceptual labeling or noting of jhanas, in which case the self is still there even though it is implicit. Conversely, they can appear as more unitary with a different degree of absence of dualistic structuring. These differences can be summarized as changes in the dualistic sense of self as the various processes that construct and maintain it are allowed to relax and become quiescent. This progressive attenuation or deconstruction is sometimes referred to simply as forgetting the self (Tanahashi, 2013). Starting with relaxation and silencing of the layers of inner narrative related to autobiographical-relational-social self, it progresses to the cessation of processes specifying phenomenal core self, such as agency, body-ownership, and spatio-temporal located-ness, then to the basic interoceptive sense of body presence (Farb et al., 2007; Siderits et al., 2013; Dahl et al., 2015; Dor-Ziderman et al., 2016; Metzinger, 2020). However, such temporary quieting down in and of itself may not yet be cessation of the constructed self as the implicit categorizations that reify the self and objects may be still operating in the unconscious substrate (Germano and Waldron, 2006). Thus, selflessness can be understood in a more refined way as not merely inner silence but as a more fundamental transformation of the nature of cognition in which cognitive processes switch from the exclusive reliance on conceptually constructed dualistic subject-object structures to a more direct unconstructed way of cognizing *via* NDA itself.

NONDUAL AWARENESS

NDA is a type of awareness, a basic non-conceptual, non-propositional awareness, without subject-object dualistic structure, hence "nondual." Statements pointing to this awareness can be most frequently found in the Indian and Tibetan nondual traditions, where it is described as:

"the pure element of awareness in all knowing. It shines by its own light; it is self-luminous" (Gupta, 1998, p.18).

"…essence of awareness, empty, lucid, and free of elaborations" (Rabjam, 2001, p.141).

"… an infinitely spacious expanse… unchanging, without transition, spontaneously present, and uncompounded" (Rabjam, 2001, p.51).

Mirror Metaphor

NDA has traditionally been compared to a mirror, while phenomena that appear to it have been compared to reflections in the mirror (Norbu, 1987; Josipovic, 2016). Its manner of knowing phenomena can be compared to mere reflecting, without categorization or further conceptual elaboration, that is, without associating, evaluating, forming decisions, or taking itself as a reified subject that knows phenomena as objects. Thus, the perceptual, affective, or cognitive contents and the states of arousal that co-occur with NDA are, so to speak, parallel to it, the way that images in a mirror are to the mirror itself. Just as a mirror is unaffected by images reflected in it, the basic properties of NDA remain, in principle, invariant regardless of what and how much phenomenal content is present, irrespective of the level of arousal (above a certain minimum threshold). The level of arousal can be compared in this metaphor to the amount of illumination in the room, so that some minimum amount is necessary for the mirror to reflect anything, but aside from that, changing the level of illumination affects only images in the mirror and not the mirror itself. Since phenomena do not affect NDA; NDA can encompass and pervade any type of content, whether perceptual, affective, or cognitive. It then knows phenomena as essentially not different from itself (Rabjam, 2007). That is, in addition to individual characteristics that make them appear the way they do, phenomena at that time also appear as having the same basic properties or dimensions as NDA. This is the key point that we will return to in the "Discussion" section.

Dimensions of Nondual Awareness

A number of distinct properties or dimensions of NDA can be self-evident from traditional and contemporary reports (Rabjam, 2001; Rao, 2005; Laish, 2015; Josipovic, 2019). Although a great many labels with overlapping meaning can be used to describe them, different dimensions of NDA have been most frequently subsumed into a few cardinal ones: presence or being, emptiness, inherent reflexivity, luminosity, bliss, and singularity. Presence or being is its all-encompassing existence. Emptiness is both an absence of phenomenal contents other than itself and an absence of conceptual processes that reify awareness as either subject or object and create the dualistic structure of experience. Inherent non-representational reflexivity, traditionally termed self-knowing or self-recognition (Ksemaraja and Singh, 1990; Rabjam, 2001; Laish, 2015), refers to NDA knowing itself to be aware without relying on mediation by conceptual and symbolic representations, hence non-representational. Luminosity or radiance refers to the transparent clear light of awareness' cognizance that illuminates both itself and any phenomena that may be present to it. Bliss is here the silent contentment of being entirely complete in itself, with no sense of any lack or any need to be other than what it is. Singularity refers to NDA being singular or homogenous and to the spontaneous unity or inseparability of all of its dimensions, rather than it being a product of the combination of dimensions, hence also, uncompounded.

NDA can be regarded to be a special kind of a self, in the sense that it is a singular aware presence that remains self-same (Deutsch, 1973; Rabjam, 2001). At the same time, because it is empty of reified subject and object, it can be regarded as not having or being a self at all. To the ordinary self, NDA appears as an object of sorts, something one might want to experience or as a capacity one might want to have. To NDA, however, the ordinary self and its constituting processes, to the extent that they can be phenomenally accessed, appear as contents within its space. The arguments between self and no-self perspectives have spanned centuries within the Asian nondual traditions and are beyond the scope of this paper (Siderits et al., 2013). In practical terms, they can be very briefly summed up as follows: If NDA is experienced as a self, it is a sign that some, however subtle, conceptualization that reifies awareness as the subject is still present, indicating that the emptiness dimension has not yet been fully realized (MacKenzie, 2012). Alternatively, if NDA is not realized as who one is, then it is still being reified as a subtle object upon which one is meditating, indicating that the dualistic split between meditator and awareness has not yet collapsed and the nondual nature of awareness has not been fully realized (Josipovic, 2014).

The main property or dimension of NDA of interest to us here is its inherent reflexive cognizance (Higins, 2011). As previous argued in more detail (Josipovic, 2019), this inherent self-knowing or reflexivity makes NDA a unique kind, in the sense that it differentiates NDA from all other phenomenal contents, as well as from the functions of consciousness like attention, memory, and so on, and from the various states of consciousness caused by the global levels of arousal in the brain. This intrinsic capacity for unmediated self-knowing qualifies this awareness as the consciousness itself or the consciousness-as-such.

Interestingly, since NDA can, in principle, contextualize, or be the space within which any aspect of experience unfolds, including conceptual ones; various self-related contents and self-specifying processes can be present or co-emergent with NDA without necessarily creating the dualistic split in the structure of experience. Which specific self-related contents manifest within NDA at any given time can to a large degree depend on one's *a priori* commitment to views about self and selflessness. It can also depend on a given situation and the responses it elicits and on the depth and stability of one's realization of NDA.

Thus, NDA is the space in which experiences unfolds, but there is nothing abstract about this space, as once NDA has been realized, it is the basic space of phenomena (Rabjam, 2001). When NDA is co-occurring with an experience of minimal phenomenal content or full absorption, it can be termed "isolated nondual awareness," after traditions in which progressive stages of absorption are used to isolate this awareness from other phenomenal contents (Tsongkhapa, 1996). How phenomenal content appears within NDA can be termed nonduality. Two mistaken conclusions occur due to an incomplete understanding of the relationship between NDA and phenomenal content. The first one is that for NDA to be present, phenomenal content has to be minimal, that is, one needs to be in full absorption. This is not so, since NDA is, in a sense, orthogonal to any content. The second one is that, if NDA is present during wakeful experience, there cannot be any conceptual processes occurring at the

same time. This is not accurate because NDA can co-occur with any content, whether perceptual, affective, or cognitive, which appears in it, so to speak, like an image in a mirror.

DISCUSSION

The majority of meditation methods involve cultivation of constructed states that depend on either decreasing or increasing levels of arousal and enhancing tonic or phasic alertness, respectively (Gellhorn and Keily, 1972; Aranya, 1984; Young and Taylor, 1998; Wallace, 2006; Craigmyle, 2013; Amihai and Kozhevnikov, 2014, 2015). In contrast, meditation methods that are concerned with NDA and authentic being, do not involve manipulating the arousal level, since NDA is independent from it, and can be discovered and present whether the arousal level is low or high, whether tonic or phasic alertness is dominant (Rabjam, 2001; Rabjam and Thondup, 2002). Such meditation methods usually carry a warning not to mistake NDA for a constructed or altered state of consciousness (Manjusrimitra and Lipman, 2001). Even though contemplative traditions sometimes refer to NDA as basic wakefulness, this does not mean that NDA is itself a specific state of arousal, like being awake, as it can be present and self-recognized whether one is fully awake or asleep in lucidity during dream or dreamless sleep. Granted, ordinary lucidity in either dreaming or dreamless sleep is not in and of itself the NDA, as a usual lucidity is the functioning of ordinary dualistic conceptual mentation. However, even such lucidity is by no means a hallucination or a mistaken assessment of the state one is in. Once realized, either within the usual waking state or when isolated in full absorption, NDA can be also realized within the dreaming and dreamless sleep (Tsongkhapa, 1996; Wangyal, 1998). NDA is also not a simple or bare wakefulness, because there are instances of bare wakefulness without any awareness (Boly et al., 2012). Likewise, conscious wakefulness (Metzinger, 2020) still has two different elements in it: a level of arousal experienced as wakefulness, and the awareness itself, in addition to whatever phenomenal contents may be present. In sum, since NDA can, in principle, co-occur with any amount of arousal, from a minimal level necessary for it to function to some maximal level of hyper-arousal that can occur in altered states of consciousness, the level of arousal does not specify NDA.

Various absorption states, including MPEs, can be specified, among others, by the amount of remaining phenomenal content, but NDA cannot be specified in this way, because it can be explicitly present or not with any amount of phenomenal content. Thus, the term MPE does not adequately capture what NDA, or consciousness-as-such, is.

Furthermore, it has been suggested that the presence of any phenomenal content however minimal implies a representational state (Metzinger, 2020). The perspective presented here disagrees with this and is closer in spirit to the phenomenological notion of pre-reflective awareness. Because NDA knowing itself is its inherent property, and does not constitute a transitive relation, there is no need for a representation, irrespective of whether NDA is isolated from other phenomenal content or co-occurring with it. Granted, using the term non-representational reflexivity for this knowing can be confusing, as reflexivity usually indicates a second-order representational cognition, but the term reflexivity as applied here indicates a very different kind of knowing, a non-representational, non-transitive reflexivity. Likewise, describing the activation of this inherent reflexivity as self-recognition does not imply recognition *via* category matching (Ksemaraja and Singh, 1990; Josipovic, 2019) The awareness-of-awareness practice, found in some contemplative traditions, has a relational representational structure as long as NDA has not recognized or realized itself. Once activated, this inherent non-representational self-knowing is just an essential property of NDA (Josipovic, 2019). The term awakened mind, as used in nondual contemplative traditions, does not refer to a state of wakefulness but to this activating of the inherent reflexivity by which awareness knows itself innately (Rabjam, 2001).

To the extent they are consciously accessible, various mental representations can appear to NDA as contents within its space, but they are parallel or orthogonal to it, so to speak, and do not define it. Furthermore, similar to the pre-reflexive perception, NDA is aware of any thoughts and other internal experiences as a first-order non-representational knowing, instead of as a second-order representational one, in other words, as just witnessing or mirroring without representation[1]. The significance of this non-representational view for our discussion is that NDA or consciousness-as-such is not a representation or a model of arousal, even though such a model may exist and function to optimize wakefulness.

When the term MPE is expanded to include the properties or dimensions of NDA, there can be considerable overlap in what the two terms denote, and the difference between them may become difficult to appreciate (Metzinger, 2020). However, as properties of NDA are non-representational and inherent to it, and are not states constructed through representations, these only appear to be the same, without actually being so. Likewise, once realized, NDA functions as the all-pervading non-conceptual space (Sansk. Dharmadhatu) that contextualizes both the intrinsic and the extrinsic aspects experience into one unified whole (Rabjam, 2007; Josipovic, 2014). This space is NDA itself, not a representation of arousal or wakefulness, irrespective of how abstract this representation may be.

As discussed in the preceding section, since phenomena, in principle, do not affect NDA, NDA can encompass and pervade any type of content, whether perceptual, affective, or cognitive. Within the space of NDA, phenomena, in addition to the individual characteristics that make them appear the way they do, also appear as having the same basic properties or dimensions as NDA. In other words, as NDA reflects phenomena that appear to it, those phenomena and states reflect the properties of NDA. Properties attributed to MPEs like epistemicity, cognizance, reflexivity, self-luminance, etc. (Metzinger, 2020) can then be seen as reflections of the inherent non-representational properties of NDA, that can appear either as unmediated or as meditated *via* mental representations.

NDA has also been contrasted with the substrate consciousness, a neither fully conscious nor entirely non-conscious matrix

[1]We thank Aviva Berkovich-Ohana for this comparison.

that is thought to function as a pervasive potential for memory and structuring of experience (Germano and Waldron, 2006). The substrate is unconscious in the sense that it is constituted by the failure of NDA to recognize itself, an obscuration of awareness' inherent reflexivity, and by the subsequent conceptual reification of NDA as a subject and of other phenomenal contents as objects, which are ordinarily unconscious processes. The substrate stores patterns of organizing experience along this dualistic subject-object polarity, from basic propositional beliefs and categorizations, to elaborate self-world models (Higins, 2011; Wallace, 2018). The purpose of contrasting NDA with the substrate is to emphasize that a mere reduction in the amount of phenomenal content or in the level of arousal does not qualify a state as being NDA or consciousness-as-such, because, until NDA has self-recognized, all experiences, no matter how minimal, have the substrate as their basis (Germano and Waldron, 2006; Higins, 2011; Wallace, 2018).

By further inflating the meaning of the term MPE, a great number of states with differing amounts phenomenal content, such as, internal silence, engagement in sequential steps of meditation techniques, or states of flow-like absorption in perceptions and actions, can all be brought under the umbrella of MPE (Metzinger, 2020). An ongoing silent alert state of vigilance and monitoring or mindfulness, with properties similar to those of NDA, can be experienced as either the background or the foreground context of such states. But without NDA self-recognizing, neither these states nor their context, can pass beyond the substrate. The question then becomes: Who or what is being mindful? Or, who or what is aware of any specific property? Realizing this requires, at first, to turn the attentional focus all the way around to face the awareness itself, and then, to sustain it there while not accepting any conceptual solutions for an answer, even when they agree with the established teachings of one's tradition or with one's personal beliefs. Instead, the holding of the question with intention to realize or directly experience the nature of awareness, as one persists in awareness-of-awareness, will lead to activating of the inherent non-representational self-knowing of NDA and the revealing of NDA as the "innermost essence" of consciousness (Rabjam, 2001).

CONCLUSION

Using the famous Zen ox-herding pictures as a metaphor, we can, arguably, compare the current state of consciousness research to being stuck in stage two of the path of discovering "the Ox": Recent advances in the scientific, philosophical, and psychological research on consciousness have given us a plethora of data that, like seeing traces of the Ox on the ground, stimulate our collective imagination and theorizing. But somehow, despite all those, we are not yet seeing the Ox itself. Current resurgence of interest in MPEs could be an important contribution to this search. However, it is crucial that we do not confuse the phenomenal contents or the levels of arousal, and their representations and models, for consciousness-as-such. Here, we have argued that only NDA, a basic non-conceptual, non-propositional awareness, that is a unique kind, can truly be considered to be consciousness-as-such. Further research is needed to advance our understanding of this foundational aspect of consciousness. Along the way, we need to resist the temptation to reduce it to other, better understood, aspects of consciousness.

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ZJ wrote introduction, NDA and discussion sections. VM wrote introduction and MPE sections. Both authors revised all sections.

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BRIEF RESEARCH REPORT
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Immersion, Absorption, and Spiritual Experience: Some Preliminary Findings

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Many traditions have utilized silent environments to induce altered states of consciousness and spiritual experiences. Neurocognitive explorations of spiritual experience can aid in understanding the underlying mechanism, but these are surprisingly rare. We present the verbal report and the electroencephalographic (EEG) alpha profile of a female participant scoring a maximal 34 on the Absorption Scale, recorded before and while she was immersed in a whole-body perceptual deprivation (WBPD) tank. We analyze her trancelike experience in terms of the imagery reported: a spaceship, corridors, doors, a man dressed in white, speaking to God, the sun, supernova, concentric images, and an out-of-body experience. Her report is indicative of a spiritual experience, given that she felt that she was "meeting God" in the laboratory. She exhibited both frontal and parietal left > right alpha power asymmetry at baseline, whereas in the WBPD condition, there was a global increase in alpha power and especially a sharp increase in right-frontal alpha power. Her verbal report and EEG alpha profile were compared to those of another female participant, also scoring high on absorption, whose verbal report was also indicative of a trancelike experience. For further comparison, we present the data for two participants scoring low on absorption. Spiritual experience that can be verbalized might be associated with a marked increase in right-frontal alpha power, as reported here. In contrast, a mystical experience characterized by ineffability would be indicated by a marked increase in left-frontal alpha power.

Keywords: spiritual experience, mystical experience, EEG, alpha, absorption

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INTRODUCTION

Many traditions have utilized silent environments to induce altered states of consciousness and spiritual experiences (Ustinova, 2017). Trait absorption, namely, the individual's ability to fully engage attention in an experience, is a primary predictor of such spiritual or religious experience (Hunt, 2000; Luhrmann et al., 2010; Luhrmann, 2017; Lifshitz et al., 2019), in the same manner that this trait predisposes for affiliated experiences, such as hallucinations (Glicksohn, 2004), sensed presence (Granqvist et al., 2005), and altered states of consciousness (Glicksohn and Avnon, 1997–1998; Glicksohn, 2019). This is especially so when coupled with generated states of heightened

absorption in an appropriate setting (Bronkhorst, 2016). As Glicksohn and Berkovich Ohana (2011, p. 54) have suggested, "the higher the absorption score, the more entranced the individual will be, circumstances permitting." Absorption is typically assessed using Tellegen's Absorption Scale (TAS; Tellegen, 1981).

A recent study employing the TAS and subjective experience of meditators, such as those of the present sample, has reported for them a mean score of 23, which was significantly higher than a mean score of 18 for non-meditating controls (Berkovich-Ohana and Glicksohn, 2017). Consequently, in the current study, we expected our participants to score relatively higher than a normative median of 19 (Glicksohn and Barrett, 2003). Further, as reported in that study, participants scoring 29+ comprised 5.6% of our normative sample; hence, the verbal reports of those participants in the present study who score between 29 and 34 are of primary interest for our investigation of spiritual experience.

In recent research looking at subjective experience arising from immersion in an environment comprising whole-body perceptual deprivation (WBPD; Glicksohn et al., 2017, 2019; Ben-Soussan et al., 2018), participants reported changes in both spatial and especially temporal experience, including reports of timelessness, which would be considered by some as constituting one component of religious experience (Fingelkurts, 2009). A stronger case could be made if some of the participants indicated that they had heard the voice of God or that they felt the presence of God (Fingelkurts, 2009). While these should be rare occurrences, they might certainly occur in participants with high trait absorption (Lifshitz et al., 2019), who experience high state absorption (or immersion) in their session (Glicksohn and Berkovich Ohana, 2012). The degree of endorsement of an item indicating having heard the voice of God ranges between 2 and 4% (Glicksohn and Barrett, 2003, p. 841). Reviewing those data involving a normative sample of 656 participants, we can now report that of 252 participants in that study who also completed the TAS, there were 12 who indicated such a spiritual experience, and of these, three scored between 29 and 34 on the TAS. In the present article, we shall report in detail the subjective experience of one of our participants, P2, presented in brief elsewhere (Glicksohn et al., 2019), who reported "meeting God" in the laboratory.

Following Lifshitz et al. (2019, p. 6), we classify her subjective report as being indicative of a *spiritual* experience. This is because in her verbal report, P2 fulfills the following three criteria: (1) "hearing God speak to you in a way you felt you heard outside your head"; (2) "having a vision that you felt was given to you by God"; (3) "feeling God near-tangibly present, as if he were standing there by your side." Her report is not viewed as being indicative of a *mystical* experience, primarily because she does not explicitly say that her experience was "ineffable, incommunicable, and indescribable" (Stace, 1960, p. 55). There is, however, a commonality of experience; for following Stace (1960, p. 131), she fulfills the criterion of "feeling of the holy, sacred, or divine."

Although neurocognitive explorations of spiritual experience can aid in the understanding of the underlying mechanism and have social implications, they are surprisingly rare (Fingelkurts, 2009; Le and Silverman, 2011). Presumably, to recall and perhaps to relive a mystical experience in the laboratory (Beauregard and Paquette, 2008) is not quite the same as to actually, and spontaneously, experience such an event. Describing such an altered state of consciousness can be revealing of the type of thought engaged in at the time (Glicksohn and Avnon, 1997–1998; Glicksohn and Lipperman-Kreda, 2007). The aim of the current article is to present and comment on such a rare spontaneous spiritual experience, as reported to us, and to investigate its electrophysiological correlates, focusing on the alpha band (8–12 Hz). In an altered state of consciousness, relative to a "resting wakefulness" state of consciousness, the left hemisphere is thought to become less active (hence, more alpha activity in that hemisphere), which is in turn balanced by a greater degree of activation of the right hemisphere. Thus, one would expect a shift to right-hemisphere dominance in altered states of consciousness (Davidson, 1976; Glicksohn and Berkovich Ohana, 2011). In addition, if the left hemisphere is less active, then the use of literal language and analytical thinking becomes impaired, leading in turn to both the experience of ineffability and a shift to an imagery-based mode of cognition (Glicksohn and Berkovich Ohana, 2011).

MATERIALS AND METHODS

Participants and General Procedure

A total of 32 healthy participants participated in this study (labeled, as in Glicksohn et al., 2019, S1–S16, and P1–P16), all being experienced contemplative practitioners, chosen to participate because of their enhanced introspective and reporting abilities. The study was approved by the ethics committee of Bar-Ilan University. Upon entering the laboratory, the participant signed a written informed consent. They all completed a number of questionnaires prior to entering the WBPD chamber, including the TAS, of present interest. Prior to entering the chamber, the participants completed a time-production (TP) task (these data have been reported in Glicksohn et al., 2017). Then, a 5 min, eyes-closed electroencephalogram (EEG) baseline recording was obtained in the open WBPD chamber, prior to the closing of its door and its illumination with white light (5 min, eyes-closed condition, labeled in the figures as baseline). The white-illuminated WBPD chamber was then closed, and a 5 min, eyes-closed EEG recording (WBPD-1) allowed us to test for the immediate effect of the WBPD. This was followed by red and indigo light, each presented for 5 min (eyes-open conditions; these 2 colored-light conditions were presented in a counterbalanced order across participants), after which a short report of subjective experience was obtained (these data, both verbal protocols and EEG, have been reported in Glicksohn et al., 2019). Then, a third 5 min, eyes-closed EEG was recorded (WBPD-2), followed by a short report of subjective experience. At the end of the session, the participants completed a second TP task and underwent an extensive interview. In this article, we focus on four participants, P2, P15, S12, and P8, presenting both their subjective reports regarding their experience during WBPD and their EEG alpha profile.

Whole-Body Perceptual Deprivation

The OVO WBPD chamber (in the shape of an egg; see Glicksohn et al., 2017, 2019; Ben-Soussan et al., 2018; **Figure 1**), created by Patrizio Paoletti and based on his Sphere Model of Consciousness (Paoletti, 2002; Paoletti and Ben-Soussan, 2019; Paoletti and Soussan, 2020), is located in the Cognitive Neurophysiology Laboratory, at the Research Institute for Neuroscience, Fondazione Patrizio Paoletti, Assisi, Italy. The chamber was flooded with white light, followed by red light and indigo light (in a counterbalanced order across participants), enabling a totally immersive WBPD. In such an environment, the participant sits in isolation and in silence. The participant's verbal reports were heard through a microphone and were recorded.

