USING SINGLE-SESSION MEDITATION INTERVENTION TO TEST THE

ATTENTION SCHEMA THEORY OF CONSCIOUSNESS

by

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I. INTRODUCTION

Awareness and Attention

An ongoing discussion continues in the psychological sciences regarding the relationship between awareness and attention. According to a recent overview, the current line of thought pertaining to this relationship is reflected in a single statement: "Attention is necessary, but not sufficient, for conscious awareness" (Noah & Mangun, 2020, p. 53). Attention, as conceptualized here, refers to the general mechanism of selecting information for cognitive processing and maintaining an alert state, and conscious awareness is used to refer to the mechanism in which subjective conscious phenomenal content is perceived (Noah & Mangun, 2020). Interestingly, Noah and Mangun (2020) discuss a notable distinction in describing consciousness as conscious contents versus conscious states – information accessible to awareness, not states of consciousness like coma and sleep – and they tend to use "conscious perception", "conscious awareness", and "awareness" interchangeably. A juxtaposition of evidence provided by Noah and Mangun (2020) reveals varying interpretations regarding the relationship between attention and awareness. Two leading considerations conceptualize attention and awareness as being distinct mechanisms or linked processes (Noah & Mangun, 2020). Criticisms against evidence supporting a distinct nature for attention and awareness often acknowledge the difficulty in truly examining these mechanisms in an independent manner (Jackson-Nielsen et al., 2011). Manipulations of attention can often lead to unintended changes in awareness and vice-versa, and it may not be possible to completely remove attention while maintaining awareness. Moreover, some theories of consciousness explain this relationship in the context of the wider attempt to understand the fundamental nature of human consciousness; that is, how humans have subjective experiences, how we attribute such experience to a sense of self, and the neural correlates of this process (the neural correlates of consciousness or NCC). The study proposed here will focus on testing one such theory of consciousness, the Attention Schema Theory of Consciousness (AST) (Graziano & Webb, 2015), that seeks to explain consciousness in terms of awareness and attentional processes.

The main idea of AST is that conscious awareness is a simplified internal model of attention (called *the attention schema*) constructed by the brain and honed by evolution that controls/guides endogenous, or voluntary, attention and produces our concept of self (Graziano, 2019; Graziano, 2020). This attention schema is thought to be an ancient mechanism evolving naturally in human development that serves two overall functions: 1) "a self model to monitor, make predictions about, and help control one's attention", and 2) "a catalyst for social cognition" to help us model other's attentional states and predict their behaviors (Graziano, 2019, p.64). According to the AST, the brain produces a concept of self by processing sensory information from which a body, or perceiver of such sensation, tends to deduce a self (Graziano & Webb, 2015). Using attention, a self is inferred when acknowledging a seemingly attainable experience of sensation. This process of inferring a self based on perceiving sensations seems to require the development in selectively allocating attention and interacting with the environment, so this mechanism called the attention schema might be developed initially quite early in the human life span (Graziano, 2019). This concept of a self is logically inferred by attributing the complex processes of attention to self-awareness by the underlying modeling of attention through awareness; that is, the attention schema, or awareness, is developed in order to avoid the need to consciously process the precise neural mechanics of attention involved in perceiving sensation. We recognize an experience is being processed and logically deduce there must be a self having that experience. Basically, as attention is modeled by awareness (the core tenet of AST – see above), the brain infers the existence of a self in order to comprehend its attending to its experiences. Thus, this theory identifies awareness and attention as being tightly linked, the latter as modeled by the former. This also recognizes attention as being the cognitive process most closely correlated to one's awareness (Graziano et al., 2019). Graziano (2019) also clarifies a distinction of "consciousness" similar to the manner in which Noah and Mangun (2020) provide: "consciousness has come to mean the act of being conscious of something" (Graziano, 2019, p. 4). In this way, he equates conscious awareness to the act of being conscious.

In essence, the AST explains the growing experimental evidence suggesting awareness and attention are closely linked (Graziano, 2020, Noah & Mangun, 2020) by proposing that conscious awareness is an internal model of attention, referred to as the attention schema, and the controller of endogenous attention. If the AST is correct, then it follows that the control of awareness should influence the control of attention; the attention schema is thought to naturally occur by the neurobiological process of attention to specifically control endogenous attention. The present study will examine this hypothetical relationship by testing how brief training in controlling awareness may lead to improving the control and sustainment of endogenous attention. The overarching hypothesis is that as one develops their control of bodily awareness, and in turn the attention schema, then one should be more effective at controlling endogenous attention.

Testing AST

To test the AST, one would have to show that practicing controlled or intentional awareness reveals a significant relationship to performance on measures of attention and some change in form of one's self-concept. Practicing or controlling awareness could take the form of fixating on sensation or exercising one's perception off a stimulus. Another approach is to show that controlling awareness predicts improved performance in attentional tasks and changes in one's conceptualization of the self. Since the attention schema is thought to produce the self-concept, the training or engagement with the attention schema should reveal a relationship with self-concept and/or in the act of self-conceptualization.

The current author conjectures that self-concept and self-conceptualization differ in that self-conceptualization is the process of building one's self-concept. In other words, self-conceptualization can be considered the action required to form the self-concept. By developing or engaging awareness, one is actively producing, and possibly passively revising, and/or reformatting their self-concept. Lesser engagement with the attention schema may support a lesser change in measures of self-concept or self-conceptualization due to its theoretical relationship with awareness. Previous research has unpacked the conceptual nature of self-concept in describing it as a cognitive schema that essentially contains organized structures of knowledge, traits, memories, and control of processing self-relevant information (Campbell et al., 1996). Self-concept in this regard could then refer to the attention schema as the originator of the cognitive schema as if awareness not only guides endogenous attention but also provides the root of subjective experience for attention. Campbell et al. (1991) also describe a structural aspect of self-concept, self-concept clarity (SCC), as the extent to which one's organized structures of knowledge and self-relevant information are clearly and consistently defined. Essentially, to assess a change in self-concept or self-conceptualization, one might measure changes in structural elements of one's self-concept, or measure changes in how one might engage in building their self-concept, via self-conceptualization. Further elaboration into how this study assesses changes in self-concept will be discussed in the "Concept of Self and AST" subsection.

Showing the differences between awareness and attention is somewhat difficult since they are so closely linked, but Wilterson et al. (2020) provide specific predictions based on the AST to examine this relationship (discussed in more detail below in the "Behavioral and Perceptual Metrics of Sustained Attention" subsection). These testable predictions for AST refer to the attention schema as the endogenous controller of attention that ultimately provides a model for controlling the attention on an object (Wilterson et al., 2020). The purpose of this study is to examine how training the theoretical attention schema, or awareness, may affect endogenous attention and changes in self-concept.

Meditation and Attention

Meditation continues to receive extensive investigations in psychological research from examining its use in psychotherapy to building a taxonomy of types and elaborating on the neurophysiological process and effects of meditation. Meta-analyses have recognized a consistent effect of meditation training on attention and attentional control (Gill et al., 2020; Hildebrandt et al., 2017; Lippelt et al., 2014; Romberg & Haarmann, 2016; Verhaeghen, 2016). In a more recent meta-analysis examining results of adults from 87 papers (Sumantry & Stewart, 2021), it was found that attentional capabilities improved (as measured with various attention tests such as the Stroop Test) with meditation intervention supporting theories positing that improved attentional ability could be a general mechanism of meditation, essentially driving meditation outcomes. Sumantry and Stewart (2021) surmise that future research should examine what specific mechanisms of meditation are most important for the attentional benefit. This study may elucidate the training of awareness as that specific mechanism, as explained in the following paragraphs.

These meta-analyses mostly review long-term meditation intervention and long-term mindfulness-based interventions, and the consensus is that an ideal long-term meditation intervention for finding effects on common psychological constructs is an 8-week program (Basso et al., 2019). Short-term meditation interventions have been studied too. Short-term meditation interventions are usually a week or less, and it has been found they improve self-regulation and executive attention via the Attention Network Test, the Stroop Task, and the Profile of Mood States (Tang et al., 2014, Josefsson et al., 2012). Important components of self-regulation include emotional regulation and attentional control (Tang et al., 2014). The findings that executive attention and self-regulation can be improved with short-term meditation intervention shows that even short practice of meditation can affect our attentional capabilities. There are far-fewer studies that investigate the effect of single-session meditation interventions on sustained attention where single-sessions are usually 10 minutes long (Colzato et al., 2015; Mrazek et al., 2012; Norris et al., 2018; Watier & Dubois, 2016). It is common to presume that novice meditation practitioners would need more than a single session to fully utilize the specific meditation style designed for a study. Extraneous variables regarding the mode of learning the style and/or the competence of the teacher have been considered in various studies according to recent meta-analyses reviewing the extensive meditation literature (Verhaeghen, 2016, Gill et al., 2020). Generally, there is an experimental group consisting of experienced meditation practitioners, novices taught by experienced practitioners, and/or a control group of novice meditators depending on the research question. Support for meditation's effect on attention is often replicated in relevant research literature, but there have been few empirical examinations of single-session meditation intervention effects on sustained attention. The present study will examine potential effects of a single-session meditation intervention on sustained endogenous attention.

AST and Meditation

In consideration of the consistent finding of meditation effects on attentional processes, it may be fitting to use meditation intervention to test theories of consciousness since it is through attention that we selectively perceive sensory information from the environment (Cohen et al., 2014). In other words, attention directs our phenomenal experience in conjunction with other processes; thus meditation, having been found to affect attention, would be intuitively useful for developing and testing consciousness theories. Being that attention is thought to be necessary for conscious awareness or perception and meditation is often found to affect attention, it seems logical that one could use meditative techniques to test specific predictions posed by consciousness theories. However, despite decades of research on meditation, it appears studies incorporating meditation intervention to specifically test theories of consciousness are lacking (beyond the investigation of nondual awareness, that is).

To utilize meditation intervention to test this theory, one could choose a specific meditation style that engages a practice on bodily awareness. There is an array of meditation styles available, which may be organized according to a commonly accepted taxonomy consisting of four main categories: Fixed-Attention, Open-Monitoring (OM), Compassion, and Loving Kindness (Raffone et al., 2019). The different styles are similar in engaging awareness and attention, except for some minor differences in how the techniques are conducted or specific procedural elements. Fixed-Attention meditation styles usually involve focusing on an object outside one's body to develop the ability to focus one's attention and reduce mind-wandering, whereas OM styles involve being aware of internal experiences where the focus is to develop an open awareness to all internal experiences without reacting to them (Raffone et al., 2019). Compassion and Loving Kindness styles generally seek to increase benevolent cognitions (Raffone et al., 2019). By the reasoning that OM meditation involves being aware of internal experiences, this style would be the most appropriate to use in training the attention schema based on the theoretical proposition that equates the schema with awareness.