Assessment of Trait Absorption

The TAS (Tellegen, 1981) comprises 34 true/false items that participants complete regarding their cognitive–affective subjective experience (e.g., with respect to synesthesia).

EEG Recording and Analyses

EEG was recorded using a 65-channel geodesic sensor net (Electrical Geodesics Inc., Eugene, OR, USA) at a 500 Hz sampling rate, referenced to the vertex (Cz), with analog 0.1–200 Hz bandpass filtering. Impedance was kept under 40 kΩ, which is within the accepted range for this system. The data were subsequently referenced offline to average reference, and both preprocessing of the data and subsequent spectral analysis (within the range of frequencies from 1 to 45 Hz) were conducted – all in line with our previous publications (e.g., Berkovich-Ohana et al., 2012; Ben-Soussan et al., 2014). In the full report of these data (Glicksohn et al., 2019), we focused on eight regions of interest (ROIs), enabling us to present an EEG alpha profile for each hemisphere, spanning the longitude extending from frontal (F), to central (C), to parietal (P), and to occipital (O) sites. On average, there were ∼40 two-second epochs of eyes-closed EEG data for each section of time – beginning, middle, end – of each condition (baseline, WBPD-1, WBPD-2), each of which was subjected to spectral analysis. Power values were summed across bins, to derive alpha (8–12 Hz) power, which was subsequently log-transformed to normalize the data. Analysis of the EEG alpha profile was conducted using a repeated-measures analysis of variance: condition (baseline, WBPD-1, WBPD-2) × time (beginning, middle, end) × hemisphere (left, right) × ROI (F, C, P, O). The analysis is conducted at the *individual* level ($n = 1$); hence, one needs to define a suitable error term. To do this, the sum of squares (SS) for all higher-order interaction terms was pooled, which we subsequently labeled as *SSE*, as was their *df* (*dfE* being 40). Focusing on the six two-way interactions, we adopted a Bonferroni-corrected p-value of 0.008 (0.05/6) for each of these. **Table 1** (derived from a larger table appearing in Glicksohn et al., 2019) summarizes the main results for each of the four participants reported here (P2, P15, S12, P8).

FIGURE 1 | The OVO whole body perceptual deprivation (WBPD) tank located in the Research Institute for Neuroscience, Education and Didactics (RINED) of the Paoletti Foundation. Written informed consent was obtained from the individual for the publication of the potentially identifiable images or data included in this article.

Analysis of Individual EEG Alpha Profiles

In the present report, we focus on the frontal and parietal components of this EEG alpha profile. We thus examine 12 power values for each individual: left frontal (LF), right frontal (RF), left parietal (LP), and right parietal (RP) at baseline, at WBPD-1, and at WBPD-2. For each site (LF, RF, LP, RP) we define two orthogonal contrasts: (1) comparing WBPD-2 to WBPD-1, allowing us to assess the influence of WBPD on alpha power, and (2) comparing the average of WBPD-2 and WBPD-1 to baseline, allowing us to assess the difference between baseline and WBPD. For these contrasts, we use *SSE* from the complete profile as a suitable error term. In addition to these contrasts, an inspection of alpha asymmetry (e.g., L > R, or F > P) should be correlated with particular reports of subjective experience (see below), as follows: (1) positive (LF < RF) or negative (LF > RF) affect (e.g., Davidson, 1992); (2) trancelike (F > P) or reflective (F < P) state of consciousness (Glicksohn and Berkovich Ohana, 2011).

Analysis of Subjective Reports

The subjective reports, which included both open-ended descriptions of the experience during the session and answers to the semistructured interview conducted at the end of the session, were given to five independent judges, having no familiarity with the participants. In the full report of these data (Glicksohn et al., 2019), we focused on three categories: *valence* (positive vs. negative), *mode of thinking* (verbal vs. imagistic), and *state of consciousness* (reflective vs. trancelike). The judges were given the printed reports, together with a coding sheet specifying these categories, and had to make

TABLE 1 | Individual EEG alpha profiles, specifying three two-way interactions that are significant for one or more of the participants.

			Hem × ROI		Condition × Hem		Condition × ROI	
Individual	**Gender**	**Age (y)**	$F(3, 40)^a$	**Partial η^2**	$F(2, 40)^b$	**Partial η^2**	$F(6, 40)^c$	**Partial η^2**
P2	F	30	40.29*	0.75	10.43*	0.34	3.77*	0.35
P15	F	44	46.15*	0.78	4.00		3.38	
S12	M	46	5.11*	0.28	4.53		2.66	
P8	M	44	14.62*	0.52	1.66		1.93	

*Hem, hemisphere; ROI, region of interest. Critical values for *corrected p-value (0.008): $^aF_{crit} = 4.98$; $^bF_{crit} = 6.07$; $^cF_{crit} = 3.71$.*

decisions for each participant and for each category. In particular, a reflective state of consciousness is defined by an act of reflective awareness on ongoing experience, whereas a trancelike state of experience is defined by the lack of reflective awareness (e.g., Glicksohn and Berkovich Ohana, 2011; Glicksohn and Berkovich Ohana, 2012). Participants P2 and P15 were considered to have reported a trancelike experience by at least four of the five judges. P2, in particular, reported a spiritual experience.

RESULTS

Verbal Reports

Our focus is on the subjective experience of participant P2, who spontaneously reported "meeting God" in the laboratory. We first present her report, and then for comparison those of three other participants: P15, S12, and P8. We comment on the reports of P2 and P15, trying to contextualize the imagery of their trancelike experiences.

Case 1

Participant P2 is a healthy, right-handed 30-year-old woman, with no history of psychological or physical trauma or substance abuse, scoring 34 (out of 34) on the TAS. Her subjective report (appearing abridged in Glicksohn et al., 2019) is the single report we have that, to our mind, could be clearly indicative of a spiritual experience. Here is her report, which was found to depict a trancelike experience by our independent judges (Glicksohn et al., 2019):

> . . .there was this spaceship that was carrying me around the universe. When the blue light set in, I saw several corridors that lead me to several doors, which could be open, and at the end there was a person dressed in white who welcomed me, and I said to myself: "I'm meeting God." [*laughing*]
>
> (Exp: "Have you ever had a similar experience?")
>
> To meet him in person, no. But, to speak to him, yes. It was like going back home, and he said to me, "So you remember why you are on Earth now? Do you know what you have to do? You have just to continue to shine and bring light to people." That's what I heard when he appeared before me.
>
> Afterward, I heard the sounds, and it was like going back into the spaceship and going around, and I felt I have to move on [*laughing*]. When the red light set in, I felt like I was in the sun and that there was this sun that illuminated everything, and I thought I have to do the same, without making distinctions, but just to shine and to be calm [*sighs*].
>
> There was this light that was like a supernova, when planets collide, and they produce many colors. I could see many concentric images, and to travel in the universe, in this vast space. Afterward, the white light appeared again, and I came back here into the egg.
>
> (Exp: "Have you ever had a similar experience?")
>
> I had similar experiences during meditation, with me leaving the body and going around into space. It was like a journey between the microcosm of my body and the macrocosm of the universe. I thought I was able to let the sun come in once I was out of the egg [*laughing*].

A few words regarding the content of this participant's report are in order, especially in relation to (1) dreams, (2) passages and overcoming obstacles, (3) encounters with higher beings, as we will detail in the following paragraphs.

(1) Dreams – The mention of a *spaceship* brings to mind Jung (1978, p. 63), who writes when describing a dream of ". . . a space-ship that comes out of the beyond to the edge of our world in order to fetch the souls of the dead. It is not clear from the vision where the ship comes from. . .."
(2) Passages and overcoming obstacles—The participant continues with a report of seeing "several corridors that lead to several doors," which is in line with Hume's (2007, p. 6) suggestion that "The notion of getting through an obstacle, or having a passage open up to permit entry to another, more sacred dimension, permeates myths, legends, religious writing and personal narrations throughout history. . . but the passage from one to the other requires opening some sort of portal. Expressions such as 'gate,' 'way,' 'door,' 'ladder,' 'bridge,' have been employed in religious discourse and texts to indicate that movement is indeed possible."
(3) Encounters with higher beings – The figure in white, which she reports encountering, appears in various such accounts. For example, Shanon (2002, p. 107) writes: "At one turn of the trail I met a bearded old man sitting on a beautifully adorned chair. The man wore a splendid white robe full of rich embroidery, some of it golden, held a scepter in his hand and his countenance was wise and benevolent." This encounter is further in line with a rich body of

literature related to (3.1) near-death experiences (NDEs), (3.2) mystical descriptions of God, and (3.3) the unity between the microcosmos and the macrocosmos, as will be detailed below.

(3.1) In an NDE in which there are reports of both timelessness (Wittmann et al., 2017) and "meeting God" (as seen in the web-based databank of the Near Death Experience Research Foundation, http://www.nderf.org/index.htm, employed by Wittmann et al., 2017), a characteristic account of such an experience would be "I encountered a form, who I knew was God, who told me it was time to now go back"[1]. In the verbal report of P2, God has a mission for her. Following Lifshitz et al. (2019, p. 6), we classify her subjective report as being indicative of a *spiritual* experience, because she explicitly reported "meeting God" in the laboratory.

(3.2) The notion of shining like a sun, both literally and metaphorically, is familiar from the mystical literature. For example, Underhill (1955, p. 237) writes: "...and straightway he became all shining like the sun." Stace (1960, p. 97) notes "That God is light is the common metaphor for his goodness and blessedness." Further, Underhill (1955, p. 249) writes, "A new sun rises above the horizon, and transfigures their twilit world. Over and over again, they return to light-imagery in this connection."

Her imagery of concentric images could have certainly been influenced by various science fiction movies that have appeared over the years and especially by Stanley Kubrick's adaptation of Arthur. C. Clarke's, *2001: A Space Odyssey*[2]. There are, however, other precursors. Watts (1962, p. 29), for example, provides an earlier and comparable description: "I begin to feel that the world is at once inside my head and outside it, and the two, inside and outside, begin to include or 'cap' one another like an infinite series of concentric spheres." The concentric circles are, perhaps "images of phosphene rings (annuli), and images of amorphous expanding waves" (Nicholson and Firnhaber, 2004, p. 56).

Similarly to NDEs, out-of-body experiences are occasionally reported by experienced meditators (Berkovich-Ohana et al., 2013). Suedfeld (1980, p. 204) has made the insightful comment: "One problem with the scientific paradigm followed by most workers in this area is that it tends to concentrate on group results and quantitative data, so that such occurrences usually do not appear in the published research even when they have been mentioned by subjects." In the present article, we are attempting to rectify this.

(3.3) Finally, the journey the participant describes between the microcosm of her body and the macrocosm of the universe, reminds one of Jung's (1978, p. 29) writing related to: "... psychic wholeness, as the historical testimonies show, has always been characterized by certain cosmic affinities: the individual soul was thought to be of "heavenly" origin, a particle of the world soul, and hence a microcosm, a reflection of the macrocosm."

Case 2

For comparison, participant P15 is a 44-year-old woman, scoring 32 on the TAS. Her subjective report is also colorful, but does not necessarily depict a spiritual experience, although this was also judged to present a trancelike experience by our independent judges (Glicksohn et al., 2019):

> The first mental link I had was about being in my mother's stomach, this relationship came to me, so that everything I experienced was what I would feel in the mother's womb, and I heard the sounds as they were amplified, and these were the sounds produced by me; these were my sounds. So, I had a higher sensitivity for those of my breath, of the sound of my breath, all my hearing abilities were activated.
>
> It was a very strong sensation, very intense from the sensory point of view. When the red set in, it had a very strong impact on me [*laughing*], and therefore there could have been a moment of anxiety in the red, but then I linked it to the sun on the stomach, to the belly exposed to light, and so the sun enters into the mother's womb, this light. . ..
>
> In the blue, I really found my depth, I really felt myself, my deep being. It was linked to the earthly experience of the sea of the blue. However, apart from this mental link, the visual association of an ocean. . . I really felt my deep being, and this gave me a feeling of calm and peace and a sense of well-being, of self-collection [*sighs*].
>
> When the white set in, I had temporal perception, because in the white I had the clear sensation of being inside the egg, of the spatial form, the sensory perception of the egg. But, at the same time, there was also a feeling of expansion. Concerning time, time was neither fast nor slow, but I stayed firm. There was absence of time. . . but, together with this, as I was moving in time, that is cued by my breath, time was cued by my sensations, but in reality, this is in the present, it wasn't fast or slow, it just was what it was. To describe this. . . floating, in suspension, that is how I would describe it.

P15 reports womb-like imagery and other associations, which are encouraged by immersion in our WBPD, as in other comparable set-ups. For example, Benson (2001, p. 125) reports that observers placed within a Turrell Ganzfeld sphere frequently described their experience as being "calming, relaxing, womb-like, uplifting, meditative, and so on." Experienced meditators, such as P15, also report "...like being in the mother's womb. A deep state of ease and peace" (Travis et al., 2017, p. 162). She also refers to the sun, but in addition she addresses the colors. The notion that red light might influence both mood and subjective experience has a venerable history (Elliot et al., 2007).

Case 3

While no participant reported what would be considered to be a mystical experience, as defined by consensual criteria (Stace, 1960), a somewhat minor variant of the experience of unity was reported by participant S12, who is a 46-year-old man, scoring 24 on the TAS:

[1] https://www.nderf.org/joann_m's_nde.htm

[2] https://en.wikipedia.org/wiki/2001:_A_Space_Odyssey_(novel)

> Very interesting, the sensation that everything is mind. There are no points of reference. Everything is the egg. It's the environment, which is unfamiliar, and then I listen more to myself. Paid more attention to myself and to the noises of the body and of the stomach. They were expanded. It was weird and funny. It is an opportunity to look inside.

Case 4

For comparison, another 44-year-old man, P8, scoring 19 on the TAS, reported:

> . . .I was very focused on my inner experience. I was very relaxed, to the point that at some stage I was actually on the edge between being awake and being asleep. . .. I saw images coming and going. . . I always had the feeling to be with a divided attention, one focused on the inside and one focused on what was going on outside. . ..

EEG Alpha Profiles

Case 1

Participant P2 exhibited both frontal and parietal L > R alpha asymmetry (**Figure 2A**). In addition, note that she exhibits a sharp increase in right-frontal (RF) alpha power in the WBPD condition. In fact, as one reviewer has stressed, there is for her a global increase in alpha. **Table 2** summarizes the individual orthogonal contrasts employed to help interpret her data (and those of the other three participants reported here), and as can be readily seen there, the size of effect for RF is impressive. Given that she reports having experienced a spiritual experience during WBPD, it is possible that this experience is associated with this marked increase in RF alpha power. As the same reviewer has suggested, at WBPD-2, the increase in RF alpha power now equals that of LF. When the chamber was flooded with white light the second time, P2 reports that she "came back here into the egg." In fact, note that at this point in time, the L > R frontal alpha asymmetry is abolished. The parietal L > R alpha asymmetry has a corresponding focus on external space in the verbal report (spaceship, doors, etc.). P2 is completely immersed in this trancelike experience.

Case 2

Participant P15 exhibits parietal (but not frontal) L > R alpha asymmetry during WBPD (**Figure 2B**). In fact, at WBPD-1, the L > R frontal alpha asymmetry is abolished. Thus, while P2 and P15 present similar parietal alpha profiles, frontally they diverge. For P15, while in the WBPD condition, there is no L > R frontal alpha asymmetry, primarily due to the gradual increase in RF alpha power, coupled with the decrease in LF alpha power in the transition from baseline to WBPD-1 (and note from **Table 2** that there is no significant difference between baseline and WBPD for LF). As for P2, the parietal L > R alpha asymmetry has a corresponding focus on external space in the verbal report of P15 ("experience of the sea of blue"). P15 is completely immersed in this trancelike experience.

Case 3

Participant S12 has R > L parietal alpha asymmetry, which reverses (L > R) during WBPD (**Figure 3A**). There is a corresponding focus on external space in the verbal report ("Everything is the egg"). In addition, the L > R frontal alpha asymmetry also reverses during WBPD, primarily due to an increase of RF alpha power, which is somewhat similar to that observed for P2 (**Figure 2A**). Note from **Table 2**, however, that none of the contrasts are significant (the increase in alpha power between baseline and WBPD for LP does not pass our Bonferroni-corrected criterion).

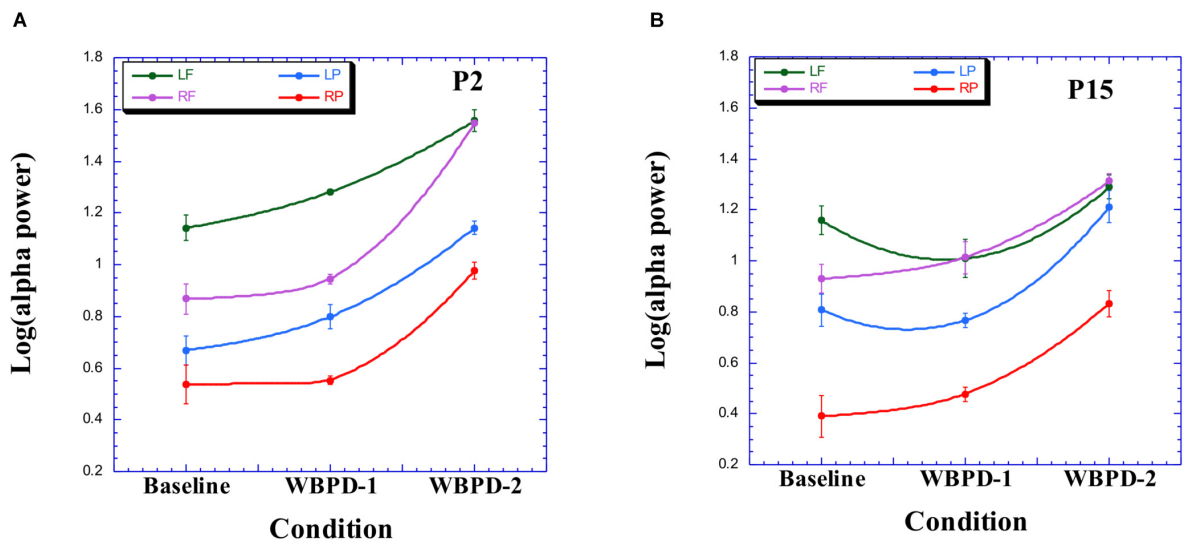

FIGURE 2 | Alpha profile for participant P2 **(A)** and for P15 **(B)**. LF, left frontal; RF, right frontal; LP, left parietal; RP, right parietal. On average, there were ∼40 two-second epochs for each section of time – beginning, middle, end – of each condition (baseline, WBPD-1, WBPD-2), each epoch being subjected to spectral analysis. Derived power values within the alpha (8–12 Hz) band were then log-transformed and averaged, for each section of time within each condition. Mean values reported here are collapsed over time within condition. Error bars refer to SE within condition, based on the three computed means.

TABLE 2 | Individual orthogonal contrasts.

Individual	MSE	ROI	SS(WBPD-2 vs. WBPD-1)	*F*(1, 40)	Partial η^2	SS (WBPD vs. baseline)	*F*(1, 40)	Partial η^2
P2	0.003	LF	0.038	10.96*	0.24	0.051	14.77*	0.30
	0.003	RF	0.182	52.87*	0.60	0.096	27.76*	0.44
	0.003	LP	0.059	17.15*	0.33	0.060	17.51*	0.33
	0.003	RP	0.091	26.30*	0.43	0.034	9.87*	0.22
P15	0.003	LF	0.039	11.44*	0.25	0.000	0.02	
	0.003	RF	0.045	12.95*	0.27	0.036	10.45*	0.23
	0.003	LP	0.099	28.82*	0.45	0.022	6.33	0.15
	0.003	RP	0.063	18.26*	0.34	0.047	13.52*	0.28
S12	0.052	LF	0.009	0.16		0.003	0.05	
	0.052	RF	0.225	4.30		0.073	1.39	
	0.052	LP	0.002	0.04		0.443	8.48	
	0.052	RP	0.001	0.02		0.209	3.99	
P8	0.004	LF	0.002	0.53		0.010	2.83	
	0.004	RF	0.018	4.98		0.013	3.66	
	0.004	LP	0.003	0.80		0.006	1.52	
	0.004	RP	0.001	0.22		0.000	0.00	

*ROI, region of interest; LF, left frontal; RF, right frontal; LP, left parietal; RP, right parietal. *Given 8 contrasts for each individual, the p-value adopted for each = 0.006 (F_{crit} = 8.53).*

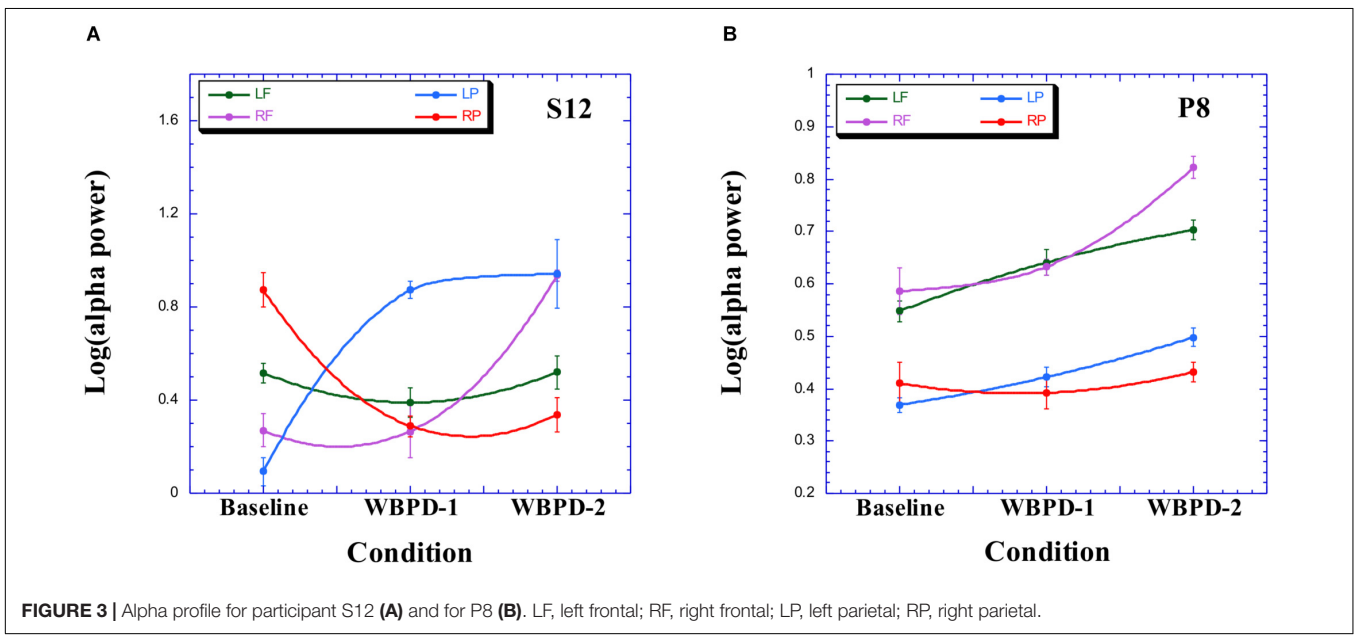

FIGURE 3 | Alpha profile for participant S12 **(A)** and for P8 **(B)**. LF, left frontal; RF, right frontal; LP, left parietal; RP, right parietal.

TABLE 3 | Participant's trait absorption (TAS), subjective experience, and EEG alpha profile.

Participant	Absorption	Ineffability	Spiritual experience	Trancelike experience	Frontal asymmetry	Parietal asymmetry	During WBPD
P2	High		+	+	L>R	L>R	RF
P15	High			+		L>R	LP
S12	Medium						
P8	Medium						

Case 4

P8 also exhibits a reversal in hemispheric asymmetry, from parietal R > L at baseline, to L > R during WBPD (**Figure 3B**). There is a corresponding focus on external space in the verbal report ("one focused on what was going on outside"). Again, we note an increase of RF alpha power during WBPD, although as with S12, none of the contrasts are significant. **Table 3** presents individual profiles for each of these participants, based on three sources of data: Trait absorption (TAS), subjective experience, and EEG alpha profile.

DISCUSSION

The present article adds to a small literature addressing neurocognitive explorations of spiritual experience (Fingelkurts, 2009; Le and Silverman, 2011). Trait absorption is clearly a relevant factor here, as others have also noted (e.g., Studerus et al., 2012). When Beauregard et al. (2009) requested from their participants "to mentally visualize and emotionally connect with the 'being of light' allegedly encountered" during their NDE, they recorded higher alpha power, relative to a control condition of mentally visualizing "the light emitted by a lamp," in both hemispheres, frontally.

Here, we found that spiritual experience that can be verbalized might be associated with a marked increase in RF alpha power (P2), and this is worthy of further study. Thus, while there is a global increase in alpha for P2 reporting a spiritual experience, note from **Table 2** the very large effect size for RF in particular.

We can contextualize these changes in alpha power and alpha asymmetry reported here for P2 and S12 with the aid of the literature, which discusses affect and alpha activity. First, note that the experience reported by P2 is both spiritual and positive. A positive experience should be correlated with lower LF alpha power, and a negative experience should be correlated with lower RF alpha activity (e.g., Davidson, 1992). If participants exposed to WBPD have sustained alertness and introspective sensitization, as one would expect from those individuals trained in contemplative meditation whose data we report here (such as P2), then one would also expect to see higher RP alpha (Benedek et al., 2014), implicating internally oriented attention. The state of consciousness of the participant can be either more trancelike (F > P) or more reflective (F < P), as we have argued (Glicksohn and Berkovich Ohana, 2011). Furthermore, Lodder and van Putten (2013, p. 230–231) have suggested categorizing the alpha power distribution as follows: (1) "normal," if P > F; (2) "moderate differentiation," if P = F; and (3) "deviant," if F > P. Combining these notions, and looking at the individual alpha profiles, we note that both P2 and P15 display "deviant" differentiation at both baseline and during WBPD, and they were both immersed in their trancelike experience. But P2 reports a spiritual experience, which she has no problem in describing. Hence, the experience is not characterized by ineffability, as would be characteristic of a mystical experience. We stress that her spiritual (but not mystical) experience might be indexed by a marked increase in RF alpha power.

Mystical experience, which is characterized by ineffability (Stace, 1960), should be associated with a marked increase in LF alpha power (Davidson, 1976), and this should be looked for. A trancelike experience is associated with parietal L > R alpha asymmetry (Glicksohn and Berkovich Ohana, 2011), as reported in this article. A reversal in alpha asymmetry noted here, from parietal R > L at baseline, to L > R during WBPD (participants P8, S12), may well be indicative of the type of dynamic shift in hemispheric asymmetry predicted by Suedfeld et al. (1994) for exposure to our WBPD environment. Indeed, our use of WBPD facilitated what Travis et al. (2017, p. 162) have termed "lively silence," which is "not passive or inert" – as clearly seen in the imagery reported by our participants. As McGilchrist (2019, p. 330) has recently noted, "A constant feature of all mystical traditions is an emphasis on the creative power of silence and stillness" and further that this facilitates "the mode of attention to the world [more] of the RH than the LH." Our data – both experiential and electrophysiological – support this view.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation, to any qualified researcher.

ETHICS STATEMENT

Written informed consent was obtained from the individual for the publication of the potentially identifiable images or data included in this article.

AUTHOR CONTRIBUTIONS

JG and TB-S designed the research, analyzed the first-person reports and EEG data, and wrote the manuscript. Both authors contributed to the article and approved the submitted version.

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REVIEW
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The Wilderness Solo Experience: A Unique Practice of Silence and Solitude for Personal Growth

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Silence is now acknowledged by science as a significant construct of healthy human development and well-being, linked to humans' neurobiology, psychology, physiology, and spirituality. This paper focuses on a particular form of silence experienced through the solo experience in the wilderness. The solo experience, involving varying periods of time spent in solitude and silence in the wilderness is a common method of intervention implemented among therapeutic and educational nature-based approaches. Numerous studies and personal accounts in the field underscore the solo experience as one of the most significant nature based interventions linked to various beneficial outcomes. These studies emphasize the significance of the wilderness, far from daily demands, and devoid of technological stimuli allowing the silence, time and space for self-reflection and contemplation on the sacredness and meaning of life. Although new to modern culture, solitude in nature is an ancient form of initiation used ceremonially by indigenous cultures worldwide. These practices challenge the individual who alone in the wilderness battles fear and loneliness only to discover inner strengths and true identity. The solo experience, viewed as enacting these ancient rituals in modern form may serve as an antidote to the loneliness, stress, and depression on the rise in the current era, which have been linked to our overly stimulated urban environments and lifestyles. This paper sheds light on how the wilderness solo is experienced and understood, specifically as contributing to therapeutic outcome and personal growth. The empirical and theoretical literature is reviewed pointing to the significance of solitude and silence as basic components of the wilderness solo. These are linked to profound personal outcomes including the discovery of new and expansive ways of knowing the self and the world, specifically as interconnected in the larger web of life, enhancing a sense of personal belonging and purpose.

Keywords: silence, solitude, nature based therapy, nature, personal growth, solo experience, wilderness, self reflection

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Nobody can counsel and help you, nobody. There is only one single way.

Go into yourself.

—Rainer Maria Rilke

INTRODUCTION

Silence is acknowledged to be a human quality or value that is important in a variety of significant areas of psychological development (Denham-Vaughan and Edmond, 2010; Kemerer, 2016; Vaughan and Klimo, 2016). Scholars and researchers underscore the many opportunities embedded in silence for human beings to explore the contents of consciousness and gain insight, free from environmental and social constraints (Lehmann, 2016; Lehmann et al., 2019). However, in modern life, immersed in noise, commotion, and stimuli, it may be hard to experience silence and further to acknowledge its benefits, especially when many individuals associate silence with unwanted feelings like loneliness and anxiety (Maxted, 2005).

This paper focuses on the facilitated *wilderness solo experience,* defined broadly by Knapp and Smith (2005) as a retreat from daily life, where the individual spends a prescribed time alone and in silence, in the wilderness, to contemplate the meaning and purpose of life, in a way that is difficult to do in everyday settings. The wilderness solo experience is commonly offered by counselors, psychotherapists, coaches, and educators, as well as by outdoor adventure leaders, and has gained empirical and professional credibility as one of the most influential components of outdoor education, contributing to participants' learning and growth (Bobilya et al., 2005; Daniel, 2005; Kalisch et al., 2011). The solo experience offered by professional practitioners as part of a therapeutic program, can be considered a unique nature-based intervention (NBI) providing individuals with a secure and professional framework to experience silence and solitude in the context of personal growth (Shanahan et al., 2019).

Silence has been underscored as a central characteristic of the solo experience in the wilderness, but the characteristics, effect, and personal experience of silence within this context have yet to be explored (Knapp and Smith, 2005), Literature in the field of health psychology has focused on silence in the context of therapeutic intervention, mostly as the absence of verbal communication, in individual psychotherapy, psychoanalysis, and group therapy (Elson, 2001; Levitt, 2001; Ladany et al., 2004). Hence, our understanding of the effect that the practice of silence has on the nature and quality of inner experience and human behavior in the field of psychology is limited (Valle, 2019). Despite growing evidence that attests to its merit (see, for example, Kalisch et al., 2011, extensive review), the wilderness solo experience, perceived as a distinct therapeutic intervention, integrating silence and solitude, has yet to gain attention within the broad field of psychology (Nicholls, 2008). This paper seeks to gain further understanding regarding the therapeutic value of silence by focusing on the wilderness solo experience as a unique growth-oriented intervention. A brief review of the study of silence in the psychological and therapeutic context is presented, followed by a description of the method of inquiry of this study, which builds upon a review of theoretical and empirical literature in order to discuss the basic components of the wilderness solo experience—silence, solitude, and the wilderness—in the context of personal growth. We conclude with a statement of the significance of the study, as well as its limitations.

SILENCE

Silence is not the absence of something but the presence of everything.

—Gordon Hempton

Although silence has commonly been defined as the absence of sound or communication (Valle, 2019), current discourse has examined silence more as a path allowing the presence and development of human qualities. In his work on the nature of silence, Picard (2002, p. 15) described silence as "an autonomous phenomenon [which is] not simply what happens when we stop talking [but] an independent whole, subsisting in and through itself." Therefore, it is through the absence of external noise that a profound process of gaining knowledge may be triggered (Picard, 2002).

The significance of silence to human experience has propelled inquiry in the realm of psychology and mental health, revealing both positive and negative aspects of silence. Lehmann (2016) utilizes the typology of silence proposed by Bruneau and Ishii (1988), denoting that silence-related phenomena fall into one of three categories: (a) silence—a solitary and mystical experience, often described as the temporal dissolution of the perception of time and space; (b) silences—social aspects of integration, connection, and communication; or (c) silencing—as a means of restricting someone else's expression by exhorting power. Although these three notions are interconnected, this paper focuses on the first category—the value of silence as a human quality linked to self-discovery and inner knowledge, defined by Lehmann et al. (2019) as being aware of, perceiving, thinking of, and analyzing the contents that show up in consciousness.

Through this lens, silence has been found to be a significant and active factor in the therapeutic process. Elson (2001, p. 351) reviewed the various types of silence occurring in it, emphasizing the opportunity for change and growth embedded in periods of silence. She described silence in the therapeutic dialect as a powerful tool that, when worked with effectively, may allow immersion in the creative experience of restoring, renewing, or initiating strengths and capacities inherent in a cohesive self. She concluded that "silence itself is a fertile mode in which the self is enriched and strengthened, the source of that quiet growth in which distortions of the self can be reflected upon and then transformed."

Dénommé -Welch and Rowsell (2017, p. 23), in their review of the epistemologies of silence, suggest that silence may support personal growth and development. The authors define silence as "providing individuals with a fluidity and mobility to shift moods and environments and as such is transitional and it invites change." Marcandonatou's (1998, p. 318) study, which investigated the experience of "being voluntarily silent for a period of four or more days" by implementing a variation of

classic existential–phenomenological methodology, revealed nine comprehensive themes that represent transpersonal dimensions of existence portraying the research participants' shift "from their personal ego-self perspective toward aspects of experience that can be named transegoic." In light of her findings, Marcandonatou concludes that silence may be linked to personal transformation, union, transcendence, mystical states, and love.

The opportunity embedded in silence for positive change and human development was the focus of Valle's (2019) metareview of the behavioral and experiential approaches to silence in psychology and the effects that intentionally practicing silence have on deepening one's experience. Based on his extensive review, Valle (2019) proposed a classificatory system of ten forms of silence, ranging from the most external worldly manifestations to the subtlest, most inwardly attuned discernments (environmental, sensory, psychic sensory, emotional, verbal, mental, pre-reflective, intuitive, ontological, and transcendent), illuminating the human potential to experience vast dimensions of human existence through various forms of silence.

These conceptualizations emphasize the psychological value of experiencing silence, which is especially relevant in the modern era characterized by intense lifestyles that leave us with very little space, if any at all, to experience internal and external quiet (Bobilya, 2005). Burns (2005) stated that it is the diversion from silence that has distanced us from gaining a deeper knowledge of self. Indeed professionals from various areas of interest posit a fundamental psychobiological mismatch between humans and their largely non-natural, technological environments and lifestyles (Byrnit, 2006). More than five decades ago, Jung (1951) stressed that as a result of the modern lifestyle, devoid of quiet introspection and reflection, "our psyche is profoundly disturbed," and the boundless activities characterizing people's daily lifestyles have led to extraverted and overstrained individuals (in Sabini, 2008, p. 255).

The opportunity to slow down and reflect in silence may be exactly what is needed to find internal peace in the busyness of our lives (Bobilya, 2005). Czech philosopher Kohak (1984) referred to silence as a gift that we need to reclaim if we are to become fully realized humans. The ancient tradition of wilderness solitude, revived in the current age as the wilderness solo experience, may provide individuals with a path to practice the gift of silence.

The Wilderness Solo Experience as a Path to Personal Growth: From Ancient Practice to Modern Times

The wilderness solo experience derives its roots from ancient traditions in which people sought healing, rejuvenation, self-knowledge, and spiritual insight, gained through journeys and retreats into the wilderness, often alone (Storr, 1988; Gibbens, 1991; Fredrickson and Anderson, 1999). Moses, Jesus, Buddha, and Gandhi are examples of great leaders who regularly spent time alone in the wilderness that was associated with their personal transformation and enlightenment (McDonald and Schreyer, 1991).

Throughout history and across cultures, removing oneself from the demands of daily life in order to contemplate life in the silence and solitude of the wilderness has been practiced in various forms. The *vision quest* is a common form of this practice. Nineteenth-century anthropologists and cultural historians first used the term *vision quest* to describe a ceremonial initiation practiced among ancient traditions, by which the individual journeyed into the wilderness for an unlimited time alone to find their individual strengths, calling, vision, and purpose in life (Gennep, 1960). Traditionally, the quest began by purifying the body, mind, and spirit and concluded with the community welcoming the individual back, commemorating the triumph by adorning him or her with a new title or role in the community (Smith, 2005a). The vision quest marked what Arnold van Gennep (1960) defined as a *rite of passage,* a universal phenomenon of human development enacted through initiation rituals involving the common sequence of separation, transition, and incorporation. In many cases, a quest into the wilderness alone was taken to mark the transition from one life stage to the next, by rising to a challenge of body, mind, soul, and spirit (Norris, 2011).

This tradition of retreat into the wilderness to gain insight, guidance, and inspiration has led to the development of the modern-day, facilitated *wilderness solo experience* as a common intervention in the field of wilderness therapy and outdoor education (Norris, 2011). In their book *Exploring the Power of Solo, Silence, and Solitude,* Knapp and Smith (2005) define the wilderness solo experience as a retreat alone into the wilderness for a prescribed time (typically several days), sometimes fasting, allowing the individual to reflect on and better understand their place, purpose, and direction in life. The wilderness solo experience is usually a facilitated group process, comprised of a significant period for preparation, followed by time alone (from several hours to several days) in a specific designated place in the wilderness, concluding with integration of the experience in the context of the group. Variations of the solo experience may include physical activities, such as hiking or canoeing, which may or may not be part of a facilitated program, and solo experiences that are implemented alone rather than in a group.

Wilderness solo experiences are widespread in outdoor and adventure programs for youth worldwide, such as Outward Bound and the National Outdoor Leadership School, and are perceived not as a survival exercise but rather as a profound growth and learning experience (Smith, 2005a). Solo experiences in the wilderness are also prevalent in various nature-based programs focusing on personal growth for adults from the general public. One example is The School of Lost Borders, founded in 1984 by Steven Foster and Meredith Little, which has facilitated thousands of people through wilderness solo experiences. The wilderness solos they offer adhere to the three basic phases of the ancient rite of passage, but while in indigenous cultures the individual would go through these phases alone and each phase could go on for an unlimited amount of time, in contemporary wilderness solos these stages are limited and facilitated by experienced guides. These programs typically involve several days of preparation during which the participants spend time together participating in ceremonial

practices designed to help them prepare for the journey as much as possible. Norris (2011), who explored rites of passage models in adventure therapy, delineates the stages: The first stage involves the preparation for the solo, which includes talks and exchanges in the group about safety issues, physical challenges, aspects of the flora and fauna in the area, and emergency procedures. A considerable part of the preparation is also dedicated to potential psychological challenges, personal fears, and clarification of the participant's personal intention for participating in the solo. This procedure rests on the assumption that the more aware the participants are of the feelings that can arise as part of the experience and of their personal intention the more they can learn from the experience (Knapp and Smith, 2005). The second stage is the initiation, typically involving three days of solitude and fasting in the wilderness. What happens during this time is highly individualized—some participants relay experiences of connecting and conversing with nature, the elements, and animals; others experience boredom, hunger, and loneliness; some experience deep love and joy; and for many this is a time to evaluate their relationships and lives (Norris, 2011). In this stage, participants are encouraged to contemplate their life's purpose (e.g., vision) and to consciously, and preferably ceremonially, mark what is ending in their life while apprenticing to a new beginning. Incorporation is the last stage, beginning with the individual's return to the group and the everyday world and the processing of the experience. Usually, participants are welcomed with a generous meal to break the fast and after a period of rest the group gathers in circle to start sharing their experiences. Here, the program guides take on the role of the elders in indigenous traditions as they listen to the stories and mirror back elements of significance and meaning of the soloists' stories (Smith, 2005b). The incorporation phase focuses on how the solo experience and insights gained can be applied to the participant's life toward positive change and profound growth.

Variations of solo time spent in silence in the wilderness are prevalent in nature-based programming worldwide and are perceived as a key factor in gaining educational and therapeutic outcomes (Knapp and Smith, 2005). A growing body of literature points to the solo experience in the wilderness as a unique experience linked to profound therapeutic outcomes (Daniel, 2005; Knapp and Smith, 2005; Coburn, 2006; Nicholls, 2008; Kalisch et al., 2011). This paper reviews the literature in the field, highlighting the facets of the wilderness solo experience that are relevant to understanding its value in the context of personal growth.

METHOD

The solo experience may be viewed from various perspectives (e.g., psychological, social, or cultural). To gain a better understanding of the therapeutic value embedded in the solo experience, literature from the fields of leisure studies, outdoor education, and nature-based therapies was reviewed, including books, personal accounts, and research studies that focused on solitude and silence experienced in the wilderness. This review was not limited by the year of publication of materials or the framework of intervention involved. Through this expanded lens, various forms of the solo experience were assessed, including what authors and researchers referred to as *solo time* or *solo experience* denoting periods of time spent in solitude and silence in the wilderness that were part of a designed program for youth as in Outward Bound. We also reviewed studies and accounts of time spent alone in silence as part of nature-based workshops for adults defined by the terms *vision quest* or *rite of passage*. In light of the limited empirical data on the topic, we expanded our initial focus on the facilitated solo experience to include various studies that focused on the experience of silence and solitude in the wilderness that were or were not part of a facilitated program. These included accounts of wilderness excursions, hiking, or canoeing alone for a period of time that provided us with important understandings regarding the value of experiencing silence and solitude in the wilderness. Additional studies focusing on solitude from the psychological literature were reviewed when current literature was not sufficient.

Empirical Review

Qualitative methods are the prominent methodology in the study of the wilderness solo experience. They provide us with an understanding regarding the subjective, lived experiences of participants in the wilderness solo (Nicholls, 2008). Various qualitative studies have been conducted with adults who experienced different forms of wilderness solitude, including wilderness immersion (Hammitt and Brown, 1984), canoeing (Swatton and Potter, 1998), hiking (Fredrickson and Anderson, 1999), solitude (Coburn, 2006), and modern vision quest ceremonies (Wilson, 2011). These studies stress the significance of the natural environment, devoid of daily commotion, human interference, and mental and emotional demands, allowing a specific form of silence contributive to self-reflection and profound insight (Knapp and Smith, 2005).

This unique form of self-reflection, experienced by spending time alone in the wilderness, was the focus of Hammitt and Brown's (1984) inquiry into the cognitive dimensions of wilderness solitude. The researchers developed a wilderness privacy scale to identify and measure the various dimensions and functions of privacy among wilderness users. The 28-item questionnaire was submitted to 109 university students in outdoor recreation classes. Their findings indicate emotional release and resting of the mind from anxiety and mental fatigue, as linked to cognitive change attained through privacy and silence in the wilderness. The researchers concluded that wilderness privacy allows for the integration of one's thoughts and experiences, which is key for releasing stress and efficient functioning (Hammitt and Brown, 1984). The wilderness privacy scale was examined by Hammitt and Madden (1989) among 184 overnight backpackers in Great Smoky Mountains National Park. Factor analysis of twenty items produced five main factors, ranging from most important to least: tranquility and the natural environment, individual cognitive freedom, social cognitive freedom, intimacy, and individualism. The natural environment, free of artificial noise and intrusions, was found to provide a sense of tranquility and peacefulness. The researchers concluded that wilderness privacy is a much more complex

concept than being alone, which they described as a form of privacy in a specific mental setting where individuals experience an acceptable and preferred degree of control and choice over the type of information they must process (Hammitt and Madden, 1989). The findings of these studies were supported eighteen years later in Hammitt et al. (2001) study, conducted as a replication and comparison of cognitive perceptions found in Hammitt and Brown's (1984) original study. The cognitive dimensions of wilderness solitude were assessed by administering the same questionnaire and data analysis to the same number (n = 109) of university students who spent time alone in nature backpacking. Cognitive states of solitude were illuminated as involving mental renewal attributed to rest from anxiety and mental fatigue. The participants attributed this renewal to the independence, individuality, and self-evaluation described as functional attributes of the wilderness, devoid of manipulation and domination from others.

Swatton and Potter's (1998, p. 15) qualitative study examined the link between wilderness solitude and personal growth. Four expert North American canoeists, ages 45 to 68, who had completed four or more solo canoe expeditions of two weeks or longer, were interviewed to understand their solitary wilderness experiences. Their findings highlighted the significance of the solo experience as involving three main components: (a) being alone in silence, which allowed the tranquility, peace, and time necessary for self-reflection; (b) the physical, mental, and emotional demands of the canoeing trip, which allowed the paddlers to become more aware of themselves in relation to the natural surroundings and propelled a sense of self-actualization; and (c) the natural environment, which provided unscheduled time devoid of disturbances or a sense of judgment by other people, allowing them to observe and explore the self with greater freedom of expression. The researchers concluded that the wilderness solo experience is a "powerful environment for individuals to become aware of their own potentials, capabilities, and talents and that solitude encourages individuals to explore, discover and actualize their potentials." These studies did not focus on silence specifically, but they did emphasize how the natural environment provided a unique form of social, mental, and environmental quiet or silence, conducive to self-reflection and mental clarity linked to personal growth.

The only study focusing on the sensed quality of silence and solitude in the wilderness solo is Nicholls (2008) qualitative study. Nicholas examined the internal and subjective "sense" of silence and solitude, defined as "quiet time." Eighteen students, males and females, who participated in the solo experience as part of a wildernesses therapy program, were interviewed, and data was collected in the form of journals and field notes. The wilderness solo emerged as involving a subjective sense of solitude, contrary to common conceptions that define solitude as an objective and external condition (Larson, 1990). The findings of this study revealed four co-occurring subjective conditions by which the sensed experience is defined: (a) a sense of being alone, (b) a positive mind frame, (c) a personal time perspective, and (d) focused attention. The positive experience and effect of the solo experience was attributed to an individual experience of solitude and silence, shared by a small social group. This led to the definition of the solo experience as *being alone together*, a term initially coined by Hammitt (1982). In the social and environmental context, the time spent in ruminative reflection and/or simply focusing on nature had a positive impact on participants' understanding of themselves and on their capacity to understand some of their unresolved and significant domestic concerns.