Mindfulness is among the most studied meditation styles and may be included in the OM and Fixed-Attention categories depending on the type of Mindfulness practice incorporated. Holzel et al. (2011) provide a review of the components that make up Mindfulness meditation; they recognize that various mechanisms act as components in Mindfulness meditation structure types, components such as attention regulation, body awareness, and others. Hölzel et al. (2011) also specify a component of OM Mindfulness techniques as utilizing body awareness where practice consists of focusing on internal experience or sensory experiences. By isolating this specific component of Mindfulness meditation, a practice of body awareness can be assessed. A recent study recognized the effect of mindfulness on attention as to how it regulates self-regulation, and uses this understanding, among other considerations, to apply it to self-regulated mindfulness technologies (Niksirat et al., 2019). They describe their instructions for implementing mindfulness applications as "Attentional Focus Strategies" recognizing the effect this particular component of utilizing bodily awareness has on attention; however, they did not test this component of meditation on sustained attention. This example simply shows how common it is to consider mindfulness as a tool for attention regulation. Additionally, they did not test this in the framework of a specific theory of consciousness. Furthermore, a few studies utilizing single-session mindfulness meditation as an intervention with young adults showed medium to large effects on sustained attention measures including the Flanker Task, Rapid Serial Visual Presentation (RSVP) task, Stroop Task, and the Sustained Attention to Response Task (SART) – these studies and their effects will be discussed in the "Participants" subsection of the "Method" section for power analysis (Colzato et al., 2015, Norris et al., 2018, Mrazek et al., 2012, Watier & Dubois, 2016).

The present study will utilize a meditation style directly derived from a recent revitalization of the ancient traditional practices of the Drukpa lineage originating from the northeastern Himalayan Indian regions, dating back to the 1060s B.C.E. This lineage preserved specific and practical instructional material on the meditative procedures employed through their tradition, and a present-day non-profit, Drukama, seeks to provide public access to these teachings (HaLevey, 2020). Certain foundational practices in this tradition would be categorized as an OM Mindfulness style, and one specific component of the detailed technique employs the mechanism of bodily awareness to focus on the inner experience of breath and active awareness of certain bodily focal points or anchors. As learning meditative techniques can be somewhat challenging, in the present study an experienced practitioner using the written instructions will first provide a brief YouTube tutorial for the underlying resistance breathing, review the technique with study participants, provide an informal assessment on the subject's understanding of the technique, and finally, an audio recording of another veteran Drukama practitioner will guide participants through the meditation (see Methods). Additionally, participants' meditation experience will be assessed with a brief scale.

Because meditation intervention has not been utilized to test theories of consciousness and single-session meditation intervention research is minimal, the present study design will incorporate a single-session OM mindfulness technique that specifically utilizes the mechanism of body awareness to focus on internal experiences. To test this practice of awareness on attention, participants will be assessed on two tasks designed to engage sustained endogenous attentional processing, as described in the next section.

Behavioral and Perceptual Metrics of Sustained Attention

Sustained attention is the ability to achieve and maintain an alert, focused state of psychological processing over a relatively long period of time (Sarter et al. 2001). As such, the maintenance of optimal performance requires sustained attention, and any task performance can be extended concurrently with sustained attention (Cohen et al., 2014). Eventually, sustained attention degrades the stability of response control where attentional allocation tends to deviate from the focus of sustained attention (Cohen et al., 2014). This can be explained by Lavie's load theory, which states that sustaining attention eventually results in directing unallocated attentional resources to more than one source of information (Lavie et al., 2014, Noah & Mangun, 2020). In other words, Lavie's load theory suggests that attention employs unallocated resources to task-irrelevant information when a task does not demand full attentional resources. As such, Noah and Mangun (2020) suggest that studies attempting to dissociate attention from awareness should provide a task that is load-intensive enough to prevent attentional resources from spreading to secondary information. The present study hypothesizes that meditation-related practice of controlled awareness will improve sustained attention via the connection between awareness and attention as described by the AST. In the present study, sustained attention will be measured using behavioral, perceptual, and neural metrics and compared between an experimental group receiving meditation intervention and a control group that does not receive meditation intervention. The meditation intervention is intended to be a load-intensive task where subjects are instructed to continually redirect their awareness to the points of focus on/in the body (see Method) actively preventing and correcting for any deviation in attentional resources, whereas the behavioral and perceptual tasks would be considered load-intensive in that the continual engagement of sustained attention is required to properly report throughout the task (as explained further in their relevant subsections in Method).

Behavioral Metric: Psychomotor Vigilance Task

The behavioral metric will be the Psychomotor Vigilance Task (PVT), which has been utilized as a measure of sustained attention since 1985 (Doran et al., 2001, Drummond et al., 2005). More recently, the use of the Psychomotor Vigilance Task has been used to measure the effects of sleep deprivation on sustained or vigilant attention

(Basner et al., 2018, Hansen et al., 2020). It is now common to consider vigilance and sustained attention as being one and the same (Basner et al., 2018, Hansen et al., 2020), but Fowler (2014) recognizes earlier considerations delineating the two terms simply as acknowledging the vigilance decrement as a reflection of the ability to sustain attention on a task. This study will recognize vigilance, vigilant attention, and sustained attention as describing the same process, consistent with recent studies (Basner et al., 2018, Hansen et al., 2020). The Psychomotor Vigilance Task (PVT) is a test that shows stimuli at random intervals (usually numbers, a letter, or a dot) to which the participant must click a designated button to acknowledge their attention thereof (see Methods section, below, for the specific details of the version of the PVT used here). Reaction time (RT) in each trial (measured in milliseconds) is used as a behavioral indicator of attentional detection of the stimuli where faster RTs indicate faster processing and attention to the stimulus. Trials may present themselves randomly for at least 30 seconds over task durations of up to 10 minutes, often referred to as variable inter-trial intervals (ITI).

Perceptual Metric: Troxler Task

The perceptual metric of sustained attention will be a perceptual phenomenon called the Troxler Effect or troxler-fading (Troxler, 1804), in which participants experience an illusory disappearance of a visual stimulus by focusing and sustaining their overt (directed by eye movement) attention on a dot or a cross positioned in the center of an image containing a neutral light-colored background (usually gray or white, with a splash of somewhat-faded color serving as part of this gray or white background). Eventually, with persistent sustained focus of attention on the dot or cross, the participant will experience the brief disappearance of the colors. Although it is shown that experiencing the Troxler Effect is associated with similar brain activity as the experience of perceptual filling-in (PFI), troxler-fading is considered to be a different phenomenon (Devyatko et al., 2017). However, Devyatko et al. (2017) discuss an interesting similarity between the Troxler Effect, motion-induced blindness, and PFI: mainly, attention modulates the illusory disappearances. De Weerd et al. (2006) also acknowledge sustained attention is involved in the disinhibitory effect of perceptual filling-in experienced in similar figures representing troxler-fading. Martinez-Conde et al. (2004) expand on the role of fixated eye movements in visual stimulation and progressively build to relate their findings to the process involved in the Troxler Effect; they have shown that this effect arises from neural adaptation due to consistent pupil stabilization. However, the illusory effect eventually ends, and the colors reappear with excessive retinal fatigue and/or when attention is shifted or broken (Martinez-Conde et al., 2004). To the present author's knowledge, the use of the Troxler Effect optical illusion on assessing sustained attention has not yet been incorporated in research. The present study will incorporate timed durations of experiencing the Troxler Effect to serve as a measure of sustained attention. Essentially, participants will monitor and report when the colors fade as the start of the effect and when any color returns to their perception. This would be similar to how one might report the presence of a red dot in the PVT, except this involves a different color, a larger area of monitoring, and a perceptual effect. One could say that in reporting when the perceptual effect begins and ends while being tasked to maintain the optical illusion, participants are engaging sustained selective attention such that attention is modulating the bottom-up effects of neural adaptation. Controls were implemented to ensure the validity of the Troxler Task's ability to measure sustained attention. One control was in conducting a zero-order analysis between the durations in maintaining perception of the Troxler Effect with the PVT RT average durations. It is also expected that the TT should elicit EEG responses commonly associated with the sustainment of attention (see “Sustained Attention Correlates” subsection).

When viewing the optical illusion, one will learn that as their covert attention increasingly deviates from the dot in the center, even as their overt attention is sustained at the dot, the troxler-fading will tend to desist. Essentially, one will have to practice sustaining their selective attention at the center of the cross while avoiding the attentional interference of the optical illusion yet reporting when the effect occurs and desists. However, being that subjects will have to attend to both the illusion and the center of the dot simultaneously, this measure is not appropriately operationally designed to measure selective attention, and as such, this task will be an additional measure for general sustained endogenous attention along with the PVT.

A few of the experiments conducted in Wilterson et al.’s (2020) study are somewhat relevant to this study’s investigation. Wilterson et al. (2020) conducted a series of experiments examining the effect of participants’ awareness of cue-target contingencies on endogenous and exogenous attention to test specific predictions posed by the AST. The cue was a centered dot, and the target was a red circle that appeared randomly in one of ten locations around the dot. Contingencies varied by likelihood of the target’s location, the target’s location, and a black mask. However, in the Troxler Task, what could be considered the cue (troxler-fading), target (centered cross), and distractor (the novelty and/or salience of perceiving the optical illusion) are all seemingly part of the task as explained in later paragraphs. The results of their second experiment supported their prediction that awareness of the contingencies was not necessary for an effect on endogenous or exogenous attention (Wilterson et al., 2020). The second experiment had subjects still visually aware of the cue and target but were not informed that the cue predicted the location of the target, so subjects eventually attuned to the cue's prediction throughout the trial. As such, participants should gradually attune to producing and extending the perceptual effect of troxler-fading, but they will be informed of the cue/target/distractor elements involved in the Troxler Effect.

Their first experiment showed that awareness of the contingencies allowed the control system, the theoretical attention schema, to shift spatial attention by use of information about the cue-target relationship (Wilterson et al., 2020), and this first experiment would reveal the cue randomly in one of 10 locations while a masked cue was also randomly presented. Subjects were instructed to indicate their attention of the cue location, either tilted to the right or left, as quickly as they could with prior instruction that the target would more likely appear at a specific side. In the present study, the indication of cue location is apparent while subjects are instructed to initially focus on the cue of the centered dot to produce the optical illusion. The third experiment was similar to the second in that subjects were not aware of the cue-target contingencies, but their visual awareness of the cue was removed by making the cue black instead of red which essentially made the cue subjectively invisible when quickly proceeded by the black mask. Their third experiment supported their prediction that visual awareness of the cue was necessary for an endogenous attention effect (Wilterson et al., 2020). By such reasoning, the information about the Troxler Effect contingencies and the subject's visual awareness of such perception should provide a reasonable effect on endogenous attention.