In Foster and Borrie's (2011, p. 7) study, the significance of the distinct *quiet time* spent alone in the wilderness lay in the connections cultivated in that space, between the participants and the natural environment. Interviews were conducted with thirty-two overnight backcountry campers, ranging from nineteen to sixty-seven years old, traveling alone by canoe. Analyses of the interviews revealed distinct ways of engagement with nature; the participants immersed themselves in simple ways of being and escaped technological information that was often said to have taken over their everyday lives. The natural environment, described by the participants as free from intentional human control, provoked new ways of relating to themselves, other people, powers greater than themselves, and the wild landscape. The majority of participants emphasized the mental calm and self-reflective thinking brought on by the wilderness. The researchers concluded that in nature, far from everyday routine, social constraints, technology, and daily duties, one has "the time and space to re-connect with others and with the greater creation." In these conditions, the participants' relationship with an array of spiritual themes was often kindled and/or sustained.

Experiencing a significant relationship and connection with oneself and the environment through solitude in the wilderness has been shown to elicit significant outcomes and, in many cases, even personal transformation. Coburn (2006) explored the nature of psychospiritual transformation experienced among twelve women hiking alone over 2,000 miles on the Appalachian Trail. Extensive review and analysis of the data, including personal accounts written by the participants, spoken stories about their experience of solitude in the wilderness, and created or chosen visual images of transformation shed light on the transformative aspects of the experience. The constructs of personal transformation that emerged included experiencing a sense of wonder, feeling competent, trusting, a sense of being fully present in the moment, becoming more authentic, and desiring to be of service. The participants attributed these constructs to the time spent alone and in silence, allowing them to experience acceptance and interconnectedness in the vast, timeless, and ever-changing natural environment. In these conditions, the participants developed a new and intimate connection with self, others, and nature that led to what they described as the dissolving of their former identity and the development of a more connected and authentic one.

Similar findings appear in Wood's (2010) research on self-evaluated psychospiritual transformation among twelve adults who participated in modern-day wilderness solos. The transformative constructs of the participants' experience included: (a) experiencing significant connections with nature through interaction or relationship, described as a sense of being a part of nature and being guided by nature instilling a sense of purpose, (b) a shift in awareness, described as a

shift from a state of questioning to a state of understanding, and (c) self-acceptance, involving the recognition of previously unrecognized parts of the self. The personal transformation was described as feeling more authentic or whole, discovering a purpose in life, and the ability to embrace life in its fullness. Such transformation involved the integration of newly discovered aspects of themselves revealed as a result of connecting with nature during the wilderness solo. This realization was attained through experiencing nature as guiding and enabling, experiencing non-separateness with the wilderness, experiencing a range of significant feelings through encounters with nature, experiencing nature as sacred, viewing inner processes as part of nature, experiencing flow states of consciousness in nature, and being passionate about maintaining a conscious relationship with nature. Being oneself in a more authentic way, feeling more serene and peaceful, and securing a purpose in life comprised the psychospiritual transformations the participants experienced. Importantly, this study reveals that modern-day wilderness solos provide the opportunity for the kinds of experiences that invite such psychospiritual change.

Unfortunately, most of these studies have been conducted with small population groups and thus have been limited in scope. Therefore, Kalisch et al.'s (2011) study of the solo experience as conducted in Outward Bound and undergraduate wilderness programs in the United States is seminal in providing us with further understandings. For almost two decades, the researchers examined participants' experiences of the solo in wilderness programs using multiple methods, including written surveys, focus group interviews, one-on-one interviews, and field notes; in some cases participants were asked to reflect on how the solo had affected them a year after the program. The 335 first-year college students who participated in solos of various lengths (twenty-four to sixty hours) as part of eighteen-day wilderness programs described the solo as the most significant aspect of the wilderness experience. The researchers assessed the components attributed to personal growth attained through the solo experience relating to three components. The first component was the participants' receptivity. Most students documented feeling excited upon entering the solo, and most of the students chose the word *solitude* when asked to identify the most enjoyable characteristic. Taken together, these factors suggest receptivity upon entering and during the experience, which often contributes to personal growth. The second component was described as optimum stress related in the context of personal growth to overcoming challenge. This suggests an explanation for the number of participants who responded positively to solitude, fasting, inactivity, or unstructured time. Although these experiences were often described as the most difficult, they were also valued or most enjoyed by some participants. The stress did not diminish the quality of their solo; rather, it was facilitative of their personal growth. The third component involved change and attunement. The data showed that as the solo progressed, the participants' attunement to their own lives, to relationships with others, and to the natural environment was also enhanced. The results indicate that although participants valued the time alone, they also found these to be the most difficult aspects of the solo. Solitude was simultaneously the most enjoyable and the second most difficult aspect of the solo, followed by boredom and preceded by fasting. Within this context the wilderness solo was an opportunity for the participants to become aware of spiritual and/or religious dimensions of life and to clarify, evaluate, and redirect themselves by setting goals for the future. By reflecting on themselves in relation to the wilderness, others, and, in some cases, God, participants became more attuned to the important matters in their lives and in the world of which they were a part.

The findings of these studies highlight the significance of self-reflection and contemplation experienced in the wider context of the wilderness. Daniel's (2005) retrospective study supports this, finding the wilderness solo to be a significant life experience, related to the contemplation of life, in relation to the larger world context. Daniel's study was conducted among participants in the Discovery Wilderness Program in 1976 and 2000. The solo phase consisted of two to four days and nights of solitude accompanied by fasting. Two hundred twenty-seven of the 446 participants were asked to recount experiences of their own choosing. Primary data sources included self-administered participant surveys and focus group interviews. Secondary data sources derived from two pilot studies conducted in 1999 and 2000 included written pre- and post-trip questionnaires, taped debriefing sessions, journal entry analysis, reflection papers, and instructors' observations and field notes. On the one hand, the solo experience was described by the participants as the most significant trip component, providing an opportunity for reflection, introspection, and contemplation in solitude and silence. On the other hand, time alone in silence was perceived by the participants as "dead" or "unproductive," which led many of them to feel uncomfortable and anxious. As such, solo time entailed mental, physical, emotional, and spiritual challenges that in retrospect were viewed as productive of empowerment and personal growth.

The results of this study suggest that the wilderness solo incorporates the characteristics of significant life events specifically attributed to five factors: (a) A new perspective was gained by the participants through examination of the self in relation to the environment, to others, and to God. (b) It was a new and/or extraordinary experience for most participants when they went on the expedition, and it was unique compared to other life experiences. (c) It took place in beautiful, natural, and inspirational settings. (d) The solo offered mental, physical, emotional, and spiritual challenges. (e) It allowed the opportunity for reflection, introspection, and contemplation in solitude and silence. These studies highlight the significance of the solo experience, specifically linked to beneficial self–reflection; however, the ability to practice self-reflection or the specific personal characteristics linked to engaging positively in these situations was not examined. Therefore Bochniak's (2007) study is important.

Bochniak focused on individual differences, specifically introversion versus extraversion, as influencing the individual's perception of the wilderness solo experience. The participants were sixty-four college students, females and males, who participated in a twelve-day backcountry canoe and backpacking trip conducted as part of a wilderness pre-orientation program.

Participants filled out a questionnaire measuring extraversion and self-actualization, in relation to wilderness solitude attunement. Participants experienced solitude in four major areas in the following order of frequency: intellectual and spiritual elements; isolation; physical and personal freedom elements; and emotional restoration. The relative novelty of the wilderness solo experience for extraverts was the strongest explanation for their higher wilderness solitude attainment scores compared to introverts, who tended to be more comfortable with being alone. Bochniak concluded by emphasizing the characteristics of the natural environment as greatly contributing to the solo experience. These included tranquility and peacefulness as a result of a lack of intrusions or distractions, opportunities for emotional restoration, and freedom from social constraints that allows individuals to exercise their own free will in thought and action, contributing to the development of individualism and a deep connection with something outside of the self. In addition, silence, described as a lack of interruptions, was considered to be an important part of the solo experience, as was the role of the instructor, although both were not assessed.

There appears to be some consensus that wilderness solos typically have positive outcomes for participants when they have free choice about when and where they spend their period of solitude. For many young people, specifically those who undertake the experience as mandatory in a structured program, the wilderness solo may not have the same positive outcomes. Maxted (2005), who examined 48-hour solo experiences of adolescents over four years, warns about the danger of romanticizing solos as spiritual growth opportunities that for some adolescents are perceived and experienced negatively. Maxted (2005) found a number of fears related to the solo experience and categorized them into fears regarding the wilderness aspects and unexpected encounters with other people, as well as fears of being alone and of the unknown within. Smith (2005b), who has facilitated hundreds of wilderness solos, attributes these fears to the fact that many people do not know how to be alone, finding solitude frightening, boring, or unproductive, emphasizing the importance of preparation and leadership. Kalisch et al. (2011) stressed the difference between being lonely and being alone, with the latter being conceived as essential for mental health and effective leadership.

Whether solitude is experienced as empowering or as a state of loneliness has been linked to the individual's mindset and coping capabilities. This was the focus of Larson's (1997) study, differentiating between loneliness as a form of "unhealthy solitude" and being alone as "healthy solitude" involving the ability to cope positively with being alone. Larson assessed these differences by sampling reports from 483 European-American fifth- through ninth-graders. Larson examined the participants' experience of their companionship and subjective states at random times during the week. He concluded that healthy solitude seems to involve aloneness, not as an end in itself but rather as a temporary withdrawal that complements healthy adjustment in the other social domains of adolescents' daily lives. This relational perspective is supported by Hollenhorst et al. (1994, p. 234), who developed a scale to measure the psychological dimensions of wilderness solitude that was administered by a survey sent to 298 forest hikers. Based on analysis of participants rating the importance of the different dimensions, the researchers described solitude as a multidimensional concept. In contrast to common notions reflecting solitude in relation to the absence of community, solitude was described as a state of being and, in relation to self, a state of mind. The researchers concluded that the success of wilderness solitude is essentially about "the capacity to cope positively with time spent alone."

Physical and mental preparation are necessary so that the individual is equipped with the personal resources and strengths for being alone and coping with self and environment in a way that serves the participant's growth (Knapp and Smith, 2005). Kalisch et al. (2011) suggest the following constructs as influencing the outcome of the wilderness solo: the participant's receptivity attained by voluntary choice to attend the program; the participant's expectations; and the instructor, who turned out to greatly influence the participants' solo experience. Therefore professional facilitation, safety measures, voluntary participation, and proper preparation, during and after the experience, may alter the participant's perception of the solo.

Maxted (2005, p. 135) also denotes the significance of preparation in order to help participants truly engage with their surroundings, especially for adolescents, as they "need to be jolted out of potential solo boredom in order to connect with nature." Drawing on reports indicating that adolescents compared to pre-adolescents may receive more benefit from the solo due to better reasoning skills, which allow for deeper self-examination (Larson, 1997), Maxted (2005) concluded that the solo bears the potential to lead to deep thinking if there is appropriate reflective skill-building as a preparation for the wilderness solo. These understandings are supported by Kalisch et al. (2011) in their study that compared experiences of soloists of different ages, finding that younger participants struggled with boredom more than older ones. Therefore Maxted (2005) suggests facilitating "mini-solos," which take place prior to the "real" wilderness solo and include observational and reflective tasks in the wilderness as optimal preparation. By gradually experiencing solitude in this way, a sense of self that can survive in the absence of immediate social reinforcement is developed and the ability to profit from solitude is enhanced.

Findings From the Literature

This review sheds light on the solo experience in the wilderness as involving a unique interplay between three basic components that are linked in the reviewed studies to profound personal outcomes, as shown in **Table 1**.

These components are: (a) silence, experienced in the wilderness solo, not as a seclusion from stimuli but more as allowing the mind to rest from cognitive processing of information and offering the opportunity to experience a form of contemplation by which significant insights regarding the self and the world are attained; (b) solitude, experienced in the wilderness solo as both a challenge and an asset, providing the

TABLE 1 | Summary of empirical studies on the wilderness solo.

Studies	Method and Participants	Silence as experienced in the wilderness solo	Solitude as experienced in the wilderness solo	The Wilderness	The psychological effect
Hammitt and Brown (1984)	Developed and administered a wilderness privacy scale among 109 university students in their quantitative study	Emotional release, and resting the mind from anxiety and mental fatigue	Personal autonomy and self-evaluation	The natural environment devoid of manipulation and domination from others allowed freedom to process information	Cognitive freedom: allowing for the integration of ones thoughts and experiences, which is key for releasing stress and efficient functioning
Hammitt and Madden (1989)	Quantitative study, factor analysis of wilderness privacy scale among 184 overnight backpackers	Lack of human generated noise and intrusion that inhibit peace of mind	Free from constraints, rules and observations from society allowed an acceptable and preferred degree of control and choice over the type of information processed	The natural environment free of man -made noise and intrusions provided a sense of tranquility and peacefulness Directive of one thoughts to what is fascinating	Individualism
Swatton and Potter (1998)	Qualitative study conducted among four adult North American canoeists	Tranquility, peace, and time necessary for self-reflection	Being alone without a sense of judgment by other humans, allowed participants to observe and explore self with greater freedom of expression	The natural environment, devoi of disturbances or sense of rush by other humans, provided an ideal environment for reflection.	Observation and exploration of self as a way to discover and actualize potentials, capabilities, and talents
Hammitt et al. (2001)	Replica of Hammit and Browns quantitative study. Questionnaires administered to 109 university students who spent time alone backpacking in nature.	Tranquility and peace of mind	Personal and social autonomy	Wilderness devoid of manipulation and domination from others	Mental renewal Independence, individuality, and self-evaluation
Daniel (2005)	Multi method pre Dominant qualitative study retrospective study among 227 students participating in a solo experience consisting of two to four days and nights of solitude accompanied by fasting in the Discovery Wilderness Program	The opportunity for reflection, introspection, and contemplation in solitude and silence	Mental, physical, emotional and spiritual challenges that in retrospect were viewed as productive of empowerment and personal growth	The natural environment evoked deep reflection. The beauty and raw power of creation inspired participants to reflect on a creator and was a source of great spiritual inspiration.	The beneficial effect included: a) a broadened understanding of self and the world; (b) a greater awareness of personal strengths and limitations; (c) an enhanced ability to accomplish or at least to try new and difficult tasks; (d) a greater faith and trust in God; (e) a greater awareness of spiritual dimensions; (f) an awareness of the interconnectedness of life; and (g) an increased
Coburn (2006)	Qualitative study to assess transformation among twelve mid age women hiking alone over 2,000 miles on the Appalachian Trail.	Experiencing a sense of being fully present in the moment	Discovering a new and intimate connection with self and nature	Experiencing a sense of wonder, in the vast, timeless, and ever-changing natural environment as well as a sense of vitality, competence and acceptance.	Developing an authentic identity and a desire to be of service

(Continued)

TABLE 1 | Continued

Studies	Method and Participants	Silence as experienced in the wilderness solo	Solitude as experienced in the wilderness solo	The Wilderness	The psychological effect
Bochniak (2007)	Quantitative and qualitative designs among sixty four college students, female and male that participated in a twelve-day backcountry canoe and backpacking trip	Emotional restoration	Physical rest and social detachment led to enhanced introspective and spiritual connections.	Tranquility and peacefulness as a result of a lack of intrusions or distractions and freedom from social constraints	Exercise of free will in thought and action, contributing to the development of individualism and a deep connection with something outside of the self
Nicholls (2008)	Qualitative grounded theory inquiry among eighteen youth at risk, participating in a solo experience	Quiet time associated with low levels of noise and a focused attention	The subjective 'sense' of solitude included a) a sense of being alone; b) a positive mind frame; c) a personal time perspective and d) focused attention.	A sense of freedom, awe and wonder inspired by being in the wilderness	Gaining an understanding of themselves and their capacity to understand their unresolved and significant domestic concerns Enhanced sense of worth and peace, personal insight, relaxation, and mental clarity
Foster and Borrie (2011)	Qualitative inquiry by interviews conducted with 32 adult overnight backcountry campers	The natural environment, free from intentional human control, provoked new ways of relating to themselves, other humans, powers greater than themselves, and the wild landscape		Mental calm and - reflective thinking brought on by wilderness	New ways of relating to themselves, other humans and nature that evoked spiritual themes
Kalisch et al. (2011)	Quantitative study conducted among 335 first-year college students who participated in solos of various lengths (twenty-four to sixty hours) as part of eighteen-day wilderness programs	Far from human distractions participants were propelled to look inward and reflect on their lives, their experiences, and their relationships with others and God. The environment also contributed a sense of peace and awe as they considered the intricacy and beauty that surrounded them	The enjoyment of being alone, and an appreciation for the opportunity to rest and to reflect on relationships, lives, and future goals but also boredom and challenging	The participants looked forward to having time to relax and to think for an extended time eliciting feeling of peacefulness.	Personal Growth was linked to: a) receptivity, b) optimum degree of stress from the wilderness experience, and c) change of pace and the opportunity for attunement to one's self and the immediate environment.
Wood (2010)	Qualitative intuitive inquiry method applied among 12 adults who participated in modern-day wilderness solos	Nature was experienced as guiding and enabling, revealing aspects of self through encounters with nature. Inner processes were perceived as part of nature, and interconnected	The opportunity for deep contemplation through reflecting unconscious material in nature	Experiencing a shift in states of consciousness	Developing a more authentic self Discovering a purpose in Life Promoting a sense of wholeness

opportunity for self-discovery, specifically as interconnected to the wider world by which a sense of belonging and purpose are elicited; and (c) the wilderness—providing the tranquility, peace, cognitive freedom and time necessary for significant self-reflection far from daily demands or human interference. The distinct way these components are experienced in the wilderness solo experience are explored in the following section in relation to various theoretical and empirical perspectives, linking these components to psychological health, well-being, and personal growth.

Silence, Solitude, and the Wilderness in the Context of Personal Growth

Silence

The silence of the forest, the peace of the early morning wind moving the branches of the trees, the solitude and isolation of the house of God: these are good because it is in silence, and not in commotion, in solitude and not in crowds, that God best likes to reveal himself most intimately to men.

—Thomas Merton

Literature in the field of outdoor education discusses silence as a key aspect of the wilderness solo, but the inner experience and effect of silence in the wilderness solo has not been explored. This review reveals silence, experienced in the context of the wilderness solo, as a unique contemplative state. In contrast to common definitions of silence as the absence of sound or communication (Elson, 2001), silence experienced in the wilderness solo has been described as a way to listen and attune to internal insights and knowledge. In the context of the wilderness solo, devoid of external (social, cultural, and mental) stimuli, this silence becomes the fertile ground for authentic self-reflection, self-discovery, and contemplation on one's personal story, in relation to the greater interconnected web of life. So although Czech philosopher Kohak (1984, p. 127) stated that "we are convinced that truth is in communication, we fear solitude no less than we fear darkness, and have striven strenuously to banish it from our lives," silence, as experienced in the wilderness solo, invites us to become aware of, and attune to, the sounds, senses, and emotions in both internal and external reality. Wendell Berry (1990, p. 120) describes this as a state in which "one's inner voices become audible [and] in consequence, one responds more clearly to other lives." Sardello (2008) calls the direct experience of silence not the absence of something, or a passive state, but more a condition of active receptivity—"living silence." Integrating this perspective into formulating a spiritual psychology, Sardello (2008, p. 19) states: "Silence is the bountiful source of our sensing our self, and all creation with newfound clarity and intimacy. . .It is silence that gives our living body its solitude, its oneness with soul and spirit."

Silence, experienced in the context of the wilderness solo, allows the mental space and cognitive freedom for deep contemplation, akin to the state of *being*. Within his theory of human motivation, needs, and self-actualization, Maslow (1968) described being as an inner state of stillness, linked to contemplation and enjoyment of the inner life (see Maslow, 1970). According to Maslow, states of being are not passive but are rather dynamic, involving growth within—exploring, experiencing, delighting, and enjoying. All these experienced states, while perceived as attitudes of pure being, essentially lead to becoming (Maslow, 1968). Seen as such, the state of being derived from silence, as in the solo experience, is akin to and contributive to the state of mindfulness, defined by Brown and Ryan (2003, p. 822) as "being attentive to and aware of what is taking place in the present." Howell et al.'s (2011) empirical research study upholds the suggested link between mindfulness, nature connection, and well-being. Their study sought to understand how silence experienced in nature relates to well-being. To assess the connection between nature experience, mindfulness, and well-being, several measures of well-being and wilderness connectedness were administered among 375 undergraduate students. Mindfulness emerged as a significant correlate of nature connectedness, suggesting that the sensory impact of experiences in nature enhance awareness that may foster mindfulness and well-being.

Goodman (1972) wrote: "There is. . . the fertile silence of awareness, pasturing the soul. . . the silence of peaceful accord with other persons or communion with the cosmos." But where does the individual go today to pasture on awareness and commune with the cosmos in a civilization immersed in noise? This review suggests the wilderness solo may provide an optimal environment for the experience and practice of silence, as a mindful state of being, in a contained framework.

Solitude

Without great solitude, no serious work is possible.

—Pablo Picasso

Solitude has been defined as "the state of being alone, separated from other people, whether considered a welcome freedom from disturbance or as an unhappy loneliness" (Encarta World English Dictionary, 1999, p. 306). As stated previously, in the wilderness solo, solitude seems to be experienced very differently, as an experience of *being alone together* (Nicholls, 2008, p. 204) or, as described by Cole and Hall (2010) in their inquiry of wilderness privacy, as *being away* from crowds of people, rather than feeling isolated. The inner experience of solitude in the wilderness, described as such, may be attributed to the natural environment enhancing awareness and connections to the wider world. Kohak (1984, p. 39) refers to "the condition of being alone in the presence of a living, familiar world, being willing to listen to it, to see and to understand it. sharing in its feel and meaning." General conceptions of solitude as being linked to loneliness, a serious problem for many people, has led much contemporary psychological research to focus on alleviating the negative effects of being alone (e.g., Ernst and Cacioppo, 1999). But psychologists interested in the positive aspects of solitude have examined its potential for human development. Winnicott (1958) stated that the fully mature adult is endowed with the potential to engage in solitude for the purpose of controlling anxiety caused by stress and has the capacity to use time alone to reestablish emotional homeostasis. Fiske (1980) described the freedom from distraction, along with focused attention when alone, as providing a unique opportunity to examine and clarify one's current life situation. Scientific literature has begun to recognize the benefits of solitude as a relief from social stressors; an opportunity for refection and insight; a chance for personal, spiritual, and creative development (Long and Averill, 2003, p. 582); an opportunity to engage in self-selected activities, relatively free of social encumbrances and expectations (Larson, 1990; Burger, 1998); and an opportunity to gain emotional release, self-appraisal, healing, and emotional renewal (Suedfeld, 1982; Storr, 1988).

Empirical research has demonstrated the link between voluntary solitude and well-being. Comfort in being alone was found to be related to lower depression, fewer physical symptoms, and greater life satisfaction (Larson and Lee, 1996). In Larson's (1997) study following fifth- to ninth-graders for one week, moderate amounts of time spent alone were significantly linked to fewer parent-reported behavioral problems, higher teacher-rated adjustment, lower depression scores, and even higher grade point averages. In an additional study, higher levels of concentration were found among teenagers during time spent by themselves, followed by an increase in cheerfulness and alertness following two hours of solitude. Among adults,

comfort in spending time alone was correlated with less sadness, fewer undesirable physical symptoms, and greater overall life satisfaction (Larson and Lee, 1996).

Solitude, experienced in the wilderness solo, seems to involve an awareness of both internal and external connections, by which an individual mindset may expand to a more interconnected one. Koch (1994) describes this in *The Philosophy of Solitude*, stating that one's consciousness in solitude is not limited to self-focus or inward direction. Solitude experienced as holding the potential for humans to become aware of and connect to broad aspects of existence is aided by silence. "The less one hears of human noise, the more disengaged from people one is, and so the deeper the solitude" (Koch, 1994, p. 20). Nouwen (1981, p. 29) agrees, referring to silence as the vehicle by which the experience of solitude is manifested: "Silence completes and intensifies solitude. . .silence is the way to make solitude a reality." Recent literature in the field of psychology demonstrates the significance of both silence and solitude in the context of personal thriving and well-being. Littman-Ovadia (2019) offers a two-dimensional model for understanding and constructing a balanced adult life: doing–being and relationship–solitude. In this model, thriving is attained by active doing (mastery/accomplishment) and by relationships (collaboration/engagement in positive relationships). These comprise two major elements within the common models of well-being (e.g., self-determination theory and the flourish/PERMA theoretical model). However, to live a balanced life, Littman-Ovadia states that the two socially desirable modes of existence—doing and relationships—must be complemented by 'being' and 'solitude'. Both of which are practiced and experienced through the wilderness solo.

The Wilderness

And into the forest I go, to lose my mind and find my soul.
— John Muir

The Wilderness Act of 1964 (U.S. Public Law 88-577) mandated congressionally designated wilderness areas, described as providing "outstanding opportunities for solitude" (Hammitt, 1982, p. 293). Although the Wilderness Act clearly specifies the concept of solitude, it does not describe the psychological benefits of these experiences in the wilderness. This review suggests that the natural environment, distant from society and the distractions and pressures of everyday life, can give rise to a unique process of self-discovery, which is elicited by internal–external attunement (Smith, 2005a). Even though experiences in the wilderness are highly individual, specific features in the natural environment seem to contribute to the positive experience of silence and solitude. The capacity to gain benevolent outcomes (e.g., caring and generous behavior) through nature connection has been discussed as *savoring,* which is conceived as the capacity to intentionally attend to positive experiences to enhance positive feelings (Bryant and Veroff, 2007).

An extensive body of research points to the distinct characteristics of beneficial experiences and outcomes of encounters in the wilderness. One example is Snell and Simmonds's (2012) study on spiritual experiences in nature. They interviewed twenty volunteer participants and found that, as part of their wilderness experience, the participants noticed a switch in their state of mind from analyzing and thinking to being rather meditative and reflective. In this state, the participants found it easier to resolve their personal issues, which led to profound changes in their beliefs, identity, and emotions (Snell and Simmonds, 2012). According to Snell and Simmonds (2012), this process resembles that outlined in Kaplan and Kaplan's (1989) Attention Restoration Theory, which provides a detailed and empirically sound explanation as to why and how the wilderness can support silence, through restoration of the capacity for directed attention. Based on the findings of their nine-year study focusing on how participants in wilderness programs experienced nature, the researchers developed the concept of "restorative environments" that promote human wellness. Kaplan and Kaplan (1989) defined the distinct characteristics of the natural environment linked to restoration, including (a) being away—from the stresses and responsibilities of daily life that demand direct attention, (b) fascination—as a unique form of effortless attention elicited toward the natural environment, (c) extent—a setting sufficiently rich and coherent that engages the mind and promotes curiosity, and (d) compatibility—the relative simplicity of living in nature and easy functioning as a coherence between the setting and one's task.

Based on a ten-year study examining the dynamics, impact, and value of the natural environment, Talbot and Kaplan (1986) found that developing a sense of comfort and attunement with the external environment promoted the development of an internal sense of ease and comfort that may support the practice of silence and solitude more than in artificial environments. Furthermore, studies that have compared the settings clearly point to the significant influence of actually being in nature, rather than being exposed to an urban or even virtual natural environment, on complex socio-emotional processes such as dealing with a life problem (Nicholls, 2008). Mayer et al. (2009) conducted studies to investigate whether exposure to nature actually facilitated individuals' ability to reflect on a life problem. In these studies, participants took a 15-minute walk in an urban or natural environment or watched a 15-minute video of a natural or urban environment. The findings of these studies show a correlation between being in nature and the participants' ability to reflect on a life problem. Self-reflection was most effective when participants were in the natural environment rather than the virtual natural environment.

The profound effect of the natural environment on this unique state of contemplation and perception has been attributed to specific characteristics of the natural environment, including the vast and boundless landscapes and the beauty and power of nature's elements. This is shown in Daniel's (2005) study examining the wilderness solo as a significant life experience. The findings of this study emphasize self-reflection experienced in wilderness solitude as involving not only the self but contemplation on the deepest questions of human existence. What is distinct about this reflection is that it is characterized by a sense of wonder and joy linked to experiencing the power of life and the unity of all. Daniel attributes this unique reflective

experience to three specific characteristics of the wilderness that evoke awe and an encompassing perspective: The *beauty* of the places, the *perspective* afforded by being on mountain peaks, and the *power* exhibited by natural elements, such as raging rivers or thunderstorms. Thus, it is not merely enhanced attention resources that support personal growth but also an expanded perspective on life that arises from the experience in nature. This sense of connection to the vast interconnected world has been shown in many cases to inspire a shift in perception, leading to transformative states (Naor and Mayseless, 2017).

So although Thoreau (1995, p. 128) stated that "solitude is not measured by the miles of space that intervene between a man and his fellows," the natural environment, far from fellow humans, may support the need for "the time and space to re-connect with others and with the greater creation" (Foster and Borrie, 2011, p. 7).

DISCUSSION

This paper examines the value of the solo experience in wilderness as a modern-day interactive path to practice a unique form of contemplative silence, by which an awareness and attunement to the larger interconnected web of life is cultivated. The studies and accounts reviewed shed light on the distinct characteristics and perceptions of the wilderness solo, involving a unique interplay between three basic components: silence, solitude, and the wilderness, contributing to personal growth, self-discovery, and, in some cases, personal transformation.

The first component—silence—emerged as a unique form of contemplation, experienced in the wilderness as a state of *being*, by which awareness and connection to both internal and external nature was enhanced, specifically as interconnected. The findings of Schlegel et al.'s (2009) study on true self-concept and meaning in life support these understandings, illuminating authenticity and self-knowledge as unique characteristics of the state of being that are essential to the sense of meaning in life.

In the context of psychotherapy, silence has been examined as a form of communication (Levitt, 2001), a way to provide space for an empathic flow between the therapist and client (Elson, 2001), and as a means to listen and convey empathy (Ladany et al., 2004). This paper presents a new perspective underscoring silence not just as a way of listening but as a way of actively discovering aspects of human existence. And as such, it may be through the practice of silence in the wilderness that significant insight and knowledge are attained regarding not only ourselves but the more subtle connections between ourselves and the larger world.

In this way, silence experienced through solo in the wilderness seems to differ from various contemplative approaches to silence that encourage the individual to turn attention away from, or even prevent, the intrusion of sounds, thoughts, emotions, and speech to achieve an inner silence, stillness, and calm (Valle, 2019). In the wilderness solo, silence is experienced as a way to become actively aware of and attuned to the external environment by which an awareness and connection between internal and external nature are developed. From this perspective, silence may elicit a shift from interactions that center on the self to a genuine dialogue between the realms of self-exploration and existential encounters with others, where relational depth blossoms (Lehmann et al., 2019). And as such, it holds the opportunity for self-reflection and contemplation of our personal story, in relation to the greater interconnected web of life.

Based on the works of Heidegger (1962) and Wittgenstein (1958); Bindeman (1981) conceptualized a phenomenology of silence, as a phenomenon that motivates the individual toward self-exploration and self-knowledge. Self-knowledge is attained through silence, by confronting us with an emptiness, mirroring the one who faces it (Bindeman, 1981). In the wilderness, this contemplative state is not only reflecting something about who we are personally but who we are in relation to the large interconnected web of life.

Although the second component, solitude, has been associated with escape or complete isolation from other people, the literature in wilderness therapy indicates that it is experienced very differently in the wilderness. Observations and studies of wilderness users described solitude experienced in the wilderness as involving an awareness and connection to the environment and as such it is experienced less as separation from society and more as connection to the wider world (Heintzman and Mannell, 2003; Bobilya et al., 2005; Wilson, 2011).

Hence, the wilderness solo is an opportunity to be socially separated while developing awareness and intimate relationships with self and the environment through attentive silence. From this perspective, solo time is not the absence of communication but a way of experiencing our unconditional connections and relationships with the world, answering our universal need to belong (Naor and Mayseless, 2019). Interestingly, "feelings of connection to something greater" are delineated by the World Health Organization (2002) as an existential dimension of health. Research has shown that well-being and happiness are associated with defining our "selves" as part of an interconnected whole (Terhaar, 2009). Recent studies relate the psychological value of experiencing a connection with the wider world, contributing to the sense of union and non-duality, which in many instances propelled a sense of meaning and sacredness toward life that was found to be transformative (Heintzman and Mannell, 2003; Bobilya et al., 2005; Naor and Mayseless, 2017).

Solitude experienced in the wilderness is one way to open us up to the various ways of belonging and relating to the world. Seigel (2007) stresses that recognizing life as interconnected leads to well-being by enticing a fundamental shift in our way of living, based on concern for the larger world rather than for our independent selves. Denham-Vaughan and Edmond (2010) describe this shift as a process involving a growing awareness to subtle aspects of our phenomenal field expanding and diffusing our sense of the self–other boundary that defines us. The potential to gain this transformational shift is reinforced by experiencing solitude and silence in the wilderness, for by relating to the environment, the illusion of our separateness as a self becomes dispelled, and we may listen and attune to

the external environment, realizing the interconnected unity of our existence.

Larson et al. (1982) described solitude as similar to an ecological niche and suggested that solitude offers potential opportunities, and dangers, either of which may be realized depending on the characteristics of the particular person attempting to thrive there. In this view, the psychological benefits of experiencing solitude depend on the "ecological niche" in which it is experienced. This review suggests the wilderness solo may provide such a niche, which may be used for benevolent outcomes when individuals are offered the proper guidance and support that would enable them to derive personal meaning and growth from the experience of solitude and silence.

The third component of the wilderness solo is the natural environment. The wilderness, perceived as a restorative environment (Kaplan and Kaplan, 1989), is characterized as far from daily demands and human interference, providing the tranquility, peace, and time necessary for self-reflection and contemplation on meaning and purpose in life. The studies reviewed in this paper show that experiencing silence and solitude in the wilderness may yield many more psychological rewards than mere restoration, including the cognitive and social freedom required for self-reflection and significant connection to internal and external reality. Thus, it is not merely enhanced attention resources that enable personal reflection but also a perspective on life gained by a sense of connection that arises from being silent and attentive to nature. Seen as such, the wilderness solo experience may contribute to a shift in perspective from one focused on the self to a more encompassing perspective based on concern for the larger interconnected world (Seigel, 2007). John Muir found this to be so, stating that the wilderness is particularly conducive to enabling people to see themselves as "a small part of the one great union of creation" (Muir, 1938). In fact, the wilderness is the most common trigger for peak experiences characterized by a deep feeling of connection and unity, which in many instances have been linked to major self and life transformations (McDonald and Schreyer, 1991; Naor and Mayseless, 2017).

The facilitated solo experience in the wilderness is one path by which people in modern society can retreat, develop, and remember the human quality and value of silence within a contained framework. And as such, for many people it might be the only option to gain the insight embedded in silence and solitude toward knowing self and personal growth. Kohak (1984, p. 40) states that through solitude in nature, we can "recall the ageless rhythm of nature and. the moral law which our bodies and spirits yet echo beneath the heavy layer of forgetting."

Limitations and Future Prospects

This paper focused on the wilderness solo experience, revealed as a unique path to an experienced sense of solitude and silence, by which a deeper knowing of self and the world is gained. Within the limits of this paper and in light of our objective to gain a better understanding regarding the value of silence and solitude to personal growth, additional components of the experience were not reviewed. Assessing additional components (e.g., experiencing the solo with others; personal history, specifically in connection with experiences in the wilderness; personal characteristics that may support or limit the ability to be alone in silence; therapeutic objectives that may focus more on coping with being alone rather than gaining personal insight; professional conduct, including the alliance and trust that provides sufficient support; and adequate preparation and integration) would contribute to our understanding of the phenomena toward a general conceptualization of the solo experience as a nature - based intervention that promotes health and well-being as provided by Irvine et al. (2020) in their model for nature-based interventions. Further inquiry is required to gain a better understanding specifically regarding the therapeutic value of experiencing silence toward personal, social, and environmental health. We hope that the potential embedded in the solo experience for personal development as reviewed in this paper will provide new prospects for therapeutic interventions that involve periods of silence and solitude.

AUTHOR CONTRIBUTIONS

LN and OM conceived of the presented idea. LN reviewed the literature in the field and put the main ideas into writing. OM advised LN on the development of the main ideas and provided critical revision of the manuscript. Both authors discussed the main objective and contribution of the manuscript resulting in the final manuscript. Both authors contributed to the article and approved the submitted version.

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Dynamics of the Sphere Model of Consciousness: Silence, Space, and Self

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The *Sphere Model of Consciousness* (SMC) delineates a sphere-shaped matrix that aims to describe subjective experiences using geometric coordinates, in accordance with a neurophenomenological perspective. According to the SMC, an experience of overcoming the habitual self and the conditioning of memories could be placed at the center of the matrix, which can then be called the *Place of Pre-Existence* (PPE). The PPE is causally associated with *self-determination*. In this context, we suggest that *silence* could be considered an intentional inner environment enabling self-perception to focus on the "here and now," which in turn improves perception of one's own body in space. To investigate the hypotheses grounded in the model, the current preliminary study examined the Place of Pre-Existence Technique (PPEt), in which practitioners are guided to focus on a self-defined aim, reach a state of detachment from the habitual self, and envision the future. Four-hundred eighty-one volunteer PPEt practitioners completed self-report questionnaires before and after an intensive 3-day meditative training. We analyzed potential relationships between subjective experiences related to physical, emotional, mental, temporal, and spatial components, as well as self-determination and silence, before and after training. The results indicated a transition from a prevailing influence of *mental dimension* on the other aspects of experience, to a prevailing influence of the *spatial dimension*. Silence was reported more often following the training and was predominantly related to mental and emotional experiences. The results are discussed in the framework of the SMC, as compared to other models, and in relation to the shift from Narrative to Minimal Self and to increased balance among the considered dimensions.

Keywords: Sphere Model of Consciousness, Place of Pre-Existence, meditation, self-determination, silence

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INTRODUCTION

Silence is often associated with both the Eastern and the Western meditative practices but has rarely been directly addressed in the scientific literature examining them. In the current paper, we consider the possible role of silence in the *Place of Pre-Existence Technique (PPEt)*, a meditative method based on the *Sphere Model of Consciousness* (SMC; Paoletti, 2002a,b, 2008;

Paoletti and Selvaggio, 2011, 2012; Paoletti and Ben-Soussan, 2019). In the SMC, silence is conceptualized as a space or inner environment intentionally created (Ben-Soussan et al., 2019; De Fano et al., 2019) that improves perception of the 'here and now' (Paoletti, 2019). Similar to other models of consciousness, such as the phenomenological matrix proposed by Lutz et al. (2015) and the Default Space Model for Consciousness (Jerath et al., 2015, 2018), the SMC is a neurophenomenological geometric model considering the subjective experience of the world first of all as the experience of a body in space (Strawson, 1959, 1974). We refer here to the definition of neurophenomenology as a research program aiming to bridge the explanatory gap between first-person subjective experience and neurophysiological third-person data, through an embodied approach to the biology of consciousness (Maturana and Varela, 1980; Varela et al., 1991). In the Lutz et al. (2015) model, the geometrical matrix is specifically structured to investigate the subjective phenomenology of mindfulness practices, mapped onto a Euclidian space in which three primary dimensions are recorded: Object Orientation, Dereification, and Meta-awareness. In the Jerath et al. (2015) model, the 3D default space is composed of all cells of the body and the thalamus fills in processed sensory information from corticothalamic feedback loops, resulting in the re-creation of the internal and external worlds within the mind. The use of the sphere shape as a matrix is a distinct feature of the SMC, which refers to the geometrical properties of this figure in describing the phenomenology of subjective experience (Paoletti and Ben-Soussan, 2019) and especially the experience of non-dual consciousness (as investigated by Josipovic, 2014; Vago and Zeidan, 2016; Vieten et al., 2018). In the SMC, the three intersecting axes of a sphere spatially represent the unfolding possible dynamics and polarity of experience, in terms of temporality (past–future), emotion (pleasant–unpleasant), and self-determination, which signifies intrinsic versus extrinsic motivation (see **Figure 1**).

According to the model, all possible subjective experiences are placeable at the intersection of the three axes. When one intentionally distances oneself from the different aspects of one's ongoing experience, which is placeable along the axes (e.g., worries about the future, recrimination about the past or recrimination for someone's behavior), one achieves neutrality and detachment from the usual experience of the Minimal and Narrative Selves. As such, the new experience of equidistance from aspects of experience can be placed in the center of the sphere, which is referred to as the *Place of Pre-Existence (PPE)*. This state of neutrality and detachment from the usual experiences of the Minimal and Narrative Selves is related to a third state, realized at the center of the sphere, defined in the SMC as *Overcoming of the Self* (Paoletti and Ben-Soussan, 2019). This state is further conceptualized as a state defined in the literature as consciousness without content, or non-dual awareness (Travis and Pearson, 2000; Raffone and Srinivasan, 2009; Metzinger, 2018; Josipovic, 2019).

The concepts of Minimal Self and Narrative Self were first proposed by William James (1890/1950) and then redefined by Gallagher (2000). The former denotes the Self as "I," the knowing subject, with a temporary presence, while the latter refers to the Self as "me," the object that is known, which incorporates autobiographical identity related to life events and decisions (Gallagher and Zahavi, 2008 [2012]). Importantly, Berkovich-Ohana and Glicksohn (2014) further suggested that experiences related to the Narrative Self are perceived as further away from the body and more abstract and related to the future and the past. Narrative Self, Minimal Self, and Overcoming of the Self are represented in the SMC as concentric circles around the center of the sphere, with greater distance from the center signifying a more abstract experience of oneself. As the PPE is located at the center of the sphere, movement toward it dictates a shift toward the Minimal Self, or even Overcoming of the Self.

Similar to Tibetan Shamatha and Theravada Vipassana (Lindahl et al., 2014), different meditative techniques grounded in the SMC, such as exposure to *OVO Whole-Body Perceptual Deprivation* (Glicksohn et al., 2017, 2019; Ben-Soussan et al., 2019) and practice of *One Minute Meditation* (OMM, Paoletti, 2018), invite practitioners to reflect on the idea that they can reach the PPE, and thus generate positive transformation of the usual self through detachment from memories and equidistance from the dimensions of experience: spatial and temporal (Travis and Pearson, 2000; Raffone and Srinivasan, 2009; Berkovich-Ohana et al., 2013; Metzinger, 2018; Josipovic, 2019), as well as emotional, mental, and physical (Paoletti, 2008; Pesce and Ben-Soussan, 2016; Ben-Soussan et al., 2017). In addition to these dimensions, which are usually reported in relation to meditative and contemplative practices (Hinterberger et al., 2014; Wittmann, 2015; Wahbeh et al., 2018), based on the SMC, we also focused on self-determination (Paoletti and Selvaggio, 2012; Paoletti and Ben-Soussan, 2019). Intentional allocation of attention to the present moment (Wahbeh et al., 2008) is a salient component of meditation and of mindfulness practice and has also been incorporated in self-determination theory (Keune and Perczel Forintos, 2010; Ryan and Deci, 2017).

The PPEt is a guided meditation that aims to lead practitioners to a neutral perception of past and present, allowing them to envision the future from the center of the sphere, where they are assumed to be relatively free from the influence of autobiographical memories. Thus, PPEt relies on the metaphor of an *empty place* (Paoletti and Bombi, 2016) for detachment, which characterizes the state of Overcoming of the Self. This metaphor presumably induces the practitioner to overcome the dichotomous perception of emotion (pleasant versus unpleasant) and time (past versus future) (Paoletti and Ben-Soussan, 2019). In this context, intentional silence (Pinder and Harlos, 2001; Paoletti and Selvaggio, 2012; Bigo, 2018) is believed to facilitate closeness to the center of the sphere.

Subjective experience of the world is first of all a physical experience of a spatial world (Strawson, 1959, 1974). In accordance, several models of consciousness have emphasized the importance of space (Khachouf et al., 2013; Jerath et al., 2015). Based on the assumption that brain circuits related to spatial representations are involved in more complex mental constructs, and that spatial representations enable abstract thought (Rizzolatti and Sinigaglia, 2006), a correspondence between spatial coordinates and dimensions of experience is

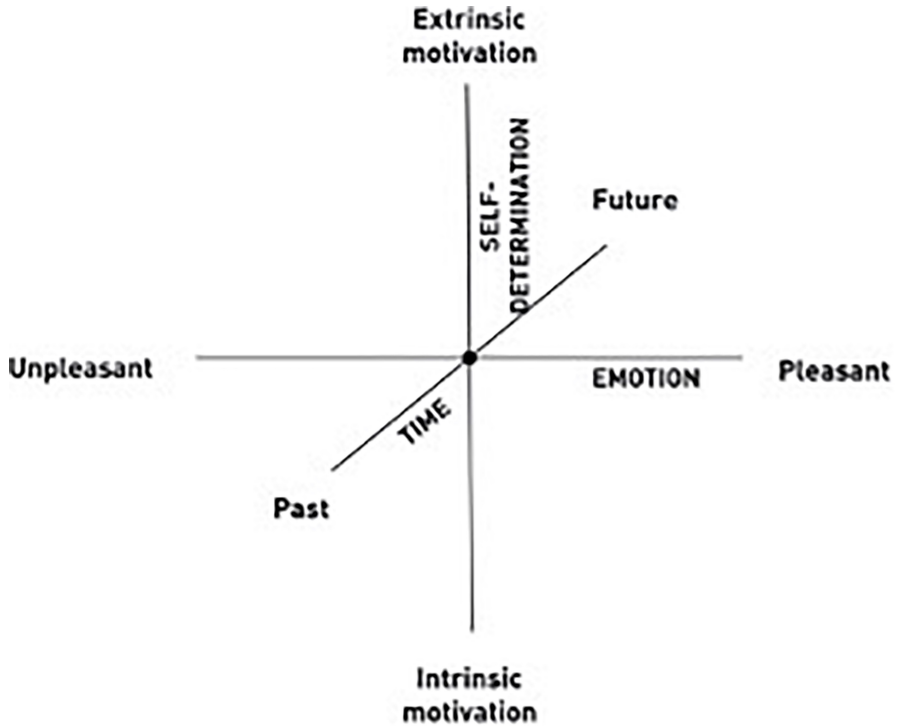

FIGURE 1 | The axes of the Sphere Model of Consciousness. The *Place of Pre-Existence* (PPE) is placed at the intersection of the three axes in the center of the sphere. Adapted from Paoletti (2002a) and Paoletti and Ben-Soussan (2019).

proposed in the SMC. Furthermore, spatial representation as the ground on which the mind builds abstract conceptualizations is also a central feature in self-representation according to Legrand (2006); Zaehle et al. (2007), and Blanke et al. (2015) Thus, to examine relationships between increased awareness of space and bodily self-perception in the 'here and now' (Legrand, 2007; Blanke et al., 2015), in the current study we examined whether intensive meditation training could affect the experience of space (Van Leeuwen et al., 2012; Hinterberger et al., 2014; Wahbeh et al., 2018) in PPEt, which would in turn alter the perception of one's self and the level of involvement in both cognitive and emotional experience. We also examined the role of silence in the hypothesized alteration in consciousness. To this end, we utilized a self-report questionnaire in which participants were asked about changes in their experience of space and its interactions with physical, emotional, mental, and temporal experience (Metcalfe and Son, 2012; Vandekerckhove et al., 2014; Barrett, 2017; Josipovic, 2019), and open questions about spontaneous silence-related experiences between two PPEt sessions, one before and one after an intensive 3-day meditation training program.