Effects may include modifying, adjusting, or controlling the attention on an object, which requires consciousness of the object.

The present study is similar except no intentional or explicitly designed cue-target contingencies are being used in the Troxler Task. Instead, one could say a cue-target contingency controls the optical illusion. What could be considered the cue, distractor, and target are built into the optical illusion and ultimately work in tangent to form the illusion; the cue is the dot/cross, whereas the target and distractor could be considered the troxler-fading effect. Maintaining attention of the dot to stimulate the troxler-fading will undoubtedly partition attentional resources towards the effect occurring. Since the attentional scope of the centered dot is small, the spotlight of attention can sufficiently cover the optical illusion while still sustaining overt attention on the centered dot/cross. However initially, the relevant attentional resources may divert completely to the experience of the optical illusion per its potential salience. Essentially, participants will learn that simultaneously modifying and sustaining attention on the dot/cross and the Troxler Effect is necessary to maintain the illusory effect while they report when the effect occurs and desists.

Their awareness of this working relationship between the arbitrary cue and distractor to initiate the optical illusion should gradually improve with more trials while the attention schema will adjust and sustain the endogenous attention on the cue-distractor relationship to extend the perceptual experience. In other words, participants should be conscious of this change in controlling attention on the centered dot to experience the troxler-fading during practice trials and adjust accordingly, and their continual experience of this relationship should contribute to an implicit endogenous attention effect in the form of longer durations of sustained attention via experiencing the troxler-fading. This can be explained by the AST in that the attention schema is specifically created to monitor and control endogenous attention, so the attention schema will be trained in the intent of prolonging the perceptual effect by sustaining attention on the centered cross. Those in the experimental group with training in perceiving and controlling their bodily awareness, per the meditative task, should be able to extend the Troxler Effect by means of better practiced control of endogenous attention. Both groups will be aware of this cue-distractor relationship as they conduct trials, but the experimental group may adjust quicker to initializing and extending the perceptual effect.

In order to assess attentional engagement during the PVT and Troxler Tasks in the present study, a comparison condition is needed in which cognition is relatively disengaged. Following Behzadnia et al. (2017), a resting state task will be used for this comparison condition that engages default mode brain activity in eyes-open and eyes-closed states (Trujillo et al., 2017). Such default mode states reflect endogenously-controlled and internally-directed states of attention that are not driven by external stimulation (Raichle et al., 2001).

Relevant EEG Spectral Power Correlates

Sustained Attention Correlates

Finally, the neural metric of sustained attention that will be utilized in the proposed study will be changes in the brain's bioelectrical activity as measured via electroencephalography (EEG), specifically changes in EEG power spectral density (PSD). Research has consistently shown that alpha-band (8 – 13 Hz) EEG PSD activity decreases and theta-band (4 – 7 Hz) PSD activity increases as a result of the engagement of sustained attention (Behzadnia et al., 2017; Fowler, 2014; Liu et al. 2019; Loo et al., 2009; Mazor and Fleming, 2020; Peng et al., 2021; Sauseng et al., 2007), with these attention-related responses emerging as early as 10 months in age (Xie et al., 2017). These changes tend to occur over frontal, central, and posterior scalp sites. Changes in beta-band (14 – 30 Hz) PSD have not been widely examined or observed in EEG studies of sustained attention, but one previous study (Loo et al., 2009) found a significant decrease in beta-band activity over time during a sustained attention task across groups of attention-deficit hyperactivity disorder (ADHD) patients and controls. Therefore, the present study will examine sustained attention-related theta-, alpha-, and beta-band EEG PSD as well.

Troxler Task Correlates

It may be noted that the present study incorporates a perceptual phenomenon in place for a sustained attention task. As outlined previously, the perceptual task should act on sustained attention; however, being that it is a perceptual task similar to PFI, EEG data may be different than what has been previously observed in the PVT. It has been found that in bistable perception, a commonly used perceptual phenomenon in investigating neural correlates of perception, a longer duration of perceptual experience correlated with alpha amplification (specifically around the parieto-occipital sulcus), and such alpha amplification is described as acting to stabilize neuronal activity and its corresponding perceptual representation in addition to acting as a filter preventing broadcast of irrelevant information (Piantoni et al., 2017). Additionally, specific transcranial stimulation of 10Hz to the occipitoparietal region enhanced alpha oscillations during sustained attention tasks resulting in increased consistent stability in the visual attention task performance (Clayton et al., 2019). Attention also directly increases the probability of experiencing PFI (De Weerd et al., 2006), and attention positively correlates to alpha-band PSD activity in PFI (Davidson et al., 2020). Sustained attention supports a similar interaction in the maintenance of the troxler-fading phenomenon, and being that attention positively correlates to alpha-band power in PFI, the Troxler Task could show greater alpha activity compared to the PVT. What could mark the Troxler Task as a sufficient sustained attention task is the specific theta amplification at both midline frontal-central and frontal-parietal regions as has been shown with the PVT, whereas alpha-band power may increase when compared to the PVT. Perhaps right temporal and midline parietal could be additional areas of interest to include when investigating how alpha-band activity may differ between the two tasks. It is also expected that beta activity could correlate with alpha activity due to Loo et al.'s (2009) findings, as previously mentioned.

OM/Mindfulness Meditation Correlates

In assessing the difference brief meditation may provide in terms of alpha, theta, and beta EEG activity at certain sites, a keen interest in alpha and theta activity prevails. Since 2010, a consensus regarding increases in both alpha and theta power presides. For example, this trend is supported in a study where short-term mindfulness meditation improved PVT performance for novice meditators (Kaul et al., 2010). Another short-term mindfulness meditation intervention showed significant increases in alpha activity but no consistent difference in theta (Wong et al., 2018). Lee et al. (2018) also report specific changes associated with long-term OM meditation: increased frontal alpha amplitude, increased alpha coherence in both frontal and parietal regions, increased theta activity in the frontal midline, increased theta coherence in frontal and parietal regions, and increased beta activity in the insula and inferior frontal gyrus. Due to the lack of feasibility and potential confound in neuroimaging assessment during meditation, these studies assess such effects as a pre-post-meditation comparison. A long-term mindfulness meditation intervention sought to assess the cross-frequency dynamics of this alpha-theta relationship and supports evidence suggesting that meditative states reduce alpha:theta 2:1 harmonicity (referring to ratio patterns in electroencephalography rhythm activity between two or more specific rhythms) towards a 1.6 ratio instead, reflecting a decreased coupling between these two frequency bands (Rodriguez-Larios et al., 2020). Interestingly, Rodriguez-Larios and Alaerts (2020) suggests this decreased coupling between alpha and theta activity reflects a decrease in mind-wandering, or in other words, an increase in mindfulness. While taking this all into account, single-session OM mindfulness meditation's impact on observed EEG differences between groups will be an interesting inquiry for the present study. While sustained attention tends to show higher theta and lower alpha, mindfulness meditation can show the inverse. It may be intuitive that prolonged sustained attention will induce mind-wandering, and Lavie's load theory can explain why in that attentional resources will tend to deviate from a task lacking in load-intensity. While the alpha-theta trend in sustained attention is a negative relationship, perceiving perceptual phenomena such as bistable perception and PFI tend to promote alpha amplification. Additionally, mindfulness meditation tends to promote alpha amplification. By such reasoning, it may be that the experimental group will show a trend in higher alpha and lower theta activation especially while conducting the Troxler Task.

Summary of Correlates

To summarize, it is expected that sustained attention will present a basic trend of increased theta amplification and reduced alpha and beta activity (specifically in the midline frontal, central, and parietal scalp regions), experiencing the Troxler Effect will be accompanied by this basic pattern but with higher alpha/beta activity, and meditation will be also be accompanied by this basic trend while potentially reversing the trend towards higher alpha and lower theta during the Troxler Effect. Basically, the experience of the Troxler Effect by those in the intervention group may reveal a reverse trend to that often seen in sustained attention yet also attributed to longevity of attention. Whether significant changes in beta-band activity will be observed between groups is part of an exploratory analysis, but overall, it is expected that beta activity will change alongside alpha activity. Specifically, beta-alpha activity will present similar changes in both groups across tasks, and beta-alpha activity will be more prominent in the intervention group while potentially being more prominent than theta activity in the intervention group's Troxler Task. The main predictions assessed in this study will be explicitly reviewed in the "Summary and Hypotheses" section.

Concept of Self and AST

Information processed in subjective experience is central to the development of our concept of self, and the AST proposes that this model of attention, as awareness, is what produces the concept of self (Graziano, 2019). Subjective experience is often discussed in the consciousness literature, but in this particular study, the focus is on how the AST describes it. According to the AST, subjective experience allows us to infer a self based on the attention schema. Therefore, if the attention schema as awareness produces our concept of self, then developing or training the attention schema should have some effect on self-concept and/or self-conceptualization. The practice of utilizing the attention schema, or awareness, should result in a change in the engagement or in the act of self-conceptualization, as well as a change in how one may form their self-concept based on the variety of aspects that help shape it. We could observe the change in quantitative averages accumulated from self-report questionnaires aimed at evaluating one's engagement of self-conceptualization, evaluating aspects of self-concept, or by use of qualitative data analysis based on structured interviewing designed to elicit responses that reflect aspects of one's self-concept. However, self-concept is a complex, multifaceted psychological construct (Wehrle & Fasbender, 2019), and various attempts at representing self-concept have been made with theoretical frameworks, like McConnell's (2011) Multiple Self-Aspects Framework. Various self-concept measures have been created over the years (Byrne & Gullickson, 1997), and various measures centered around the assessment of components or aspects that help form the self-concept have been utilized over the years (Campbell et al., 1996). However, this study will consider using self-reported agreement with phenomenological indicators for Autonomy and Personal Growth dimensions from Ryff's six-model Psychological Well-Being (PWB) as such self-reporting requires one to engage in self-conceptualization in order to respond which ultimately provides a response that reflects a product of their self-concept (Ryff & Keyes, 1995).

The well-known Psychological Well-Being Scale by Ryff portrays dimensions of one's psychological well-being, and one's self-report of their psychological well-being is inherently involved in self-conceptualizing. In other words, this assessment is more of a task eliciting self-report that inherently requires some form of self-conceptualization specifically framed in dimensional constructs relevant to certain aspects of one's self-concept. Essentially, this is an activity of reflecting on self-conceptualization to provide a proxy measure for changes in self-concept. One could go as far as saying reflecting on self-conceptualization is an act of self-conceptualization as one would be essentially evaluating their self-concept.