METHOD

Participants

A total of 481 volunteers (62% women; mean age = 45.36 ± 11 years; education = 51.2% middle/high school, 48.8% undergraduate/graduate school; occupation = 49.2% self-employed and 36.5% clerical/office worker) participated in the study. All completed the SMC Meditation Practices Questionnaire (SMC-MPQ; see Section "Measures") following two separate PPEt sessions, one before and one after a 3-day meditation course, which included theoretical instruction and nine OMM training sessions (Paoletti, 2018; see Section "Relationships Between the Constructs of the Five Dimensions and Self-Determination"). Of the 481 participants, 419 (259 women; mean age = 45.52 ± 11.36 years; education = 50.8% middle/high school, 49.2% undergraduate/graduate school; occupation = 50.1% self-employed and 34.4% clerical/office worker) attended the PPEt session on the first day of the training program, and 429 (270 women; mean age = 45.15 ± 11.29 years; education = 51.5% middle/high school, 48.5% undergraduate/graduate school; occupation = 48.3% self-employed and 38.5% clerical/office worker) attended the session on the final day of training.

The participants, who volunteered for the survey in a non-clinical, training setting, were recruited using opportunity sampling. The main aim was to carry out an exploratory study for investigating the characteristics of PPEt related to the SMC and, hence, developing new hypotheses to be explored in further studies both in clinical and empirical settings with neurophysiological tools (Smith et al., 2015). The study was approved by the Bar-Ilan University ethics committee. Participation was voluntary and required provision of written informed consent.

Intensive 3-Day Meditation Training

Meditation training constituted an intensive 3-day course, which included three 2-h classes and OMM sessions each day. OMM (Paoletti, 2018) is a brief (1 min) meditation technique during which practitioners divide attention between breathing and envisioning the best version of themselves. Before the OMM session, several instructions are provided to prepare practitioners for meditation: (1) connect to an emotion related to self-esteem; (2) keep in mind an image associated with your best self-representation; (3) enhance an emotional state characterized by distance, detachment, and determination; (4) make a commitment to yourself; and (5) choose small actions to initiate change.

Classes addressed emotional intelligence and provided in-depth analyses of the aforementioned five points. PPEt was practiced at the beginning of the first day and again at the end of the last day of the course. Each session comprised a 20-min guided meditation, before which participants were given three instructions: (1) focus on a self-defined aim; (2) aim for deep relaxation and to reach an 'empty space'; (3) achieve a neutral perception of the past and the present, for envisioning the future.

Measures

Participants were administered the SMC Meditation Practices Questionnaire (SMC-MPQ), a novel qualitative and quantitative self-report questionnaire, following each of the two PPEt sessions. The SMC-MPQ was constructed to empirically examine the SMC (Paoletti, 2002a,b, 2008; Paoletti and Ben-Soussan, 2019). It examines level of awareness of specific inner states and the ability to think critically about them, specifically in terms of the ability to analyze and evaluate evidence and arguments without bias from experience and prior knowledge (Noone et al., 2016; Holland et al., 2017).

The questionnaire focuses on the SMC constructs related to the following five dimensions:

1. Physical – The physical dimension involves physical energy, muscular state, and perceptual sensitivity (Paoletti, 2008; Paoletti and Selvaggio, 2011; Herbert and Pollatos, 2012; Farb et al., 2015);
2. Emotional – The emotional dimension refers to awareness, acceptance, and control of both positive and negative emotions, to achieve a state of balance and emotional neutrality (Gratz and Roemer, 2004; Baer et al., 2008; Paoletti and Selvaggio, 2011; Paoletti, 2013);
3. Mental – The mental dimension involves complex cognitive processes of understanding and awareness of the quality and quantity of thoughts and intuitions (Brown and Ryan, 2003; Baer et al., 2008; Paoletti, 2008; Abdoun et al., 2019);
4. Spatial – The spatial dimension refers to changes in spatial perception during practice, including awareness of the self in the surrounding space, and modification of the perception of oneself in space (Wittmann, 2013);
5. Temporal – The temporal, or time, dimension can be broken down into (1) temporal changes in time perception during practice, including awareness of the present time, awareness of elapsed time, and changes in perception of oneself over time (Wittmann, 2013; Pfeifer et al., 2016), and (2) changes in past, present, and future time perspectives, as processes that allow the practitioner to categorize and structure life events to give them coherence and meaning (Zimbardo and Boyd, 1999).

For these five dimensions, eight variables – (1) physical, (2) emotional, (3) mental, (4) spatial, (5) time perception during practice (temporal dimension), (6) present time perspective (temporal dimension), (7) past time perspective (temporal dimension), and (8) future time perspective (temporal dimension) – were each assessed by two items, one qualitative (e.g., *Briefly describe the quality and quantity of your perceptions with respect to the spatial dimension during the practice of the "Place of Pre-Existence"*) and one quantitative. More specifically, in the quantitative items, participants were asked to indicate their level of involvement on a 5-point Likert scale ranging from "not at all involved" (0) to "extremely involved" (4). Participants were also asked to think critically about how the technique had worked for them (Noone et al., 2016; Holland et al., 2017).

The SMC-MPQ also evaluates self-determination, in terms of problem-solving capacity, aspirations, and release from conditioning (Deci and Ryan, 1995; Wehmeyer, 2015). The three items in this area required participants to indicate their level of awareness on a 5-point Likert scale, ranging from "not at all aware" (0) to "extremely aware" (4).

Data Analysis

Preliminary descriptive and bivariate correlation analyses (Pearson correlation coefficient; two-tailed significance) were conducted, followed by a one-way analysis of variance (ANOVA; with Hochberg's GT2 *Post Hoc* Test, Welch's Robust Tests of Equality of Means with Games-Howell's *Post Hoc* Test, and calculation of Holm–Bonferroni corrected p-values for multiple comparisons) and multiple linear regressions (MLR; stepwise, *enter* method).

Analyses were conducted for the total sample and for an age- and sex-stratified random subsample of the total sample, to enable execution of multiple comparisons. This type of sampling, which usually results in lower variance, provides a more precise estimate of main sample means and totals (Blaikie, 2003; Lohr, 2019). Ninety-two participants who attended the entire 3-day course (and completed both the 'before' and 'after' questionnaires, with no missing data) were randomly selected (evaluating margin of error, confidence level, means and standard deviations, number of strata, total population size, etc.) for inclusion in the subsample (57 women; mean age = 47.67 ± 10.47 years).

The factor structure of the SMC-MPQ was examined, as was the reliability of each variable loading on a specific factor, to enable the use of inferential statistics (Wanous and Hudy, 2001; Ginns and Barrie, 2004; Fuchs and Diamantopoulos, 2009; Diamantopoulos et al., 2012). Preliminary correlation analyses showed positive, significant ($p \leq 0.01$) linear relationships among all eight variables. The KMO measure (>0.930) and Bartlett's Test of Sphericity ($p < 0.01$) confirmed the adequacy of the sample. Next, the results of an exploratory

factor analysis (EFA) (extraction method: principal component analysis; rotation method: promax with Kaiser normalization) revealed a two-factor model with good internal reliability ["Five Dimensions" factor (eight items): Cronbach's *alpha* = 0.885; "Self-determination" (three items): Cronbach's *alpha* = 0.882] and accounting for 62.2% of the total variance explained. Moreover, the two-factor model fit indices were acceptable (RMSEA = 0.064; CFI = 0.91; TLI = 0.85). Further analyses showed, for each variable, good communalities (>0.500) and high factor loading values (>0.680).

To examine the connection between silence, space (spatial dimension), body (physical dimension), and the PPEt before and after training, we first conducted a framework analysis. This qualitative data analysis (QDA), in which the texts were categorized and thematic patterns were identified (Ritchie and Lewis, 2003; Neuman, 2013; Richards, 2014), was performed with a focus on the construct of silence. As in previous research on meditative techniques, the construct of silence was operationalized based on the extent to which it, or similar terms (e.g., tranquility, vacuity, emptiness, stillness, peace, absence of noise/chaos, calmness; Cambridge Dictionary, 2019; Encyclopedia Treccani, 2019; Merriam-Webster Thesaurus, 2019), was referenced in the reports of practitioners. The concepts of "absence of thoughts and/or disturbing emotions" and "still mind" (Del Monte, 1995; Dawson, 2003; Manocha et al., 2007, 2010, 2011; Manocha, 2011; Vago and Zeidan, 2016) were also included in this context.

RESULTS

Effects of Training on Constructs of the Five Dimensions and on Self-Determination

The ANOVA results indicated significant differences between the two time points (higher levels after training compared to before training) with respect to the spatial, past time perspective (temporal dimension), present time perspective (temporal dimension), future time perspective (temporal dimension), physical, emotional, and mental dimensions, as well as with respect to the self-determination variables (**Table 1**).

Relationships Between the Constructs of the Five Dimensions and Self-Determination

The preliminary bivariate correlation analysis showed positive, significant ($p \leq 0.01$) linear relationships among all eight variables related to the SMC constructs.

Further investigations with MLR revealed the following significant relationships among participants who attended the pre-training PPEt session (see **Table 2A** and **Figure 2**):

- Emotional dimension (IV) and problem-solving capacity and aspirations (DV).
- Mental dimension (IV) and problem-solving capacity, aspirations, and release from conditioning (DV).

TABLE 1 | Analysis of variance and multiple comparison results: Differences in the five dimensions and self-determination measures of the Sphere Model of Consciousness Meditation Practices Questionnaire before and after training.

*Dependent variable**	*F*[1]	*df1*	*df2*	*p*	*Mean difference*	*Std. error*	*p*
Physical dimension	3.33[a]	3	1013	0.019	−0.17	0.06	0.048
Emotional dimension	6.22[b]	3	249.1	0.000	−0.25	0.06	0.000
Mental dimension	8.23[b]	3	247.2	0.000	−0.27	0.06	0.000
Spatial dimension	3.47[a]	3	955	0.016	−0.21	0.07	0.048
Past time perspective (temporal dimension)	3.51[b]	3	255.8	0.016	−0.21	0.07	0.048
Present time perspective (temporal dimension)	3.61[b]	3	236.7	0.014	−0.23	0.07	0.028
Future time perspective (temporal dimension)	8.57[a]	3	993	0.000	−0.44	0.09	0.000
Problem-solving capacity	9.80[b]	3	251.1	0.000	−0.30	0.06	0.000
Aspirations	11.11[b]	3	243.6	0.000	−0.33	0.07	0.000
Release from conditioning	12.52[b]	3	246.4	0.000	−0.39	0.07	0.000

*[1]Statistics: [a]ANOVA; [b]Welch's Robust Tests of Equality of Means. [2]Multiple comparisons: [c]Hochberg's GT2 Post Hoc Test with equal population variances; [d]Games-Howell's Post Hoc Test with unequal population variances. *Only significant differences reported; $p < 0.05$. Holm–Bonferroni adjusted p-values were calculated for all comparisons.*

TABLE 2 | Multiple linear regression models with Sphere Model of Consciousness Meditation Practices Questionnaire self-determination measures as dependent variables.

Model	*Independent variable*	β	*t*	*p**
(A) Pre-training (*n* = 419)				
Model 1: Problem-solving capacity as dependent variable[a]				
	Emotional dimension	0.12	2.10	≤0.05
	Mental dimension	0.14	2.44	≤0.05
Model 2: Aspirations as dependent variable[b]				
	Emotional dimension	0.16	2.00	≤0.05
	Mental dimension	0.16	2.77	≤0.01
	Time perception (temporal dimension)	0.11	2.10	≤0.05
Model 3: Release from conditioning as dependent variable[c]				
	Mental dimension	0.12	2.11	≤0.05
	Time perception (temporal dimension)	0.10	1.97	≤0.05
(B) Post-training (*n* = 429)				
Model 4: Problem-solving capacity as dependent variable[a]				
	Emotional dimension	0.17	3.17	≤0.01
	Mental dimension	0.11	2.26	≤0.05
	Spatial dimension	0.13	2.47	≤0.05
Model 5: Aspirations as dependent variable[b]				
	Emotional dimension	0.14	2.67	≤0.01
	Spatial dimension	0.14	2.59	≤0.01
	Time perception (temporal dimension)	0.11	2.02	≤0.05
Model 6: Release from conditioning as dependent variable[c]				
	Emotional dimension	0.12	2.22	≤0.05
	Spatial dimension	0.12	2.13	≤0.05
	Time perception (temporal dimension)	0.14	2.77	≤0.01

*Model 1[a] = adjusted R^2 = 0.08, F(5,393) = 7.06, $p \leq 0.01$; Model 2[b] = adjusted R^2 = 0.09, F(5,392) = 8.07, $p \leq 0.01$; Model 3[c] = adjusted R^2 = 0.07, F(5,390) = 6.23, $p \leq 0.01$; Model 4[d] = adjusted R^2 = 0.11, F(5,404) = 10.33, $p \leq 0.01$; Model 5[e] = adjusted R^2 = 0.10, F(5,402) = 8.68, $p \leq 0.01$; Model 6[f] = adjusted R^2 = 0.10, F(5,403) = 8.70, $p \leq 0.01$. *Only significant results are reported; $p < 0.05$. All reported correlations were positive; $p \leq 0.01$.*

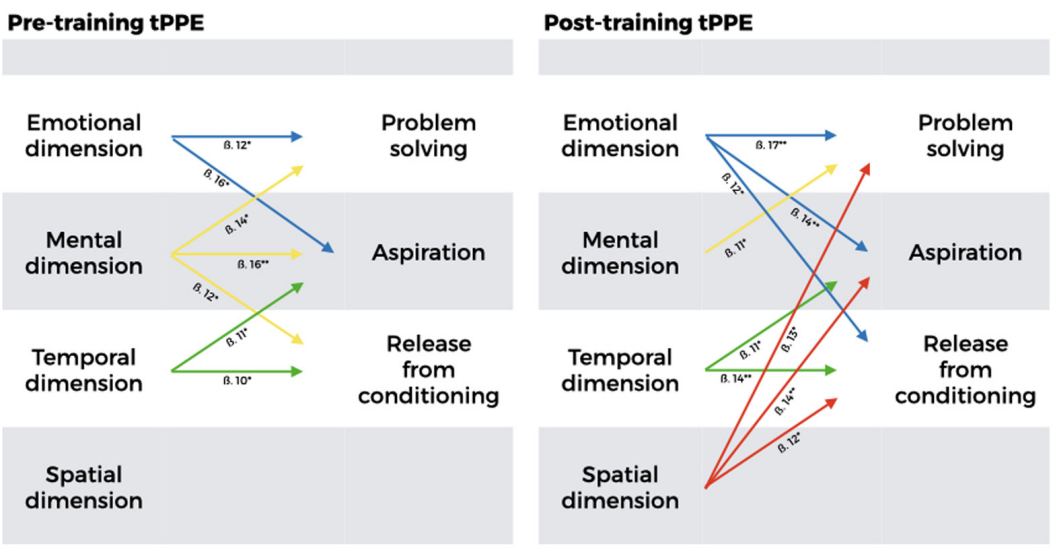

FIGURE 2 | Graphic representation of multiple linear regression models (dependent variables: self-determination; independent variables: emotional, mental, spatial, and temporal dimensions). PPEt, technique of the Place of Pre-Existence. *$p \leq 0.05$, **$p \leq 0.01$. See **Tables 2A,B** for further details. Note that while the temporal dimension remained the same, the spatial dimension only appeared after training.

TABLE 3 | Personal reports of the 429 participants who attended the PPEt session on the final day of training.

Category	*Self-reports*
Physical dimension	*"I perceived my energy state more clearly; the muscles relaxed; I clearly felt the limits of the body perimeter."* (#384) *"I felt a very deep relaxation; I felt expansion."* (#393)
Emotional dimension	*"I felt how much love and how many mistakes I had made in life and I wanted to dissolve them. I was moved as I went back to the place of pre-existence where I was peaceful, instead."* (#147) *"Moments of mental silence, surprise at the possibility of transforming some negative/stressful emotions to neutral."* (#149)
Mental dimension	*"My thoughts were constructive and solution-oriented, then they became silence and listening."* (#160). *"The mind had no thoughts; it was there, it didn't worry, it didn't speak, it was listening and enjoying the here and now."* (#255)
Spatial dimension	*"I perceived space more as if there were no obstacles, as if we were one."* (#6) *"It seemed to me that I was no longer limited by the body, but part of the whole."* (#236)
Time perception (temporal dimension)	*"Time expanded; it was no longer as before; everything was wrapped in light and gratitude; I felt powerful and capable."* (#252) *"I felt that time had no continuity, it was a single flow, the various moments seemed consequential."* (#282)
Past time perspective (temporal dimension)	*"I saw myself in the past: I did not judge the events of my life. Events had lost their sign and therefore their intensity."* (#65)*"I felt true happiness in remembering positive events and neutrality in remembering negative events as they had no longer strength and influence on me."* (#394)
Present time perspective (temporal dimension)	*"I felt the body, the breath, the flow of energy."* (#204) *"The present as the transition, the point of contact between the past and the future. Being able to flow through the past to support the present and build the future. Live, not theoretical, experience during practice."* (#10)
Future time perspective (temporal dimension)	*"I felt expanded space, trust, hope, quiet, promise."* (#256) *"Feeling of having dissolved my conditionings and being able to live more freely and fully, without constrictive confrontations; full power of myself."* (#282)

Analyzed categories: physical, emotional, mental, spatial, temporal, past present and future time perspectives dimensions. #Participant number.

- Time perception (Temporal dimension) (IV) and aspirations and release from conditioning (DV).

Furthermore, the preliminary bivariate correlation analysis, among participants who attended the post-training PPEt session, showed positive, highly significant ($p \leq 0.01$) linear relationships among all eight variables related to the SMC.

The following significant relationships were found after performing MLR analysis (**Table 2B** and **Figure 2**):

- Emotional dimension (IV) and problem-solving capacity, aspirations, and release from conditioning (DV).
- Mental dimension (IV) and problem-solving capacity (DV).
- Spatial dimension (IV) and problem-solving capacity, aspirations, and release from conditioning (DV).
- Time perception (Temporal dimension) (IV) and aspirations and release from conditioning (DV).

Based on theoretical hypotheses regarding how PPEt works, the aim of the MLR analyses was to evaluate possible relationships of the variables related to the SMC constructs with changes in the personal level of awareness of a personality characteristic, such as self-determination ability. **Table 3** shows the personal reports of the 429 participants, who participated in the PPEt session on the last day of training, to better understand the quality of the variables related to the SMC constructs associated with the five dimensions.

Silence and Related Variables

The QDA focusing on the construct of silence investigated potential associations between this state and the other variables. Following the pre-training PPEt session ($n = 419$), 58 participants made reference to silence, in relation to the following variables: (1) mental state (37/58; e.g., "My thoughts were free from judgments, memories, and mental schemes; the noise disappeared, and silence appeared,"); (2) emotional state (12/58; e.g., "I experienced the redefinition and focalization of the emotions, bringing them to a neutral and useful condition," "I felt the transition from positive to neutral emotions as breathing became calmer and inner peace increased," "I felt positive emotions of peace, possibility, trust and compassion."); (3) critical thinking about the technique's effects (9/58; e.g., "The technique took me to a neutral place without time or space, where I find the possibility of starting a new story."). Of the participants who attended the post-training PPEt session ($n = 429$), 115 referred to silence, in relation to the following variables: mental state (51/115), emotional state (38/115), and critical thinking regarding the ways the technique worked for them (26/115).

DISCUSSION

Shifting From the Mental to the Spatial Dimension

According to Strawson (1959, 1974), our subjective experience of the world is, in the first place, a physical experience of a spatial world, and the primary process in self-consciousness is convergence of perception and action into one's body and its location in space (Blanke and Metzinger, 2009; Limanowski and Blankenburg, 2013). In this context, it is noteworthy that expanded embodiment and sense of presence are at least partially reflected in physical balance and spatial orientation; more integrative transformations of consciousness associated with meditative and lucid dreaming are correlated with superior performance, while the opposite is true for disintegrative states (Hunt, 2007).

These assumptions led to the concept of embodied cognition, of which Varela et al. (1991) are among the foremost proponents. According to this approach, the body is both physical and subjective, such that one's body does not become an object like any other perceived object. Although the body becomes objective by being perceived, the perceivability of the body makes it subjective (Menon, 2016). Moreover, in the model proposed by Jerath et al. (2018), the formation of a 3D body space within the mind is considered the very basis of consciousness. Khachouf et al. (2013) pointed out that pre-reflective self-awareness includes a sheer bodily component with affective valence, associated with the insula and anterior cingulate cortex, which are often activated in concert, and which have been viewed as limbic analogs of the sensory and motor cortices, respectively (Heimer and Hoesen, 2006; Craig, 2009). This interpretation fits nicely with the role of these regions in providing a bodily component of sense of self, related to homeostatic and basic sensorimotor loops. Within the search for neural structures underlying embodied transcendental features of consciousness, Khachouf et al. (2013) also note that it would not be exhaustive to consider the historical/autobiographical sense of self as the ultimate *a priori* structure to which extrinsic stimuli should conform in order to become conscious. In this context, it has further been observed that Narrative Self is phenomenologically placed further away from the body, in the domain of abstract thought (Edelman and Tononi, 2000; Berkovich-Ohana and Glicksohn, 2014).

While some have found that increased consciousness is accompanied by increased spatial perception (Wahbeh et al., 2008; Hinterberger et al., 2014; Blanke et al., 2015), others have found it to be related to decreased spatial boundaries (Baars, 1998; Travis and Pearson, 2000; Metzinger, 2018). Consequently, the main aim of the current study was to investigate the change in the experience of spatial, temporal, emotional, mental, and bodily perception, as well as the experience of silence and self-determination through self-reporting, in light of the SMC. The main finding was that before training, PPEt experiences related to the spatial dimension did not appear to influence other dimensions, while after training, the spatial dimension influenced the self-determination variables, especially, problem-solving capacity, aspirations, and release from conditioning (see **Figure 1**). This result suggests a shift from the Narrative Self, in which the mental dimension is more influential, to the Minimal Self, in which the spatial dimension is predominant. This shift in the phenomenology of consciousness supports the influence of the spatial dimension on other dimensions after training.

Experience of the Minimal Self as interoceptive (Legrand, 2006; Blanke and Metzinger, 2009; Limanowski and Blankenburg, 2013) seems to be strengthened at the expense of the Narrative Self through meditative practice (Dolan, 2004; Farb et al., 2007; Ben-Soussan et al., 2015). The SMC, on which the meditative techniques utilized in this study are based, refers to a distinction between primary sensory (and thus spatial) and higher-order sensory consciousness (Edelman and Tononi, 2000), related to Minimal and Narrative Selves, respectively. More specifically, the proposed correspondence between spatial coordinates and dimensions of experience is based on the assumption that sensorimotor circuits underlie higher-order cognitive processes (Rizzolatti and Sinigaglia, 2006). The current results are, therefore, consistent with the SMC, which delineates spatial dimensions providing a visual matrix in which mental contents can be placed. This should also be true with regard to the effect of training on the spatial dimension, as the perception of oneself in space would represent the neurophenomenological substrate of Minimal Self-awareness (Varela et al., 1991; Legrand, 2006; Blanke and Metzinger, 2009; Khachouf et al., 2013; Limanowski and Blankenburg, 2013; Jerath et al., 2018).

Silence and a Possible Shift Toward the Minimal Self

The second aim of the study was to examine experiences related to silence, and their relationship to the other dimensions studied. The results demonstrated that participants made more references to silence in their post-training reports (14% to 27%). Silence-related reports regarding the mental dimension decreased in favor of both emotional and critical thinking about the practices. This suggests that intentionally sought silence indeed has a role in the shift toward the Minimal Self, as represented in the SMC.

In this regard, silence could have a significant role in reducing the self-confirmatory loop of the self, as noted by Khachouf et al. (2013). They point out that a shared characteristic of many contemplative practices is the instruction to maintain steady posture and minimize the variability of sensory input, for example by maintaining gaze direction and choosing a silent environment. Cognitive activity related to external input, which is generated through adjustment of an internal probabilistic model based on sensory data, becomes cognitive activity about the self (Khachouf et al., 2013), which could be conceptualized as a shift of attention from the external to the internal environment (Ben-Soussan et al., 2019; De Fano et al., 2019; Paoletti and Ben-Soussan, 2020, in press). It has further been suggested that by intentionally entering an (inner and outer) state of silence, we gradually move toward the center of the sphere (Paoletti and Ben-Soussan, 2019; Paoletti et al., 2020), which is also characterized by timelessness and spacelessness (Vaitl et al., 2005; Studerus et al., 2011; Wittmann, 2015). Consequently, the current study and subsequent examinations can have practical implications in the context of cognitive psychotherapies. Future investigations are required to examine whether additional dimensions are involved in achieving greater silence, and whether silence is specifically related to greater equilibrium among the physical, emotional, and mental dimensions. Additional work might also aim to increase our understanding of the different aspects of silence, including its possible use as a suggestion, psychological effects, and their physiological correlates.

Concluding Remarks and Limitations

The current preliminary study was the first study to examine the PPEt. A clear limitation involves our inability to distinguish between the effects of the OMM and PPEt practices and the lack of another meditation-based intervention and a waitlist

control group. Thus, the increased influence of spatial dimension, assumed to be a result of PPEt, could be related to OMM as well, or to expectation bias. Future work with additional study and control groups, in which the current and additional practices are tested separately, can potentially isolate the specific effects of each.

Additional studies should further investigate the neurophysiological correlates of both techniques, and their possible synergistic effects. Furthermore, while open self-report methods are important, it might be beneficial to combine them with additional structured questionnaires, such as the Inventory on Subjective Time, Self, Space (STSS; Jokic et al., 2018) as well as electrophysiological measures. We are currently working in these directions. Finally, while it is difficult to examine the possible differential effects of training on various psychological profiles and their electrophysiological correlates, in group settings, additional studies could examine this in the lab.

DATA AVAILABILITY STATEMENT

All datasets presented in this study are included in the article/supplementary material.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Bar-Ilan University Ethics Committee. The participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

AP, TD, TB-S, and JG contributed to the conception and design of the study. GS organized the database and performed the statistical analysis. AP, TD, and TB-S wrote the manuscript. JG and GS contributed to the manuscript revision and read and approved the submitted version. All authors contributed to the article and approved the submitted version.

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BRIEF RESEARCH REPORT
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Correlates of Silence: Enhanced Microstructural Changes in the Uncinate Fasciculus

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Silence is an important aspect of various meditation practices, but little work has focused specifically on the underlying neurophysiology of silence-related meditative practice, and on how it relates to the self-reported experiences of practitioners. To expand current knowledge regarding the neurophenomenology of silence in meditation, we directly investigated first-person reports of silence-related experiences during the practice of Quadrato Motor Training (QMT) and their association with changes in fractional anisotropy (FA). Participants recorded their cognitive, emotional, and physical experiences upon beginning QMT and again after 6 weeks of QMT practice. These reports were evaluated qualitatively and quantitatively. Findings showed that change between the two time points in self-reported silence-related experiences was negatively correlated with change in attentional effort, and positively correlated with changes in the left uncinate fasciculus. These results expand current knowledge regarding the neuroanatomical correlates of silence-related experiences during meditation.

Keywords: silence, mind-wandering, attentional effort, DTI, uncinate fasciculus

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INTRODUCTION

Silence plays a role in most Eastern and Western meditative practices, such as Zen meditation and Vipassana (Lin et al., 2008; Shonin et al., 2013). In the history of Buddhist doctrines described in Ariya Pariyesanā Sutta, for example, the Buddha urges monks to maintain "Noble Silence" (Anālayo, 2017). This expression represents a meditative state called "dhyana," an altered state of consciousness characterized by freedom from thoughts and mental representations, enabling a deep stillness (Feuerstein, 1996).

While many researchers have emphasized the importance of silence in meditation (Vago and Zeidan, 2016; Pfeifer et al., 2019, 2020), to date little work has focused on the self-reported experiences of practitioners and the underlying neurophysiological changes associated with silence-related experience of meditative practices (Hernández et al., 2018). For example, a 15 min Quiet Time training consisting of meditation or another quiet activity such as reading silently was found to significantly increase resilience and decrease anxiety compared to a control group,

showing increased emotional regulation (Wendt et al., 2015). The students who spent more time meditating also had higher resilience scores, self-reported improved sleep, happiness, and self-confidence.

It has recently been suggested that through a voluntary act of silence, used as a paradigm similar to sensory deprivation one can intentionally move from the narrative self, to the minimal and eventually overcoming the self (Paoletti et al., 2020; Paoletti and Ben-Soussan, 2020). The state of overcoming of the self, which can further be compared with self-transcendence, absorption, and non-dual states (Josipovic, 2014; Vieten et al., 2018), is characterized by changes in the perception of time and space shifting gradually toward "timelessness" and "spacelessness" (Berkovich-Ohana et al., 2013; Wittmann, 2015, 2020). Importantly, similar experiences following the Quadrato Motor Training (QMT) have been reported (Ben-Soussan et al., 2013, 2014b, 2019). For example, a recent cross-sectional study revealed that advanced-QMT practitioners showed longer and more accurate produced durations in a time production task, than did Aikido practitioners and a physically inactive control group (Ben-Soussan et al., 2019), suggesting that similarly to other forms of meditation (Wittmann, 2015), QMT has the capacity to dilate the subjective time experienced, possibly by inducing greater awareness of the present moment and of the body. In fact, QMT has been recently ascribed to mindfulness practices involving movement (Diamond and Ling, 2019), trading off speed with the opportunity for mindfulness and reflectivity (Ben-Soussan et al., 2014b; Diamond and Ling, 2017).

Mindful movements are characterized by a focus on movement in the present moment while excluding other thoughts and body movements (Kabat-Zinn, 2009; De Fano et al., 2019). Mindful movement practices involve key aspects of mindfulness such as preparation and execution of movement, regulation of attention, working memory, and decreased mind-wandering (Russell and Arcuri, 2015), mind-wandering being a construct opposing that of mindfulness (Mrazek et al., 2012). QMT involves each of these aspects: regulation of divided attention, working memory updating (e.g., noting one's current location to know where to move to next), and prevention of mind-wandering via a need to be "in the here and now" due to constantly updating commands (Ben-Soussan et al., 2014b; De Fano et al., 2019). Mindful movement further engages "higher-order" inhibition and response selection that underlie attention and cognitive control that require moment-by-moment sensorimotor updating (Clark et al., 2015; Kimmel and Rogler, 2018). In line with this, QMT requires second-by-second mindful awareness for attending the upcoming next command (Ben-Soussan et al., 2014b; De Fano et al., 2019).

QMT (for a recent review see De Fano et al., 2019) is a movement meditation in which both individual experience and brain functioning have been examined. During QMT, practitioners step in different directions on a square delineated on the floor. The method requires smoothly executed, goal-directed behavior in response to predetermined verbal instructions separated by silent interstimulus intervals (ISIs), which are known to increase the duration of attention (Leckart et al., 1970). These quiet interstimulus intervals can be considered moments of external silence permitting also inner silence in which the participant awaits the upcoming command. In fact, it has previously been claimed that silence allows for better management of stimuli, representing a state of preparation in and toward emptiness (Teschner, 1981; Davies and Turner, 2002; Stratton, 2015; Paoletti and Ben-Soussan, 2020) which in the current context is manifested by the upcoming command.

In line with this, previous work suggests that QMT can induce a *state of waiting* (Ben-Soussan et al., 2014b), which might decrease mind-wandering and narrative-focused thought (Farb et al., 2007), thereby eliciting the experience of inner silence and increase a state of mindfulness. A month of QMT by both meditation practitioners and non-practitioners groups, in contrast to a single session of QMT was further found to report altered states of consciousness and attentional effort experiences. Crucially, these experiences were reported by the groups that practiced the QMT for 4 weeks, but not in the group that practiced it for only 1 day (Ben-Soussan et al., 2017).

In a recent longitudinal study, Piervincenzi et al. (2017) further reported that six weeks of daily QMT practice led to a bilateral increase of fractional anisotropy (FA) in tracts related to sensorimotor and cognitive functions (including the corticospinal tracts, anterior thalamic radiations, and uncinate fasciculi), reflecting better white matter integrity. However, the relationship between the brain changes and self-reported experiences associated with QMT remains currently unknown, particularly with respect to silence-related components.

Importantly, there is growing evidence that increased mindfulness, may act as a marker for improved emotion regulation skills (Creswell et al., 2007) and positive reappraisal (Garland et al., 2009, 2011). These two cognitive coping strategies are thought to be mechanisms by which mindfulness regulates emotion and stress (Vago and David, 2012), functions which are becoming increasingly important. In this context, it is important to note that the uncinate fasciculus is a tract of fibers connecting limbic structures to the prefrontal cortex. The uncinate fasciculus is associated with many functions ranging from learning visual associations to episodic memory, language and social emotional processing (Thomas et al., 2012, 2015; Von Der Heide et al., 2013). It is critical for both emotion regulation, transformation and reappraisal, and may thus underlie the improvements observed in the study of the effects of different types of meditation (Vago and David, 2012; d'Arbeloff et al., 2018).

These results related to the relationship between reappraisal, mindfulness and neurophysiological changes are further in line with different models of consciousness, such as the Self-awareness, self-regulation, and self-transcendence (S-ART) model (Vago and David, 2012) and the Sphere Model of Consciousness (SMC, Paoletti, 2002; Paoletti and Ben-Soussan, 2019, 2020; Paoletti et al., 2020). According to the SMC, reappraisal and voluntary movement toward a state of contentless consciousness, also defined as *momentary silent consciousness* (Baars, 2013; Josipovic, 2019) may have a decisive role in the experience (Paoletti et al., 2020; Paoletti and Ben-Soussan,

2020), in which focusing one's attention on silence can be used as a paradigm for facilitating better internal communication through an internal environment intentionally created (Paoletti and Selvaggio, 2013; Paoletti et al., 2017; De Fano et al., 2019). Consequently, in this study, silence was operationalized as self-reported absence of thoughts and a subjective experience of mental quietness as suggested by various authors (Rudrauf et al., 2003; Hinterberger et al., 2014; Josipovic, 2014, 2019; Winter et al., 2019; see **Table 1**), thus describing a state in which participants spontaneously experienced and reported a sort of contentless consciousness.

While the described neuroplastic changes are intriguing and can potentially underlie the benefits ascribed to the practice of mindfulness meditation, it has often been neglected to actually test the relationship between neuroplastic processes and changes in *lived experience* (Varela et al., 2016), especially in the context of silence. To expand current knowledge regarding the neurophenomenology of silence in meditation, we used a new approach to investigate first-person reports of silence-related experiences during QMT in relation to the changes in white matter as measured by FA. Together with the subjective experiences of silence during QMT practice, we expected to find an association between changes in silence-related self-report categories and FA changes.

Examining the relationship between silence and neuroanatomical changes can aid in unraveling the neuronal mechanisms underlying potential changes in the lived experience reported by subjects, as well as training induced-silence, and cognitive and emotional changes reported by the participants (Ben-Soussan et al., 2013, 2017). As silence, which is both required and produced in the QMT, may also be the means by which attention and mindfulness could be increased (Ben-Soussan et al., 2017; Paoletti et al., 2020; Paoletti and Ben-Soussan, 2020), and since these changes have previously been linked to, among others, FA changes in the uncinate fasciculus (Luders et al., 2011; Tang et al., 2012; Hölzel et al., 2016; Piervincenzi et al., 2017), we hypothesized that changes in self-reported silence-related experiences would be correlated with changes in the uncinate fasciculus structural connectivity. More specifically, we expected to find a positive correlation between change in these two variables, reflecting a silence-related enhanced connectivity in brain structures previously reported to be related to emotional and cognitive regulation associated with mindful experience (Creswell et al., 2007; Garland et al., 2009, 2011). In this context, it is important to note that the uncinate fasciculus is a bidirectional, long-range white matter tract that connects lateral orbitofrontal cortex and Brodmann area 10 with the anterior temporal lobes (Schmahmann and Pandya, 2007; Wheeler et al., 2017). Brodmann area 10 is thought to enable maintenance of previously running tasks in a pending state for subsequent retrieval and execution upon completion of an ongoing task (Koechlin and Hyafil, 2007) – an ability that is constantly required during QMT (Ben-Soussan et al., 2014a,b; De Fano et al., 2019). In addition, it is further related to emotional regulation (Steffens et al., 2011), which was previously found to improve following QMT (for a recent review see De Fano et al., 2019).

In addition, we examined relationships between spontaneous silence-related and other categories of self-reported experience during QMT. Silence shares characteristics with other states elicited by deliberative mindful practice, such as flow (Ben-Soussan et al., 2013) and mindfulness (Ben-Soussan et al., 2017), both of which are associated with reduced attentional effort (Harmat et al., 2015). For this reason, we further wanted to investigate possible interactions between experience of silence and other states or cognitive functions associated with QMT practice. In accordance with previous studies, we expected changes in silence-related categories to be positively correlated with change in mindfulness categories, and to be negatively correlated with change in attentional effort categories.

METHODS

Participants and Design

We recruited 50 healthy volunteers in accordance with the inclusion and exclusion criteria reported in Piervincenzi et al. (2017). The researchers explained the study aims and procedures to participants and verified that they understood. All participants signed written informed consent forms in accordance with the Declaration of Helsinki. The ethical committee of the Università Campus Bio-Medico di Roma, Rome, Italy, approved the experimental phase I study entitled "Effect of Quadrato Motor Training on the brain of healthy volunteers" (MOTO-BRAIN, 09/14 PAR ComEt CBM). The present study was part of a larger project investigating longitudinal effects of QMT using various brain imaging techniques (results published in Lasaponara et al., 2017; Piervincenzi et al., 2017). Participants underwent magnetic resonance imaging (MRI) and electroencephalography (EEG) at two time points: the day of recruitment (t_0) and following 6 weeks of daily QMT practice (t_1). Participants were asked to keep a personal diary to document information about their practice and habits during the period of exercise. After excluding participants who did not complete the questionnaires at both time points, the final sample included 22 healthy right-handed participants (12 women, mean age 35.6 years, *SD* 5.4).

Quadrato Motor Training (QMT)

During QMT, participants stand at one corner of a 0.5m × 0.5 m square and move to different corners in response to recorded verbal instructions provided at variable intervals indicating the next corner to which they should move. In order to correctly perform QMT there are different rules such as start each step with the leg inside the square (i.e., the right leg when on the left side of the square and *vice versa*), wait for the instruction without anticipating the movement and keep their gaze on an empty wall without looking at the platform or the position of the feet. So, participants must carefully control the quality of each movement, inhibit automatic motor responses before the instruction and divide their attention toward the external instructions, the proper task execution and the internal state of the body, sustaining their attention for the whole practice duration. For additional details, see Ben-Soussan et al. (2013).

TABLE 1 | Definition of the macro-categories and sub-units produced by qualitative content analysis of diary entries on Quadrato Motor Training (QMT).

Macro-category	Sub-unit	Definition	References
Macro-categories and sub-units			
Attentional Effort	Attention and concentration	Increased focused attention and/or concentration during QMT	Coull, 1998
	Tiredness	Temporary sensation of fatigue due to QMT	Ream and Richardson, 1996; Abbiss and Laursen, 2007
	Distraction	Temporary inability to selectively focus attention on QMT-related stimuli (e.g., command, posture)	Kahneman, 1973
Mindfulness	Stability and harmony of the body	Feeling physically well, balanced, vigorous; positive body image and body schema	Ryan and Frederick, 1997; Cahn and Polich, 2006
	Positive emotion	Pleasant emotions (e.g., joy, happiness, relaxed); positive moods and/or attitudes	Cahn and Polich, 2006; Niven, 2013; Paoletti and Ben-Soussan, 2019
	"Being in the Waiting"	Ease of attending to the next instruction during QMT practice (e.g., without anticipating movements)	Ben-Soussan et al., 2017
Altered State of Consciousness	Intuition	Sudden and/or unexpected solution to a problem and/or change of perspective regarding a specific event	Wackermann et al., 2002; Kahneman, 2003
	Spontaneous visualization	Spontaneous visuospatial imagery (e.g., geometrical patterns, pictures, landscapes and/or lights)	Dane and Pratt, 2007; Lindahl et al., 2014
	Sense of wonder	Unexpected surprise, pleasure and/or enjoyment related to thoughts, feelings, and experience	Goldstein, 2002; Jacob et al., 2009
Silencing	Reduced mind-wandering	Decrease in intrusive, non-task-related, and/or irrelevant thoughts	Smallwood and Schooler, 2006; Mrazek et al., 2012; Vago and Zeidan, 2016
	Silence	Absence of thoughts; subjective experience of mental quietness	Rudrauf et al., 2003; Hinterberger et al., 2014; Josipovic, 2014, 2019; Winter et al., 2019

The original three macro-categories were defined in Ben-Soussan et al. (2017).

First-Person Reports

Participants kept a diary in which they were required to document their responses to three questions, regarding their (1) cognitive, (2) emotional, and (3) physical experiences during QMT. Data from the diaries were coded into an Excel worksheet and analyzed using qualitative content analysis (Mayring, 2004). In the first step, we constructed a grid to define the content categories. We began this process with a grid developed and validated in previous work (Ben-Soussan et al., 2017) and proceeded describing macro-categories and sub-units that will be considered to evaluate the content of first person reports. Along with these already used categories, we added an additional category related to silence and reduced mind-wandering (collectively called "Silencing"), which represents the main focus of the current study. We included Reduced Mind-wandering in the Silencing macro-category, as the reduction in intrusive, irrelevant, and unintentional thoughts represents an important step toward quiet restful presence (Vago and Zeidan, 2016). An exhaustive list of macro-categories and sub-units with their definitions is provided in **Table 1**.

In this study, response provided to each of the three questions served as the meaningful unit of analysis. Our corpus thus comprised 132 units of analysis, which could be coded with one or more indicators depending on the content (examples of coding for each sub-unit are provided in **Table 2**). This codification method was chosen because it enables occurrence and co-occurrence analyses (see Qualitative Analysis section below). Three researchers coded the answers using Atlas.ti software (Atlas.ti Scientific Software Development GmbH, Berlin, Germany). Inter-coder reliability was calculated using Krippendorff's alpha, an index based on disagreements rather than agreements in the coding phase. According to Krippendorff (2018), the simplest inter-coder agreement coefficient is:

$$\alpha = 1 - \frac{D_o \text{ observed disagreement}}{D_e \text{ expected disagreement}}$$

The acceptability threshold for this index is >0.667, whereas >0.800 is considered good (Krippendorff, 2018). We calculated Krippendorff's alpha separately for each macro-category used in the study, resulting in an overall alpha of 0.758 (Silencing: 0.906, Attentional Effort: 0.728, Mindfulness: 0.797, Altered State of Consciousness: 0.388). Given the low reliability of the Altered State of Consciousness category, we excluded it from further analysis.

Qualitative Analysis

Occurrence analysis was used to determine how many times a specific category was assigned to a sentence in t_0 and t_1 time points. This kind of analysis allows comparison of each macro-category and sub-unit occurrence between time points (taking all participants into account). Co-occurrence defines how many times two sub-units are coded together in the same sentence. Two main measures were utilized: the number of times a specific co-occurrence between two units was found and the strength of the relationship between two units (c-coefficient). C-coefficient

TABLE 2 | Examples of reports categorized in each of the content analysis sub-units.

Macro-category	Sub-unit	Example
Examples of quotations for each sub-unit		
Attentional effort	Attention and concentration	*Less dispersion, my reasoning is slower but more focused* (S31).
	Tiredness	*Tired and drowsy*. I need to be stimulated to activate myself (S39).
	Distraction	"In a hurry" *between thoughts of "it's late," "I have to do thousands of things"* and thoughts of "stay here, you have all the time" (S16).
Mindfulness	Stability and harmony of the body	*I am feeling looser, light, stronger, and more energetic.* I haven't had a cold yet (S34).
	Positive emotion	I like it. I feel in relation with space. *I feel peace* and a quiet curiosity (S25).
	"Being in the waiting"	I felt full willingness to perceive the experience as *being able to be in the waiting without expectations or anxiety* (S01).
Altered state of consciousness	Intuition	Thought fluidity, *association of thoughts in a "creative" and resolving way (= solutions), intuitiveness* (S11).
	Spontaneous visualization	Even during the day, sometimes *I visualize the square* (S18).
	Sense of wonder	Happy, *enthusiastic*, nervous, *surprised by the speed of time passed during the exercise* (S40).
Silencing	Reduced mind-wandering	Increased perception of the space around me, *reduced number of repetitive thoughts* (S18).
	Silence	An increased *emptiness of thoughts*, even in the part of the sequence that I know, I am able to wait for the next instruction. Time is dilated. Attention is expanded. *Silence* (S25).

The relevant parts related to the sub-unit are marked in italics.

varies between 0 (no co-occurrence) and 1 (full co-occurrence). It is calculated as follows:

$$c - coefficient = n_{12}/(n_1 + n_2) - n_{12}$$

where n_{12} is the co-occurrence frequency of two codes, while n_1 and n_2 are their occurrence frequency.

Quantitative Analysis

To conduct quantitative and correlation analyses between the first person reports and DTI data, we quantified the scores of the macro-categories and sub-units for each participant. As indicated above, each participant answered three questions. We assigned one point to a sub-unit every time it was coded in one of the answers. Thus, the score range for each sub-unit was from 0 (never coded) to 3 (coded in each answer). Finally, we grouped the scores based on macro-category (Ben-Soussan et al., 2017; see **Table 1**). In this way, we obtained quantified scores that represented the salience of each macro-category for each participant. We then calculated a delta score by subtracting t_0 scores from t_1 scores. A positive delta indicates increased reference to a category from t_0 to t_1 while a negative delta indicates a decrease between the two time points.

All quantitative analyses were conducted using STATISTICA 10 (StatSoft Inc., Tulsa, United States). We compared t_0 and t_1 using the Wilcoxon matched pairs test for non-parametric datasets. We used Spearman's correlation to investigate the possible association between Silencing score and Attentional Effort and Mindfulness scores.