These subscales are relevant to self-concept by their theoretical nature. Werhle & Fasbender (2019) explain that self-concept is multifaceted and includes an interlaced relation between self, self-concept, and identities. Identities include social identities and rely on the evaluation of contextual social relations (Werhle & Fasbender, 2019). Autonomy and Personal Growth directly involve engagement with self-conceptualization as described in the theoretical context of the PWB construct outlined by Ryff & Keyes (1995) and explained further by Seifert (2005).Autonomy directly involves one's expectations and beliefs regarding social pressures and personal standards (Seifert, 2005). In other words, Autonomy is thought to portray expectations and beliefs about one's social identities. On the other hand, Personal Growth assesses one's sense of their developed self in the context of time (Seifert, 2005) – "self" includes the capacity to reflect on oneself, and "self-concept" is constructed by the thoughts and feelings in reference to oneself (Werhle & Fasbender, 2019). If self-concept is constructed by self-referential thoughts and feelings, then the theoretical nature of both the Autonomy and Personal Growth constructs can be considered as a form of self-conceptualization that reflects changes in self-concept. Additionally, the Autonomy and Personal Growth PWB dimensions are also relevant to self-conceptualization in that high scorers exhibit the following descriptors: high scorers in Autonomy tend to regulate and evaluate self by their standards and reflect an independent nature, whereas high scorers in Personal Growth conceptualize an improvement in self, feel there is continued development to attain, conceptualize self as growing and expanding, perceive their potential, and reflect more self-knowledge (Seifert, 2005; Ryff & Keyes, 1995; Ryff, 2013).

There does appear to be a problem in trying to assess changes in self-concept being that this study is not longitudinal; it is difficult to imagine a significant change in self-concept can occur in such a short timeframe. Dimensions, and the items thereof, from Ryff's PWB model are described as phenomenological indicators encapsulating the six-model nature of psychological well-being (Ryff, 2013); the dimensions of psychological well-being do not appear to be traits based on items assessed as phenomenological indicators. The main difference between state and trait measures is the fluidity of change in time where states are considered less fluid or exhibit more change across time than traits. However, research has shown that these dimensions can remain moderately stable across a decade: specifically, in four dimensions (purpose in life, self-acceptance, environmental mastery, and personal growth) and in better-educated older adults (Hauser et al., 2005).

It is also difficult to say if brief engagement of the attention schema will significantly alter one's self-conceptualization and/or self-concept when considering self-concept is the totality of "learned attitudes, beliefs, and evaluative judgements that people hold about themselves" (Wehrle & Fasbender, 2019, p. 1). Specifically, one's self-concept is shaped by experiences and contexts over time (Wehrle & Fasbender, 2019), so one may have trouble reasonably expecting a brief single-session OM Mindfulness meditation, being operationalized as the training of one's attention schema, to significantly affect this totality of historical experience involved in the formation of self-concept. Self-concept differentiation (SCD) is a construct that is thought to be a structural aspect of self-concept and is defined as the variation of one's self-representations across different social roles or situations (Diehl & Hay, 2011). How age correlates with SCD, self-concept coherence (indicated by low scores in SCD, a contrast to SCD), and self-concept clarity (SCC) has been investigated in past research, and findings tend to suggest that young adults show lower SCD thus higher self-concept coherence when compared to older adults (Diehl & Hay, 2011). Another study found that SCC tends to peak in middle-adulthood as age increases, then dips again into later adulthood – the SCC/age relationship resembles an inverse u-shaped curvilinear pattern where SCC should be higher and more stable in middle-adulthood (Lodi-Smith & Roberts, 2010). Essentially, this trend seems to support an intuition that as adults age, they are expected to have more maturational development and less expected variance in their life course (and social roles) as opposed to young adults and older adults. Additionally, it is intuitive that older adults may have less SCC being that neuropsychological development tends to decline in late adulthood (Corral et al., 2006). The current study expects to draw its sample from mainly young adults, so to assess self-conceptualization with an expected short timeframe, it would be best to use a construct that is less stable over time – in other words, it may be best to use state measures rather than trait measures. This understanding results in consideration for using other constructs to encapsulate the change in self-conceptualization, but there is evidence of a significantly strong negative correlation between SCD and the Personal Growth and Autonomy subscales (Diehl et al., 2001) suggesting one's self-concept differentiation predicts lower degrees of Personal Growth and Autonomy. In other words, self-concept coherence should be positively correlated to the Personal Growth and Autonomy PWB dimensions. Additionally, evidence shows that Autonomy and Personal Growth PWB dimensions were significantly positively affected by various clusters of high/low SCD/SCC scores suggesting there is a relationship between self-conceptualization and the PWB dimensions (Diehl & Hay, 2011). Furthermore, it is documented within a sample of young adults that SDC and SCC significantly predicted aspects of psychological adjustment, though SCC predicts psychological adjustment better than SDC (Bigler & Neimeyer, 2001).

Mainly, the choice of using the Autonomy and Personal Growth subscales is based on evidence showing significant relationships to various SCD/SCC clusters (Diehl & Hay, 2011) and SCD (Diehl et al., 2001), SCC's ability to predict psychological adjustment via PWB measurements (Bigler & Neimeyer, 2001), and the theoretical nature of such constructs being relevant to self-conceptualization. It is evident that these subscales may reveal a relationship with self-conceptualization and self-concept thus providing a reasonable expectation of change in one trial.

However, the PWB measures may have to be modified to prompt for more momentary experiences rather than drawing a response from historical context like some items in these subscales tend to do. However, one's engagement with self-conceptualization involves their totality of experiences in that their experiences inform their self-concept, so one may consider that their historical context cannot reasonably be excluded in assessing self-concept. In other words, removing the consideration of prior experiences from elicited self-reports may limit one's ability to self-conceptualize as if the self is solely formed by momentary experiences. Frankly, there will be a limit to how well we can assess this change in self-concept with these specific measures.

In consideration of how to assess one's self-concept, adding state-measures in addition to the PWB subscales may help in encapsulating the multifaceted complex nature of self-concept. In light of Wehrle & Fasbender's (2019) discussion, this study strives to assess the extent of change in being able to clearly and consistently define one's self through the training of one's self-awareness, or attention schema. The question as to whether these particular measures can be affected by the experimental condition is yet to be determined, and few studies have specifically investigated effects of single-session open-monitoring mindfulness on self-concept or self-conceptualization. Whether the measures can appropriately gauge the trajectory of change in self-concept in such a short timeframe will be questionable, regardless of the type of self-concept measure utilized. The temporal element involved in this study necessitates an outcome of a type of state-measure, and considering the historical context involved in self-reporting specific dimensions of PWB, it may be prudent to also assess SCC being that this construct is meant to measure the extent to which one can clearly define the contents of their self-concept (Campbell et al., 1991) and seems to be more flexible in terms of temporal stability, especially for young adults. A modified version of the revised SCC (Campbell et al., 1996) scale will be utilized as a state-measure of change in self-concept.

In addition to assessing one's self-concept clarity from baseline to post-test, a measure clarifying the extent to which self-awareness co-varies with the training of awareness will be added as well. This addition should further clarify whether the theoretical proposition of an internal model of attention can significantly co-vary with a psychometric-based measure of self-awareness. Therefore, the Private Self-Consciousness (PSC) subscale of the original Self-Consciousness Scale (SCS-R) (Fenigstein et al., 1975) will be used in order to assess changes in self-awareness. These measures will be discussed further in their associated subsections in the “Method” section.

Summary and Hypotheses

To summarize, this study will examine the effect of single-session OM mindfulness meditation intervention on sustained attention and self-conceptualization in the framework of AST’s main theoretical proposition. Examining single-session meditation effects, using meditation intervention to test a theory of consciousness, and using the Troxler Effect optical illusion as a novel measure for sustained attention are all meant to address gaps in the research literature, but the main focus is testing predictions as posed through the framework of the AST. By implementing the OM Mindfulness component of bodily awareness practice, this study will assess whether awareness could be a model of attention and whether the engagement with this model significantly influences self-conceptualization. Incorporating the Troxler Task along with the PVT and portion of the 84-item Scale of Psychological Well-Being, this study will assess the outcome of how awareness may relate to sustained attention and concept of self. If awareness is a model of attention and this model, as the attention schema, produces our concept of self, then practicing short-term meditation intervention, specifically utilizing bodily awareness, should predict better control of sustained attention and influence changes in self-concept. Furthermore, distribution of sustained attention in the Troxler Task should significantly correlate with performance in the PVT, and EEG analysis should show increases in frontal-central-parietal theta-band EEG power and decreases in alpha-band (and possibly beta-band) power while participants perform the sustained attention tasks.

The following list outlines specific hypotheses summing up the prior points made: 1) the experimental group should score significantly better in sustained attention task scores, 1a) average PVT durations will be compared between groups possibly showing quicker RT in the experimental group; 2) those who practice the single-session OM mindfulness technique may be able to produce the Troxler Effect quicker and maintain the effect longer overall; 2a) durations of the troxler-fading perceptual effect from start to end will be compared between groups and may show that the experimental group is able to prolong the perceptual effect better than control, 2b) durations to start the troxler-fading perceptual effect will be compared between groups as to understand how the time it takes to initiate the effect may relate to how long attention can be sustained at prolonging the effect thereby also providing a control for possible retinal fatigue; 3) Troxler Task (start to end of perceptual effect) and PVT RTs should have a significant correlation; 4) Troxler Task and PVT EEG data may show specific trends within and between groups; and 5) the experimental condition may significantly influence changes in self-concept (indexed by PWB scales and SCC). Mainly, the experimental condition should significantly improve sustained attention and significantly alter one's degree of change in self-conceptualization. The specific trends mentioned in the third prediction will focus on the midline frontal (10/5 site Fz), midline central (10/5 site Cz), and parietal (10/5 site Pz) as follows: 1) presence of theta amplification and alpha/beta attenuation on both tasks (this will also serve as a type of control to ensure sustained attention is being measured in the Troxler Task), 2) higher alpha/beta activity in Troxler Tasks when compared to the PVT, and 3) Troxler Task within the intervention group may show more prominent changes in alpha/beta activity than the control.