MRI Data Acquisition

Imaging data were acquired using a Siemens 1.5-T MAGNETOM Avanto (Siemens, Erlangen, Germany) whole body scanner equipped with a 12-element designed Head Matrix coil, as part of the standard system configuration. Diffusion-weighted images (DWIs) were acquired using an axial pulsed-gradient spin-echo echo-planar sequence (7600/103; 38 sections; section thickness, 3.0 mm with no intersection gap), with diffusion-encoding gradients applied in 12 non-collinear directions (b factor 0 and 1000 s/mm^2; number of acquired signals, four). A 2D fluid-attenuated inversion recovery (FLAIR) T2-weighted scan was also used to exclude the presence of small vessel ischemic disease and other supra- or infra-tentorial brain lesions [Repetition Time (TR) = 11,460 ms, Echo Time (TE) = 102 ms, Inversion Time (TI) = 2360 ms, Field of View (FOV) = 280 × 330 mm, Number of Excitations (NEX) = 2, matrix = 248 × 320, 1.00 × 1.00 mm^2 in-plane resolution, horizontal slices with a slice thickness of 3.0 mm and no gap].

MRI Data Analysis

To avoid a type I error induced by the effect of WM hyperintensities on brain connectivity results, two expert radiologists managed by CCQ examined all MRIs. Participants were excluded when more than three lesions with a maximum diameter of 5 mm were detected in the subcortical or periventricular WM on axial FLAIR images (Quattrocchi et al., 2015).

Preprocessing of Diffusion Data

All DWIs were visually inspected for artifacts and preprocessed using different tools from FDT (FMRIB Diffusion Toolbox, part of FSL (FMRIB's Software Library v.5.0.8[1]; Smith et al., 2004). Images were corrected for eddy current distortion and head motion using a 12 parameter affine registration to the first no-diffusion-weighted volume of each participant, and the gradient directions were rotated accordingly (Leemans and Jones, 2009). Corrected images were skull-stripped using Brain Extraction

[1]https://www.fmrib.ox.ac.uk/fsl/

Tool (Smith, 2002). Diffusion tensor images were then generated for each participant and each time point using the Diffusion Tensor Imaging ToolKit software package (DTI-TK[2]; Zhang et al., 2006). An unbiased longitudinal analysis approach was chosen for the registration of DTI data (Keihaninejad et al., 2013) using DTI-TK, which applies a registration algorithm that leverages the full diffusion tensor information to drive the registration, improving the alignment of WM structures (Wang et al., 2011). At the end of the registration procedure, each participant's DTI data were normalized to the ICBM-152 template (Zhang et al., 2011), and FA maps were generated for each participant using the normalized tensor images (for details on the DTI data analysis, see Piervincenzi et al., 2017). FA data from each participant were further analyzed using selected modules of the Tract-Based Spatial Statistics (Smith et al., 2006) toolbox, available in FSL. The mean FA image was created and thinned to create a mean FA skeleton, which represents the centers of all tracts common to the group. Each participant's FA image was then projected onto this common skeleton to minimize any residual misalignment of tracts.

To investigate the potential association between Silencing and training-induced DTI effects, a voxelwise correlation analysis was carried out between ΔSilencing (t_1–t_0) and ΔFA maps (t_1–t_0) using permutation-based non-parametric statistics via the FSL *randomize* tool (Nichols and Holmes, 2002) with 5,000 permutations. Resulting statistical maps were thresholded using FDR $q = 0.05$. Correlation analysis was performed inside the mask of previously reported longitudinal FA changes (for details on DTI analysis, see Piervincenzi et al., 2017).

RESULTS

QMT Elicitation of Silence and Mind-Wandering Content

Following a session of QMT (at t_0), 36% of the participants reported experiences related to Silence and 27% reported Reduced Mind-wandering. In addition, 95% of the participants reported experiences related to Mindfulness and 63% to Attentional Effort. After 6 weeks of training (t_1), 9% of the participants reported experiences related to Silence and 13% to Reduced Mind-wandering. Also at t_1, 95% of participants reported experiences related to Mindfulness and 72% to Attentional Effort. Thus, content in the Silencing macro-category significantly decreased between t_0 and t_1 ($p < 0.04$; see **Figure 1A**). Changes in the other macro-categories were not statistically significant (all $p > 0.23$).

When we analyzed the two sub-units of the Silencing macro-category, we observed that both Reduced mind-wandering and Silence were higher at t_0 (6 and 9, respectively) than at t_1 (both 3). However, only the decrease in the Silence sub-unit was significant ($p < 0.03$; **Figure 1B**).

The Attention and concentration sub-unit increased from 48 to 74% of the responses in the Attentional Effort macro-category, while those of Tiredness and Distraction both decreased, from 39 to 21% and from 13 to 5%, respectively, (see **Figure 1C**).

Correlation Between Silencing and DTI Changes

We observed a significant correlation between changes in Silencing and changes in FA maps following 6 weeks of QMT ($p < 0.05$ FDR corrected). More specifically, a positive correlation was found between change in Silencing and regions showing longitudinal increments of FA in left uncinate fasciculus (MNI peak coordinates: $x = -33$, $y = 9$, $z = -6$; $t = 2.65$; $r = 0.57$, $p < 0.01$) (**Figure 2**). Thus, greater FA increase was associated with a higher number of reports related to the experience of silence.

Correlations Between Silencing, Attentional Effort, and Mindfulness

A significant negative correlation between change (t_1–t_0) in Silencing and change in Attentional Effort ($r = -0.47$, $p < 0.05$) suggested that participants who show greater change in Attentional Effort exhibit less change in Silencing, and vice versa (**Figure 3A**). All other correlations were non-significant (all $p > 0.30$).

We observed a strong significant positive correlation between Reduced Mind-wandering and Silence (components of the Silencing category) ($r = 0.72$, $p < 0.001$), a significant negative correlation between Attentional Effort and Reduced Mind-wandering ($r = -0.49$, $p < 0.05$), and a correlation that approached significance between Attentional Effort and Silence ($r = -0.40$, $p = 0.058$) (**Figure 3B**). All other correlations were non-significant (all $p > 0.21$).

We also observed an increase in co-occurrence of Positive Emotion and Attention and Concentration (from 3 to 8; c-coefficient: from 0.09 to 0.17) and a contextual decrease of Positive Emotion and Silence (from 6 to 1; c-coefficient: from 0.20 to 0.02).

DISCUSSION

The aim of the current study was to study the potential connection between silence-related experience during the practice of QMT and microstructural changes previously reported in Piervincenzi et al. (2017). While self-report techniques have their limitations (Rappert et al., 2017), they offer the possibility to capture the subjective dimension intrinsic to the personal experience, and thus a deeper understanding of the relationship between the different constructs, disentangling the subtle differences in the relationships among silence, attentional effort, and mindfulness.

Our results showed that 36% of participants reported experiences related to silence and 27% reported reduced mind-wandering during the first session of QMT practice. After 6 weeks of training, only 9% of the participants reported experiences related to silence and 13% reported reduced mind-wandering during practice execution. Hence, contrary to our expectation, participants reported fewer experiences related

[2]https://dti-tk.sourceforge.net/pmwiki/pmwiki.php

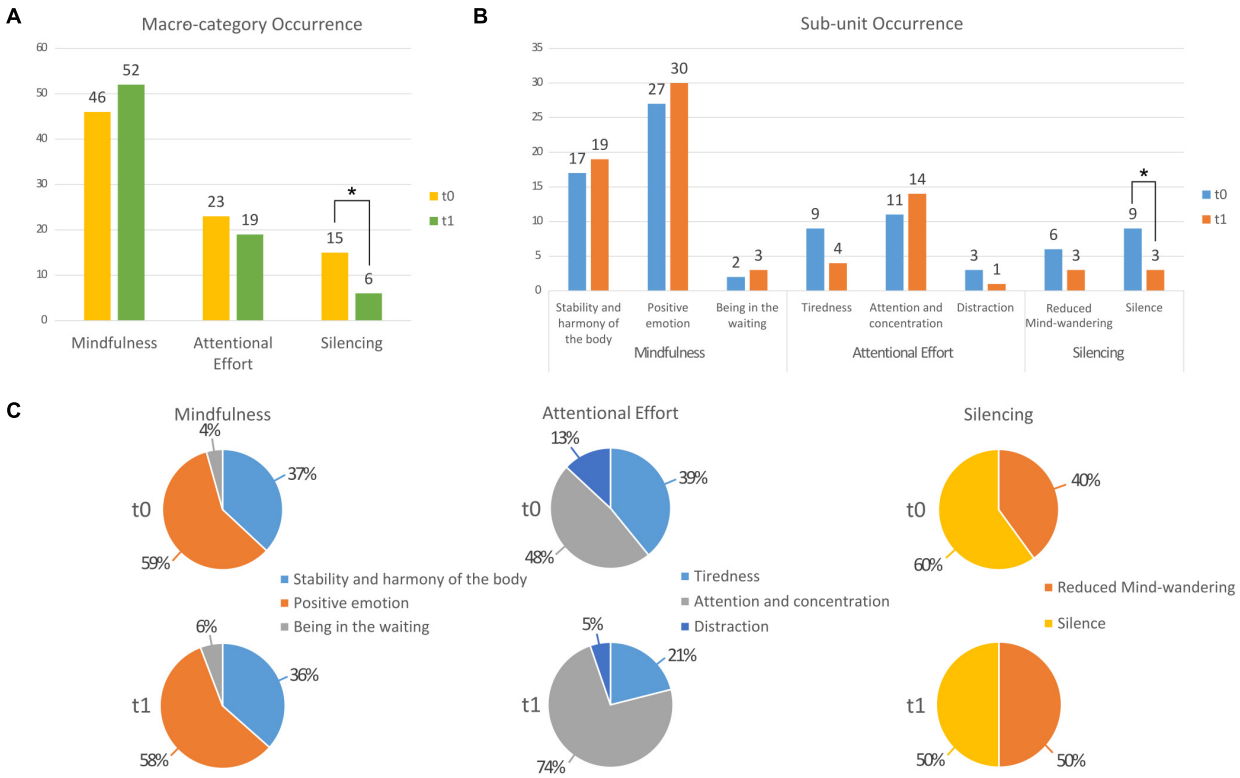

FIGURE 1 | Bar graph presenting results of the occurrence analysis comparing t_0 and t_1 **(A)** for each macro-category and **(B)** for each sub-unit. **(C)** Pie charts presenting the score distribution within each category at t_0 and at t_1. $^*p < 0.05$.

to silence and reduced mind-wandering after the 6 weeks period of daily training. It is possible that the participants experienced a sort of "normalization" or habituation to silence-related experience, reducing its salience. Namely, the same experiences of silence and reduced mind-wandering might have felt stronger and more salient to participants when they were new to QMT than when after 6 weeks of practice. In support of this interpretation, t_0 reports were more complex and seemed aimed at explaining the experience of reduced thoughts (e.g., "strange absence of thoughts, more silence," "no thoughts"), while t_1 reports were simpler and more direct (e.g., "silence," "quietness") – as if participants had become more familiar with this kind of experience. Of course, "silence" or "quietness" might simply designate personally significant labels for more complex experiences. In this context, we note Varela's (1996) proposition that greater integration of self-report techniques in empirical research requires that participants receive adequate training to increase their ability to report accurately. This is in line with the Tibetan tradition of denoting meditation practice with the term *gom*, which literally means *to familiarize with* (Saggar et al., 2012).

In line with our hypothesis, silence-related experiences were positively correlated with changes in the uncinate fasciculus. In humans, the uncinate fasciculus is engaged in tasks that involve naming, single word comprehension, response inhibition, face processing, and monitoring of outcomes (Arnodio and Frith, 2006; Catani et al., 2013). Disconnection of the uncinate fasciculus, on the other hand, causes impairment of object-reward association learning, and reduced performance in memory tasks involving temporally complex visual information (Gaffan and Wilson, 2008). The bidirectionality of information flow in the uncinate fasciculus allows orbitofrontal cortex-based reward and punishment history to rapidly modulate temporal lobe-based mnemonic representations (Von Der Heide et al., 2013). In accordance, while disruption of uncinate fasciculus activity might cause memory and learning deficits, enhancing its activity through training may foster the ability to evaluate past experiences, especially those related to reward and punishment (Von Der Heide et al., 2013). This, in turn, might result in more effective monitoring and management of ongoing performance, as participants in this and previous studies have reported increased attention and concentration (Ben-Soussan et al., 2017), possibly mediated by the silence required to correctly perform QMT.

Given that there are a number of functions associated with the uncinate fasciculus, one should keep in mind that the observed changes might be due to other effects of QMT training besides the construct of silence. For example, the reported changes in uncinate fasciculus might be ascribed to associative learning (Thomas et al., 2012) particularly that involving visual-motor associations (Thomas et al., 2015) to perform the QMT. In fact, the subjective experience of silence

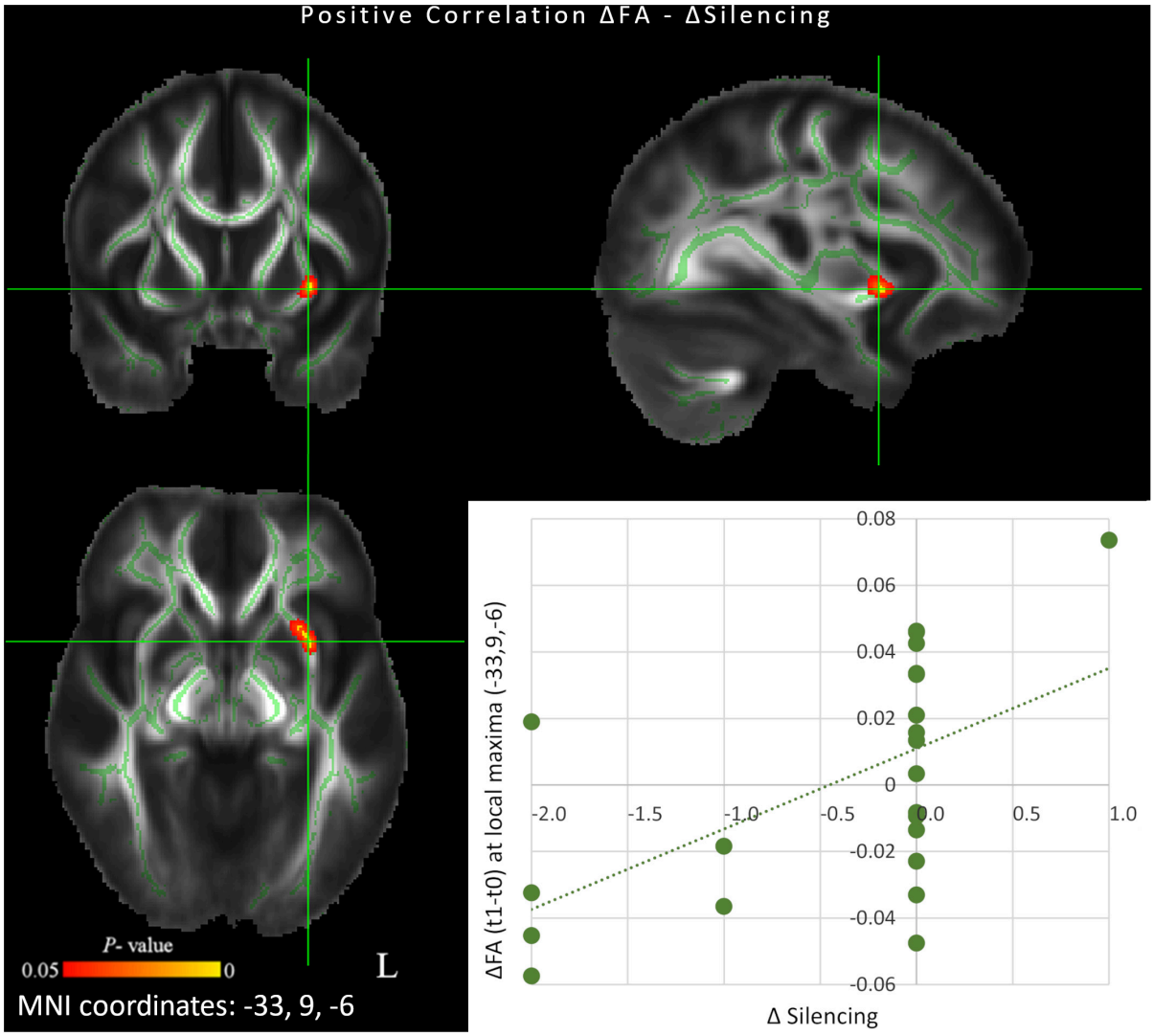

FIGURE 2 | Scatterplot and results of voxel-wise correlation analysis between longitudinal changes in fractional anisotropy (FA) maps and concomitant changes in Silencing score (red-yellow color) between t_0 and t_1 ($p < 0.05$ FDR corrected). Only clusters showing a spatial extent of at least 30 voxels are reported. The study-specific FA skeleton, representing the centers of principal white matter tracts, is displayed in green, overlaid on the mean FA map. Anatomical localizations of peak MNI coordinates (mm) were established according to the JHU White-Matter Tractography and the JHU ICBM-DTI-81 White-Matter Labels atlases.

could reflect reduced cognitive processing associated with the transition from early cognitive to middle associative motor learning stages to a later autonomous stage. Thus, as one of our reviewers has suggested, the current changes in uncinate fasciculus correlated with subjective experience of silence, is so because both are reflective of motor learning. This latter view is of interest to mindfulness theory as it suggests that performing repetitive sequenced movements can establish mindfulness states and provide mindfulness training benefits after learning of the sequenced movements has progressed to the later stages of motor learning.

The current results also showed a negative correlation between the Silencing and Attentional Effort macro-categories. Moreover, the Silence and Reduced Mind-wandering sub-units showed a strong positive correlation between them, and were both negatively correlated with Attentional Effort, but not with the Mindfulness category.

In this study, we explored for the first time self-reported subjective phenomenological experiences of silence during QMT practice and their correlations with changes in structural brain connectivity. However, it is not clear what is the mechanism underling these changes. Future studies should examine the causal relationship between QMT experience-related reports of silence and changes in FA by means of more specific assessments related to silence, as well as comparing it to additional training groups. The uncinate fasciculus matures later and more slowly than other brain fiber connections, and might continue developing beyond the age of 30 years (Lebel et al.,

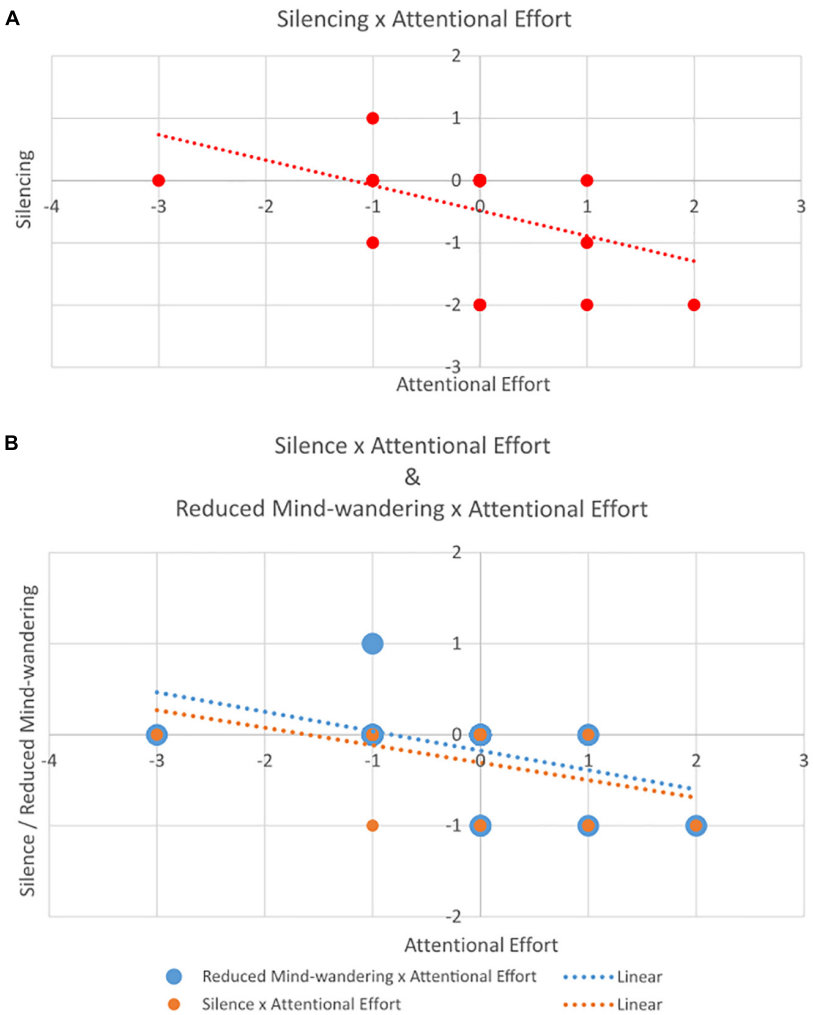

FIGURE 3 | Scatterplot of correlation between change in **(A)** Silencing (*y*-axis) and Attentional Effort (*x*-axis); and **(B)** Reduced Mind-wandering and Silence (both on *y*-axis) and Attentional Effort (*x*-axis).

2008). This might enable greater structural plasticity in response to a variety of internal or external (De Fano et al., 2019) environmental influences (Markowitsch and Staniloiu, 2011), such as induced internal and external silence.

LIMITATIONS AND CONCLUSION

The lack of a control group is one of the main limitations of this study. However, neural, neuronal, and cognitive changes related to QMT have been compared to different control groups in the past, controlling for both cognitive and motor load, demonstrating its specificity (see Ben-Soussan et al., 2013, 2014b; Venditti et al., 2015; Paoletti et al., 2017).

More in detail, QMT related changes have been studied by comparing groups performing QMT with active control groups performing verbal or motor tasks (Ben-Soussan et al., 2013). This study demonstrated that cognitive and neurophysiological changes can be specifically induced by QMT practice (Ben-Soussan et al., 2013). Moreover, QMT's impact on emotional regulation has been studied comparing two groups of meditators, one performing a breathing meditation + QMT and the other one performing only the breathing meditation (Paoletti et al., 2017). In this case, increased affect balance was attributed to the group which also performed the QMT practice, while self-efficacy increased in both groups.

For these reasons, in our opinion, the lack of a control group in the present study represents a limitation but taking in consideration (1) the observed reliable specificity of QMT-related cognitive, neurophysiological and emotional modulation, (2) the results of other studies showing improvements in self-efficacy, emotional and cognitive modulations following mindfulness or meditative practices (Creswell et al., 2007; Garland et al., 2009, 2011; Wendt et al., 2015), we can associate the here presented results about silence reports and their correlation with uncinate fasciculus connectivity to the prolonged performance of QMT as a meditative practice.

Moreover, several studies have already demonstrated the longitudinal reliability of DTI measures, including previous learning studies where control groups did not show FA changes (Scholz et al., 2009; Taubert et al., 2010). Nevertheless, despite demonstrations from previous work, the present findings are limited by the lack of a control condition. Another possible interpretation which cannot be excluded by the present work, involves the expectation due to receiving the intervention.

It is important to underline that the content of this manuscript goes beyond the main aim pursued by the original longitudinal study, of studying the cognitive, emotional, and physical experiences related to QMT performance. The exploration of silence-related experience to QMT practice was not part of the experimental design, and participants have never been directly asked or cued to mention it. Nonetheless, it emerged spontaneously from first-person reports, suggesting that silence could represent a particularly relevant component of this meditative practice.

This study provided interesting insights, but further investigations specifically designed to assess the impact of the experience of silence in meditative sensorimotor trainings and their neurophysiological correlates are required.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Ethical Committee of the Università Campus Bio-Medico di Roma. The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

TB-S and FC designed the research. CQ performed the research. FM, AD, and FA analyzed the first-person reports. CP and FC analyzed the DTI data and DTI correlations. TB-S, FM, CP, JG, and FC wrote the manuscript. AD, FA, and CQ contributed to the writing process. All authors contributed to the article and approved the submitted version.

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