II. METHOD

Participants

In reviewing studies to assess an effect of single-session meditation on self-conceptualization, only qualitative assessments were relevant. Unfortunately, there is no clear expectation regarding effect sizes on self-conceptualization (PWB and SCC). Thus, sample size for the present study was estimated according to expectation regarding effect sizes of 10-minute single-session mindfulness interventions on sustained attention. An a-priori power analysis was conducted through G*Power (Faul et al., 2007) to see how many participants might be needed to find a medium to large effect size for the planned t-tests with an alpha of .025 and power of .8 (Cohen, 1992). The assumption for medium to large effects was derived from a review of single-session studies assessing effects on sustained attentional control. The following studies assessed young adults who engaged in single-session mindfulness meditation and were later tested in sustained attentional tasks: Norris et al. (2018) found a medium to large effect size (d = .6) of a 10-minute mindfulness meditation session affecting Flanker Task accuracy, which engages sustained and executive attention, when compared to a control; Colzato et al. (2015) found a medium effect (d = .57) of an OM single-session affecting less attentional lag in the Rapid Serial Visual Presentation (RSVP) task but only when compared to FA meditators; and others reveal a medium effect size (respectively, d = .46, .36) of single-session mindfulness sessions on a variation of the Stroop Task (Watier & Dubois, 2016) and the Reaction Time Coefficient of Variability in the Sustained Attention to Response Task (SART) (Mrazek et al., 2012). Some of the previous Cohen-d coefficients were calculated using an online tool (Lenhard & Lenhard, 2016) while others required hand-calculation, and an average of the four coefficients produces a result of .5, rounded to the nearest tenth. Based on this average estimate of intervention-related effects on sustained attention, it was determined that a minimum number of 52 total participants would be necessary for a medium effect size of .5 (*d*). Since the most similar study revealed an intermediate effect size of .6, an a priori analysis revealed that the minimum number of total participants needed for an intermediate effect (one-tailed, alpha = .025, power = .8) would be 72. However, that estimation is a result of a 10-minute single-session, whereas this study is to conduct a 20-minute single-session.

Unfortunately, no clear expectation is held regarding the needed sample size per a-priori power analysis since there is no data consisting of 20-minute single-session OM Mindfulness effects on sustained attention as far as the author is aware, but this study aimed to collect data from at least 62 participants with a 1:1 ratio between groups and gender. This goal was largely met. A total of 61 subjects (18 – 24 years, M = 19.5, SD = 1.86) underwent trials from June of 2021 to March of 2022, 30 (22 females) in the control group and 31 (23 females) in the experimental. However, due to time constraints, the gender and between-group 1:1 ratios were not strictly maintained. Inclusion criteria included an absence of any history of attentional disorders or neurological conditions, and normal or corrected-to-normal vision. Some participants were recruited from introductory psychology classes at Texas State University and compensated with class credit. Other participants were recruited via approved flyers/advertisements for paid participation at a pay scale of $15 per hour for approximately two hours of participation for each participant. Participants were randomly assigned to experimental and control groups in the order by which they scheduled their lab appointment. Group distributions for resilience, perceived stress, and meditation experience were examined with planned t-tests. Informed Consent and all following procedures were provided in line with the protocol approved by the Texas State University Institutional Review Board.

Questionnaires and Scales Materials

The scales, assessments, and surveys incorporated in this study included a demographic and medical information questionnaire, an original Meditation Experience scale, a modified SCC scale, the Private Self-Consciousness Scale and a portion of the 84-item PWB scale. The demographic and medical information form recorded basic demographic information (e.g. education, age, gender, nationality, and ethnicity) and medical/health information necessary to evaluate the potential presence of abnormalities in the EEG data for the purpose of participant exclusion. In other words, responses to the medical/health survey helped explain any potential EEG data abnormality, which if present to an excessive extent, excluded a participant's data from EEG analysis. No participants were excluded for these reasons, but a total of seven subjects were removed from EEG analysis due to six (subjects 3, 41, 27, 39, 57, 60) with technical recording issues and one (subject 46) with excessive artifacts (EEG analysis: N = 54, 1:1 ratio between groups).

Participants completed a Meditation Experience scale that measures a degree of overall meditation experience based on Likert-scale responses. Two questions are asked: "1) How much continuous experience of meditation have you had in your life? (Report total number of days you performed/practiced for at least 20 minutes)" and "2) How much have you meditated in the past year? (report the total number of days practicing at least one session of at least 20 minutes per day)". The first question was scored in accordance with an 11-point Likert scale where 0 is "Never" and 10 is "More than 15 years", whereas the second question was scored in accordance with a 10-point Likert scale where 0 is "Never" and 9 is "more than 10 months". Scores from both questions were summed to provide a degree of meditation experience. A block of text provided an explanation of meditation, expected durations, and different types of meditation to serve as examples. A large portion of the text used to describe meditation and different techniques was adapted from prior research (Nash & Newburg, 2013, Raffone et al., 2019), while some text is added by the researcher for the inclusion of esoteric and other spiritual traditions not commonly considered.

The Autonomy and Personal Growth scales from the PWB scale (Schmutte & Ryff, 1997) served as measures of one's engagement in self-conceptualization by eliciting a response that inherently involves evaluation of self-conceptualization. However, the pre-post differences were the measures of interest here. Essentially, the change in degree of self-conceptualization was encapsulated in the difference of elicited engagement with self-conceptualization at two points in time. The scales originate from the 84-item version of the Scales of PWB with 14-item scales representing each of the six dimensions of PWB (Schmutte & Ryff, 1997). Internal reliability (alpha) estimates for the 14-item scales have been reported ranging from .82 to .90 (Schmutte & Ryff, 1997). Particularly, the Autonomy and Personal Growth scales had internal consistency (alpha) estimates of .83 and .85, respectively (Schmutte & Ryff, 1997). There were 14 unique items from each scale of Personal Growth and Autonomy disbursed evenly between the pre-test and post-test formats for this study. Each item was a Likert-based response where 1 corresponds with "strongly disagree" and 6 corresponds to "strongly agree". Seven reverse-scored items are included in the Autonomy scale, and six are in the Personal Growth scale. Pre-test and post-test formats maintained a roughly equal number of reverse-scored items and regularly scored items. Scores from each item were summed for each pre-test and post-test format resulting in a pre-score and post-score for comparison of engagement with self-conceptualization of each relevant PWB dimension while the difference was considered as the change in the degree of engagement with self-conceptualization.

PSC and SCC

Fenigstein et al. (1975) originally defined private self-consciousness (PSC) as the attending to one's inner thoughts and feelings and as a measure of sensitivity to inner feelings. It is also described as an index of dispositional self-awareness (Cramer, 2010), distinguished as measuring the extent of one's inward focus of attention including beliefs about oneself (DaSilveira et al., 2015), and it includes both Internal State Awareness and Self-Reflectiveness sub-dimensions. However, this study did not consider the particular sub-dimensional aspects as separate factors; rather, the current study utilized the construct of PSC to assess the validity of the experimental condition as an operationalization of awareness training. Regardless of SCC being considered an aspect of self-concept, it can serve as an index of self-concept and self-conceptualization. Essentially, this model is controlling for some form of quantitative dispositional self-awareness to further analyze how the influence of the experimental condition may correlate with a psychometric-based self-awareness construct, and it is modelling self-concept and self-conceptualization by using an aspect of self-concept (SCC) and responses that would engage self-conceptualization (PWB sub-scales) for outcome measures representing a degree of change in self-conceptualization. The PSC scale is a sub-scale of the original Self-Consciousness Scale introduced by Fenigstein et al. (1975), and its construct validity and reliability have been supported extensively since then: significantly correlated with thoughtfulness (r = .48) (Turner et al., 1978); significantly correlated with reflection (r = .64) as measured by the Reflection-Rumination Questionnaire (Trapnell & Campbell, 1999) and self-reflection (r = .68) as measured by the Self-Reflection and Insight Scale (DaSilveira et al., 2015, Grant et al., 2002); test-retest correlations of (Pearson's r) .84 (Fenigstein et al., 1975), .77 (Heinemann, 1979), .76 (Scheier & Carver, 1985), and (at the largest retest gap of 6 weeks) .53 (Abrams, 1988). The 9 items in this subscale are 4-point Likert scales where 0 corresponds with "not like me at all" and 3 corresponds with "a lot like me", and only one item is reverse-coded. Examples of items include: "I think about myself a lot", "I'm quick to notice changes in my mood", and "I'm always trying to figure myself out."

Self-concept clarity is a structural aspect of self-concept and is defined as the extent to which one's personal attributes and other contents of self-concept are clearly, consistently defined across time (Campbell et al., 1991, Cambell et al., 1996). The revised (Campbell et al., 1996) Self-Concept Clarity scale was used as an index of self-conceptualization along with the PWB scales, but the scale will be modified to reflect more of a state-measure instead. For instance, the original item #3 ("I spend a lot of time wondering about what kind of person I really am.") was modified to "I wonder about what kind of person I really am." Generally, any past-tense sentences were reconstructed to prompt for a moment-based response while maintaining the main point of the question. The updated (Cambell et al., 1996) SCC proved to have high internal consistency (α =

.86) and test-retest reliability (4-month interval α = .79 and 5-month interval α = .70), but no reliability analyses have examined a modified version such as the one being used in the current study. Items are 5-point Likert-scales where "strongly disagree" is scored as 1 and "strongly agree" is scored as 5. There are 12 items in all, and 10 are reverse-coded. Both scales were summed individually to provide each pre and post-test scores, and the pre-post differences were used for analysis.

Controlling for Pandemic Influence

To control for how the pandemic may affect one's performance in this study, the Brief Resilience Scale (BRS, Smith et al., 2008) and the Perceived Stress Scale (PSS, Cohen et al., 1994) were given at the beginning of the participant's scheduled lab appointment along with the pre-test evaluations, the Meditation Experience Scale, printed informed consent, and the demographic and medical information questionnaire. The BRS and PSS both contain five-point Likert-scale items, total of six items for the BRS and 10 items for the PSS. The BRS (α ranging from .80 to .91) (Smith et al., 2008) measures one's resilience, defined as the ability to recover from stress (Smith et al., 2008), and has three reverse-scored items where 5 corresponds to "strongly disagree" and 1 corresponds to "strongly agree", whereas regularly scored items will have 1 correspond with "strongly disagree" and 5 with "strongly agree". The PSS (average $\alpha > .70$ across 12 studies) (Lee, 2012) gauges one's perceived stress within the past month, and items are scored with 0 corresponding to "never" and 4 to "very often" with four reverse-coded items. The BRS was scored as an average for analysis, whereas the PSS was scored as a sum across items.

Meditation Training

The experimental group conducted a portion of a meditation technique outlined in HaLevey's (2020) instructional guide after completing their pre-test surveys, whereas the control group went directly into conducting the sustained attention tasks. Participants in the experimental group were initially guided through a foundational breathing exercise, referred to as resistance breathing or ocean breathing, via a YouTube instructional video (commonly utilized between beginners in HaLevey's Drukama Treasury community) and, if it was necessary, by additional assistance from the experienced practitioner. Next, the experienced practitioner provided instructions to the participant per the guide, and following the instruction, a short informal assessment was given to the participant to ensure they understand the procedure. This did not take more than 10 minutes and was meant to prepare the participant in conducting the relevant single-session meditation while in the given environment (EEG cap, seating posture, etc.). Those who were randomly assigned to the meditation group conducted their meditation with a guided audio recording (exactly 18 minutes and 28 seconds in length including background nature and singing bowl sounds at 4Hz to drown out any extraneous noise) of an experienced practitioner reading directly from the instructional guide and pausing for three minutes after each step relevant to the bodily anchors and breathing technique. The relevant meditation technique began with focusing on the breathing exercise, then shifting one's awareness to a relative point on/in the body. Participants were instructed to shift their awareness between three specific points holding awareness of sensation on each one for the allotted three minutes. Overall, the participant conducted a practice trial for approximately 10 minutes followed by the audio-guided meditation for about 20 minutes.

At the beginning of the session, participants were briefed on the likelihood of failing at the practice of maintaining pure awareness without being distracted by mental phenomena, fatigue, and/or daydreaming. It was expected that subjects may have a difficult time practicing this technique being that many of the participants could be considered novices. The study did not control for how much effort subjects maintained in their meditative session, but the informal assessment conducted after the sessions gauged whether the participant slept during the session or not. Only three participants (subjects 35, 40, and 42) explicitly reported being fatigued, finding it difficult to hold awareness without daydreaming or feeling sleepy during meditative practice. In the attempt to control for fatigue across groups, hours slept before the study was compared between groups. Beyond this, no further indications of poor effort were brought to the attention of the investigator.

Resting State Task

Participants performed a baseline resting state task before performing each of the attention tasks. Participants were instructed to sit comfortably while fixating on a cross at the center of a computer screen, to relax, keep still, and minimize eye movements and blinks. Ten minutes of resting state activity were recorded, five minutes with eyes open and five minutes with eyes closed in interleaved 1-minute intervals. The order of eyes-open and eyes-closed performance were counterbalanced across participants. This task always occurred before the meditation intervention and the attention tasks.

Troxler Task

Instructions for the task were provided during a practice trial. Following instruction, participants were presented with the Troxler Effect image at the center of a computer screen distanced about 75 cm. (+/- 2 cm.) away from their face. The Troxler Effect image consisted of a cross positioned in the center of a square image containing a neutral light greyish-white background with splashes of faded colors (see Figure 1). Participants were instructed to hold the troxler-fading effect (prolonged by their sustained focus on the centered cross) for as long as they could and to report (by means of pressing a computer spacebar) the start and end of their perception of troxler-fading. These button presses will start and stop a clock that records the total duration of the perceived troxler-fading and the total duration of troxler-fading onset, twenty trials were conducted in total, and the average durations (in milliseconds) for each the onset and maintenance will be collected for statistical analysis. Each trial was followed by a brief rest period lasting as long as was necessary for the participant to blink (to reduce as much retinal fatigue as possible) and/or rest their eyes.

Figure 1. *Troxler Task Image*

Note: This is a smaller scale image of what will be used in the study. Participants will be asked to fixate on the cross at the center of the image to induce the perceptual effect.

PVT

In the PVT, participants attended to a small fixation cross at the center of a computer screen. At random intervals (2–10 second ITI), a red dot appeared at the center of the screen (roughly 2 x 2 inches). Participants were instructed to respond as rapidly as possible via button (spacebar) press when they visually detect the red-dot stimulus. Participants were encouraged to respond with their dominant hand. The participant's response stopped the counter from updating and the final counter value, corresponding to the participant's reaction time (RT) in milliseconds, provided performance feedback for that particular trial. The final counter value was replaced by a new fixation cross after a one-second exposure duration. Participants had 30 seconds to respond before the computer automatically aborted a given trial. This task consisted of 100 trials presented over a 10-minute time interval, and the average response time was collected for statistical analysis. No misses or false alarms were found across any participant.

Procedure

All study procedures took place in the Texas State University Department of Psychology Cognitive Electrophysiology Laboratory. After reviewing informed consent, while researchers prepared participants for the EEG, participants completed the demographics and medical information questionnaire, the Meditation Experience scale, and the pre-test formats for the modified SCC scale, the Private Self-Consciousness Scale, and the PWB survey. After EEG setup, the experimental group and control group performed the resting state tasks. Then, the experimental group underwent the meditation training session, followed by the two sustained attention tasks (Troxler Task, PVT), whereas the control group just performed the sustained attention tasks. The resting and sustained attention tasks are presented through E-Prime software (Psychology Software Tools Inc., Pittsburgh, PA, USA). The order of performance for the Troxler Task and the PVT was counterbalanced across participants. For both the experimental and control groups, the post-test surveys were conducted after performing the two sustained attention tasks and while removing the EEG cap and electrodes. Participants were then given a debriefing explanation about the purpose of the study.

All Center for Disease Control (CDC) guidelines, pertaining to the prevention of furthering the current Covid-19 pandemic, were implemented as designated by the Standard Operating Procedure for the ELA 222 Cognitive Electrophysiology Laboratory filed with the Texas State University IRB and Office of Sponsored Projects.

EEG Recording, Pre-processing, and Spectral Power Computation

While following all standard recommendations for the Active II system and using the international 10/5 system for recording sites (Jurcak et al., 2007, Figure 6), EEG signals were recorded while participants performed the Resting, Troxler, and PVT tasks. EEG signals were recorded using a BioSemi electrode cap with 72 Ag/AgCl electrodes connected to a BioSemi Active II amplifier (BioSemi, Amsterdam, Netherlands). Channels were sampled at a rate of 2,048 Hz (400-Hz bandwidth) then downsampled online to 256Hz, EEG signals were recorded with respect to a common mode sense electrode positioned between sites PO3 and POZ. Recorded EEG data was then imported into the MATLAB (MathWorks, Natick, MA, USA) computing software environment where data analysis was performed using custom-made in-house scripts. EEG trials for the Resting task and PVT were divided into 1-second epochs with 50% overlap and then re-referenced to an average reference montage. For the Troxler task, the Troxler Effect

Maintenance time (TEM) for each task trial was subdivided into consecutive 1-second epochs. These EEG epochs then underwent manual artifact scoring to remove artifact-contaminated data. Also, epochs contaminated with blink and saccade-related electroocular (EOG) artifacts were rejected from analysis through an automatic algorithm based on limiting amplitudes (+/- 50 µV) recorded from two EOG channels: 1) the bipolar montage of site NZ along with the average of two electrodes at the inferior orbits of the eyes was used to detect blinks and vertical saccades; and 2) the bipolar montage of AF9 and AF10 was used to detect horizontal saccades. After artifact-removal, the eyes-open resting condition's average accepted epochs totaled 410.04 (SD = 126.38, 69% of total on average per subject), and the eyes-closed resting condition had an average of 352.61 in accepted epochs (SD = 119.2, 59% of total on average per subject). Roughly half of total epochs per subject were accepted on average for the PVT task (M = 577.13, SD = 207.26), whereas the TT had 86.5% total accepted per participant on average (M = 261.81, SD = 275.75).

Next, EEG spectral power (μV^2) was computed for each epoch via Fast Fourier Transformation (FFT) tapered by a 1-second Hamming window and then converted into decibels (dB). For each participant and task condition, mean EEG power values across trials was computed within three EEG frequency bands: theta (4 – 7 Hz), alpha (8–13 Hz), and beta (14–25 Hz). Following prior studies (Behzadnia et al., 2017, Fowler, 2014, Liu et al., 2019, Loo et al., 2009, Peng et al., 2021, Xie et al., 2017), mean EEG power was quantified over midline frontal (10/5 site Fz), parietal (10/5 site Pz), and central (10/5 site Cz) scalp regions.

Analytic Approach

Prior to statistical analyses, a log10 transformation was performed to all attention variable distributions to resolve problematic skewness and kurtosis. Other univariate outliers resulting in problematic kurtosis were corrected via the methods suggested by Tabachnick and Fidell (2019), in which outlier values were either constrained to a value equivalent to a z-score of 1.96 (subject 7's ME score was altered to 11.3304) or values were minimally altered just enough to resolve non-normality (subject 10's PSC pre-post difference was changed to 8, subject 59's PG pre-post difference was changed to 12, subject 56's SCC pre-post difference was changed to 10, and subjects 59 and 23 had $\log_{10}$TEI scores changed from 2.57/2.71 to 2.81).

Next, independent-samples t-tests were used to assess between-group differences in control variables to reduce alternative explanations for potential significant differences in sustained attention and/or self-concept between groups. The self-concept variables (Autonomy, SCC, and PG) were analyzed using separate univariate ANOVAs with each variable's pre-post differences as outcomes and group condition as main factor. Moreover, the relationship between the relevant TEM durations and the PVT RTs was assessed by conducting a bivariate correlation (zero-order) analysis as a proxy to assess the Troxler Task's ability to measure sustained attention. An additional marker of attention was the measurement of EEG power commonly exhibited in sustaining attention (amplified theta and diminished alpha-band power). Also, independent-samples t-tests (alpha = .025 for PVT, but .05 for the Troxler measures) was conducted to assess Troxler Effect Initiation time (TEI), TEM durations, and PVT RTs between groups. The standardized beta coefficients were reported for the Troxler-specific tests to reflect the small magnitude of change between groups. Additionally, 2 x 3 mixed-model ANOVAs were used to assess EEG power spectral density within each frequency band of interest (including beta, alpha, and theta) during the Resting, PVT, and Troxler tasks. The between-subjects factor for these ANOVAs was Group (Meditation, Control). The within-subject factors for the Resting task ANOVA was Condition (Eyes Open, Eyes Closed) and Electrode Site (FZ, CZ, PZ). The within-subject factors for the PVT ANOVA was Task (PVT, Eyes Open Resting) and Electrode Site (FZ, CZ, PZ). The within-subject factors for the Troxler Task ANOVA was Task (Troxler, Eyes Open Resting) and electrode site (FZ, CZ, PZ). In addition, EEG power between the PVT and Troxler Task was compared using a 2 x 3 ANOVA with within-subject factors as Task and Electrode Site and between-subject factor of Group.

All violations of sphericity for tests involving the three-level factor of Electrode were subjected to Greenhouse-Geisser correction (in the Results section below, G-G epsilon values are included in the reported statistics for ANOVAs with significant sphericity violations). All post-hoc comparisons were Bonferoni-adjusted for multiple comparisons.

III. RESULTS

Group Comparison Controls

Planned independent t-tests for age, meditation experience (ME), resilience, perceived stress (PS), education in years, and hours slept before the study reveal no significant differences between groups; see Table 1 for descriptive statistics for each group. The control group's ME distribution had problematic positive kurtosis resulting in an overall kurtotic distribution. Due to ME being a variable of interest in a planned future exploratory analysis modeled after a pilot study, the control group's ME normality was corrected. After correcting normality, the independent t-test results remained non-significant indicating no major differences in meditation experience between groups.

Table 1. *Planned Independent T-tests for Control Variables*

	Control	**OMM**	
	Mean (SD)	Mean (SD)	*t*-test
Age	19.63 (1.92)	19.33 (1.83)	0.62
Education	13.03 (1.45)	12.83 (1.60)	0.51
Sleep	7.85 (1.54)	7.64 (.99)	0.65
ME	2.53 (3.41)	3.87 (4.56)	-1.53
Resilience	3.51 (0.72)	3.32 (0.79)	1
Stress	17.57 (5.62)	18.35 (7.98)	-0.45

Note: ME is Meditation Experience, values presented for Sleep are hours, and values for Education are years. ME Means/SDs are presented as they were before correcting normality, but t-scores are presented from test conducted after correcting kurtosis. OM = Open-Monitoring Mindfulness group.

Sustained Attention

Troxler Effect

The bivariate analysis between the overall log10(TEM) and log10(PVT) scores was non-significant (r = .101, p = .44) suggesting the Troxler Task may not have been engaging sustained attention. In order to gauge how the duration to produce the Troxler

Effect may have affected participants' ability to maintain the optical illusion, the log10(TEI) bivariate correlation between each the log10(TEM) and log10(PVT) variables was assessed. Between-sample t-test results for the Troxler Task were also not significant (TEM: β = -.002, log10(TEM): $t(59) = 0.200$, $p = .84$; TEI: β = -.124, log10(TEI): $t(59) = -0.132$, $p = .9$). Upon descriptive analysis, the average duration of maintaining the Troxler Effect was slightly less in the experimental than the control group, and the average duration of initiating the Troxler Effect was less in the control than the experimental group. Average durations to initiate the Troxler Effect were significantly correlated with the average durations in maintaining the optical illusion but only in the control group. This along with TEI within-subject means suggests that, on average, it took less time for the experimental group to initiate the optical illusion. See Table 2 for an overview of the within-group bivariate correlations between corrected sustained attention distributions and within-group descriptive statistics for the attention and self-concept distributions.

Table 2. *Preliminary Descriptive Statistics and Bivariate Correlations*

	Control	**OMM**
	Mean (SD)	Mean (SD)
A	2.47 (4.96)	3.16 (4.13)
PG	-1.27 (3.69)	-1.06 (4.46)
SCC	0.73 (4.41)	0.32 (4.02)
PSC	0.34 (2.97)	-1.03 (2.27)
PVT	285.53 (84.92)	258.64 (48.64)
TEI	10746.80 (11298.79)	8577.28 (5345.53)
TEM	19449.92 (21298.97)	19384.91 (20802.86)
Control	**r-values**	
	log10(TM)	log10(PVT)
log10(PVT)	0.129	
log10(TEI)	0.363*	-.129
OM		
	log10(TM)	log10(PVT)
log10(PVT)	0.061	
log10(TEI)	0.301	0.060

Note: * p < .05, A = Autonomy, PG = Personal Growth, SCC = Self-Concept Clarity, PSC = Private Self-Consciousness, PVT = Psychomotor Vigilance Task, TEI = Troxler Effect Initiation, TEM = Troxler Effect Maintenance, OM = Open-Monitoring Mindfulness group. PVT, TEI, and TEM values are in milliseconds, and values presented in the bottom half are the Pearson-r bivariate correlation coefficients after corrections.

Psychomotor Vigilance

The independent-samples t-test examining how the groups differed in sustained vigilant attention via PVT performance was found to be non-significant (in milliseconds: $B = -26.9$, $SE = 17.65$; log10(PVT): $B = -.034$, $SE = .025$, $t(59) = 1.298$, $p = .173$) indicating the roughly 20-minute single session of OM Mindfulness meditation did not significantly alter the average durations of RTs in the PVT when compared to a control group who did not practice training awareness. In other words, through one's training of the Attention Schema, their ability to sustain overt vigilant attention was not affected.

Self-Conceptualization

Reliability and PSC

The test-retest reliability coefficients (Cronbach's alpha, α) for the SCC and PSC variables were .91 and .84, respectively. The inter-item reliability (α) coefficients for the 14-item Ryff PWB sub-scales (Autonomy (A) and Personal Growth (PG), respectively) were .85 and .71. Within-group pre-post differences for the SCC, PSC, A, and PG scores were computed as their own variables for following statistical analyses. An independent-samples t-test assessed between-group differences in PSC and was found to be statistically significant (β = -.256, $t(58) = 2.017$, $p = .048$), indicating the intervention did affect self-awareness; however, this change also suggests that self-awareness was reduced by the intervention.

Self-Concept Clarity and Psychological Well-Being

An analysis of variance examining how a single-session OM Mindfulness meditation may alter one's degree of change in self-conceptualization among three variables (Autonomy, Personal Growth, and Self-Concept Clarity) was found to be non-significant ($p = .017$) in each test (Autonomy: $F(1,59) = .35$, $p = .55$, $\eta_p^2 = .006$; PG: $F(1,59) = .03$, $p = .87$, $\eta_p^2 < .00$; SCC: $F(1,59) = .37$, $p = .37$, $\eta_p^2 = .006$) with most variance being accounted for in both Autonomy and SCC. Such results indicate that the single-session meditation practice was not enough to significantly alter one's change in self-conceptualization.

EEG PSD Analyses

Resting Task

The ANOVA procedures revealed significant mean differences between resting state conditions, indicating that alpha-band power was amplified from eyes-open to eyes-closed across all electrode sites. There were also significant main effects of Condition and Electrode Site, plus a significant interaction between these factors. Follow-up comparisons indicated greater power at the FZ and PZ sites and increased alpha power across all sites when eyes were closed. There was also a significant interaction effect of Condition, Site, and Group, but the interpretation of interaction with Group is arbitrary as the Resting Task was conducted before the experimental manipulation occurred. See Table 3 for descriptive statistics and ANOVA results.

Table 3. *Means and Analysis of Variance for Resting Task Alpha EEG Power*

Task	Site	Mean	Std. Error
Eyes-Open	FZ	16.437	0.458
	CZ	15.195	0.469
	PZ	17.413	0.520
Eyes-Closed	FZ	20.213	0.461
	CZ	18.734	0.440
	PZ	21.911	0.493

Frequency Band	Effect	F	η_p^2	GG Epsilon
	Condition	F(1,52) = 158.84	0.753**	-
	Condition x Group	F(1,52) = 1.32	0.025	-
Alpha	Site	F(2,51) = 122.65	0.828**	.91*
	Site x Group	F(2,51) = 2.61	0.093	-
	Condition x Site	F(2,51) = 10.98	0.301**	.846*
	Condition x Site x Group	F(2,51) = 3.47	0.120*	-

Note: ** denotes significance at $p < .005$. * denotes significance at $p < .05$. Epsilon significance indicates violation of sphericity. All PSD values are in decibels.

PVT

In order to assess EEG power reflecting engagement with sustained vigilant attention during the PVT task, the comparison condition of eyes open resting was utilized. Along with a significant main effect of Electrode Site, theta-band activity also exhibited a significant Task x Electrode Site interaction (see Table 4). Main effects of Electrode Site were significant for beta- and alpha-band power, whereas beta power exhibited a significant interaction effect of Site and Group (Table 4).

Table 4. *Analysis of Variance for PVT EEG Power versus Resting Eyes-Open*

Frequency Band	Effect	F	η_p^2	GG Epsilon
	Task	F(1,52) = .101	0.002	-
	Task x Group	F(1,52) = .603	0.011	-
Alpha	Site	F(2,51) = 93.07	0.785**	.89*
	Site x Group	F(2,51) = .90	0.034	-
	Task x Site	F(2,51) = 2.73	0.097	.95
	Task x Site x Group	F(2,51) = .88	0.033	-
	Task	F(1,52) = 1.08	0.02	-
	Task x Group	F(1,52) = .00	0	-
Theta	Site	F(2,51) = 39.52	0.608**	.912
	Site x Group	F(2,51) = .83	0.032	-
	Task x Site	F(2,51) = 11.96	0.319**	.914
	Task x Site x Group	F(2,51) = 1.35	0.05	-
	Task	F(1,52) = .064	0.001	-
	Task x Group	F(1,52) = 1.28	0.024	-
Beta	Site	F(2,51) = 142.63	0.848**	.681**
	Site x Group	F(2,51) = 3.38	0.117*	-
	Task x Site	F(2,51) = 2.07	0.075	.896*
	Task x Site x Group	F(2,51) = 1.91	0.07	-

Note: ** denotes significance at $p < .005$. * denotes significance at $p < .05$. Epsilon significance indicates violation of sphericity.

On average, both alpha and beta activity did attenuate slightly at sites FZ and CZ but not at site PZ when conducting the PVT task compared to the Resting Eyes-Open task;

however, the differences were not significantly affected by task (see Table 5). Alpha-band power was more prominent at the PZ site, but beta-band power was more prominent at sites FZ and PZ. On the other hand, theta-band activity was significantly different across Electrode Site, and an interaction effect between Task and Site was also present. Theta-band activity was larger at sites FZ and CZ but not PZ on average while considering the overall distribution. See Table 6 for the descriptive statistics for theta-band activity in the PVT compared to the Resting Eyes-Open task.

Table 5. *Descriptive Statistics for Alpha and Beta PVT EEG Power versus the Resting Eyes-Open*

Frequency Band	Site	Mean	Std. Error		Mean Difference
Alpha	FZ	16.414	0.438	CZ	1.237*
				PZ	-1.105*
	CZ	15.177	0.442	FZ	-1.237*
				PZ	-2.342*
	PZ	17.519	0.519	FZ	1.105*
				CZ	2.342*
	Task	**Site**	**Mean**	**Std. Error**	
	RO	FZ	16.437	0.458	
		CZ	15.195	0.469	
		PZ	17.413	0.520	
	PVT	FZ	16.392	0.428	
		CZ	15.159	0.430	
		PZ	17.625	0.530	
	Site	**Mean**	**Std. Error**		**Mean Difference**
Beta	FZ	11.148	0.339	CZ	1.378*
				PZ	0.125
	CZ	9.770	0.364	FZ	-1.378*
				PZ	-1.253*
	PZ	11.023	0.379	FZ	-0.125
				CZ	1.253*
	Task	**Site**	**Mean**	**Std. Error**	
	RO	FZ	11.151	0.367	
		CZ	9.806	0.395	
		PZ	10.933	0.396	
	PVT	FZ	11.146	0.338	
		CZ	9.733	0.349	
		PZ	11.112	0.368	

Note: * denotes significance at $p < .05$, RO = Resting Eyes-Open, PVT = Psychomotor Vigilance Task, all PSD values are in decibels.

Table 6. *Descriptive Statistics for Theta PVT EEG Power versus Resting Eyes-Open*

Site	Mean	Std. Error	Site	Mean Difference
FZ	19.071	0.343	CZ	1.301*
			PZ	1.907*
CZ	17.771	0.392	FZ	-1.301*
			PZ	.606*
PZ	17.164	0.416	FZ	-1.907*
			CZ	-.606*

Group	Task	Site	Mean	Std. Error
Control	RO	FZ	18.852	0.550
		CZ	17.446	0.625
		PZ	16.969	0.653
	PVT	FZ	18.936	0.448
		CZ	17.409	0.520
		PZ	17.023	0.547
OMM	RO	FZ	19.069	0.550
		CZ	18.053	0.625
		PZ	17.362	0.653
	PVT	FZ	19.429	0.448
		CZ	18.175	0.520
		PZ	17.302	0.547

Task	Site	Mean	Std. Error
RO	FZ	18.960	0.389
	CZ	17.749	0.442
	PZ	17.165	0.462
PVT	FZ	19.182	0.317
	CZ	17.792	0.367
	PZ	17.163	0.387

Note: * denotes significance at $p < .05$, RO = Resting Eyes-Open, PVT = Psychomotor Vigilance Task, all PSD values are in decibels.

Troxler Task

The same comparison condition of Resting Eyes-Open was utilized to examine how EEG power varied in the engagement of sustained selective attention per the TT.

Significant main effects were found for Task and Electrode Site factors within alpha and beta frequency bands, but not the theta-band (see Table 7). Also, alpha- and beta-band power exhibited significant interaction effects of Task and Electrode Site (see Table 7). Overall, beta and alpha activity was attenuated at all three sites of interest, whereas theta activity slightly decreased at sites FZ and CZ but not site PZ (see Tables 8 - 11). Beta and alpha-band power generally decreased across groups when conducting the TT compared to Resting Eyes-Open (see Table 9 and 10). There was a slight average increase in theta-band power for the intervention group at site FZ but no significant between-group differences (Table 11).

Table 7. *Analysis of Variance for TT EEG Power versus Resting Eyes-Open*

Frequency Band	Effect	F	η_p^2	GG Epsilon
Alpha	Task	F(1,52) = 51.01	0.495**	-
	Task x Group	F(1,52) = 1.05	0.02	-
	Site	F(2,51) = 66.97	0.724**	.89*
	Site x Group	F(2,51) = .11	0.004	-
	Task x Site	F(2,51) = 10.13	0.284**	.74**
	Task x Site x Group	F(2,51) = 1.16	0.044	-
Theta	Task	F(1,52) = 3.63	0.065	-
	Task x Group	F(1,52) = .48	0.009	-
	Site	F(2,51) = 53.304	0.676**	.92
	Site x Group	F(2,51) = .71	0.027	-
	Task x Site	F(2,51) = 16.34	0.391**	.87*
	Task x Site x Group	F(2,51) = .56	0.021	-
Beta	Task	F(1,52) = 50.15	0.491**	-
	Task x Group	F(1,52) = .83	0.016	-
	Site	F(2,51) = 113.6	0.817**	.704**
	Site x Group	F(2,51) = 1.57	0.058	-
	Task x Site	F(2,51) = 2.65	0.094*	.76**
	Task x Site x Group	F(2,51) = .57	0.022	-

Note: * denotes significance at p < .05, ** denotes significance at p < .005. Epsilon significance indicates violation of sphericity.

Table 8. *Descriptive Statistics for TT Theta EEG Power versus Resting Eyes-Open*

Frequency Band	Site	Mean	Std. Error	Site	Mean Difference
	FZ	18.937	0.360	CZ	1.465*
				PZ	2.076*
	CZ	17.472	0.405	FZ	-1.465*
				PZ	.610*
	PZ	16.862	0.402	FZ	-2.076*
Theta				CZ	-.610*
	Task	**Site**	**Mean**	**Std. Error**	
	RO	FZ	18.960	0.389	
		CZ	17.749	0.442	
		PZ	17.165	0.462	
	TT	FZ	18.914	0.361	
		CZ	17.194	0.395	
		PZ	16.558	0.371	

Note: * denotes significance at $p < .05$, RO = Resting Eyes-Open, TT = Troxler Task, and all PSD values are in decibels.

Table 9. *Descriptive Statistics for TT Alpha and Beta EEG Power versus the Resting Eyes-Open*

	Site	Mean	Std. Error	Site	Mean Difference
Beta	FZ	10.802	0.356	CZ	1.481*
				PZ	0.427*
	CZ	9.321	0.386	FZ	-1.481*
				PZ	-1.054*
	PZ	10.375	0.385	FZ	-.427*
				CZ	1.054*
	Task	**Site**	**Mean**	**Std. Error**	
	RO	FZ	11.151	0.367	
		CZ	9.806	0.395	
		PZ	10.933	0.396	
	TT	FZ	10.454	0.371	
		CZ	8.836	0.388	
		PZ	9.817	0.385	
	Site	**Mean**	**Std. Error**	**Site**	**Mean Difference**
Alpha	FZ	15.929	0.436	CZ	1.206*
				PZ	-.638*
	CZ	14.722	0.444	FZ	-1.206*
				PZ	-1.844*
	PZ	16.567	0.501	FZ	.638*
				CZ	1.844*
	Task	**Site**	**Mean**	**Std. Error**	
	RO	FZ	16.437	0.458	
		CZ	15.195	0.469	
		PZ	17.413	0.520	
	TT	FZ	15.420	0.428	
		CZ	14.250	0.432	
		PZ	15.721	0.511	

Note: * denotes significance at $p < .05$, RO = Resting Eyes-Open, TT = Troxler Task, and all PSD values are in decibels.

Table 10. *Within-Group Descriptive Statistics for TT Alpha/Beta EEG PSD vs Resting Eyes-Open*

	Group	Task	Site	Mean	Std. Error
Alpha	Control	RO	FZ	16.605	0.648
			CZ	15.259	0.663
			PZ	17.612	0.736
		TT	FZ	15.354	0.605
			CZ	14.222	0.611
			PZ	15.722	0.722
	OMM	RO	FZ	16.269	0.648
			CZ	15.131	0.663
			PZ	17.213	0.736
		TT	FZ	15.486	0.605
			CZ	14.278	0.611
			PZ	15.719	0.722
Beta	Control	RO	FZ	11.149	0.519
			CZ	9.611	0.558
			PZ	10.880	0.560
		TT	FZ	10.226	0.524
			CZ	8.560	0.548
			PZ	9.713	0.545
	OMM	RO	FZ	11.152	0.519
			CZ	10.001	0.558
			PZ	10.986	0.560
		TT	FZ	10.682	0.524
			CZ	9.113	0.548
			PZ	9.920	0.545

Note: RO = Resting Eyes-Open, TT = Troxler Task, OMM = Open-Monitoring Mindfulness Group, and all PSD values are in decibels.

Table 11. *Within-Group Descriptive Statistics for TT Theta EEG PSD versus Resting Eyes-Open*

	Group	Task	Site	Mean	Std. Error
Theta	Control	RO	FZ	18.852	0.550
			CZ	17.446	0.625
			PZ	16.969	0.653
		TT	FZ	18.597	0.511
			CZ	16.729	0.559
			PZ	16.293	0.525
	OMM	RO	FZ	19.069	0.550
			CZ	18.053	0.625
			PZ	17.362	0.653
		TT	FZ	19.230	0.511
			CZ	17.659	0.559
			PZ	16.822	0.525

Note: RO = Resting Eyes-Open, TT = Troxler Task, OMM = Open-Monitoring Mindfulness Group, and all PSD values are in decibels.

PVT Versus Troxler Task Comparison

For this comparison, only the alpha and beta-band EEG powers were of interest. Both ANOVAs revealed significant main effects for Task and Site, and a significant interaction effect of Task and Site was present for both frequency bands (see Table 12). Overall, alpha activity was attenuated in the TT when compared to the PVT and was most prominent at the PZ site. The control group also showed slightly more alpha-band power than the experimental group (see Table 13), but the experimental showed more beta-band power (see Table 14 for beta); however, there were no significant between-subjects effects. The same trend of attenuation occurred in the TT when analyzing beta-band power between tasks, but beta activity was most prominent at site FZ and PZ (Table 14).

Table 12. *Analysis of Variance for PVT EEG Power versus Troxler Task*

Frequency Band	Effect	F	η_p^2	GG Epsilon
	Task	F(1,52) = 54.47	0.512**	-
	Task x Group	F(1,52) = 2.72	0.05	-
Alpha	Site	F(2,51) = 73.21	0.742**	.87*
	Site x Group	F(2,51) = .43	0.016	-
	Task x Site	F(2,51) = 17.02	0.4**	.83**
	Task x Site x Group	F(2,51) = 1.9	0.069	-
	Task	F(1,52) = 61.56	0.542**	-
	Task x Group	F(1,52) = .06	0.001	-
Beta	Site	F(2,51) = 136.1	0.842**	.79**
	Site x Group	F(2,51) = 2.78	0.098	-
	Task x Site	F(2,51) = 22.34	0.467**	.95
	Task x Site x Group	F(2,51) = 1.46	0.054	-

Note: * denotes significance at $p < .05$, ** denotes significance at $p < .005$. Epsilon significance indicates violation of sphericity.

Table 13. *Descriptive Statistics for PVT EEG Power in Alpha-Band versus Troxler Task*

Site	Mean	Std. Error	Site	Mean Difference
FZ	15.906	0.420	CZ	1.201*
			PZ	-.767*
CZ	14.705	0.424	FZ	-1.201*
			PZ	-1.968*
PZ	16.673	0.505	FZ	.767*
			CZ	1.968*

Task	Site	Mean	Std. Error
PVT	FZ	16.392	0.428
	CZ	15.159	0.430
	PZ	17.625	0.530
TT	FZ	15.420	0.428
	CZ	14.250	0.432
	PZ	15.721	0.511

Group	Task	Site	Mean	Std. Error
Control	PVT	FZ	16.652	0.605
		CZ	15.253	0.608
		PZ	18.024	0.749
	TT	FZ	15.354	0.605
		CZ	14.222	0.611
		PZ	15.722	0.722
OMM	PVT	FZ	16.131	0.605
		CZ	15.065	0.608
		PZ	17.226	0.749
	TT	FZ	15.486	0.605
		CZ	14.278	0.611
		PZ	15.719	0.722

Note: * denotes significance at $p < .05$, PVT = Psychomotor Vigilance Task, TT = Troxler Task, OMM = Open-Monitoring Mindfulness Group, and all PSD values are in decibels.

Table 14. *Descriptive Statistics for PVT EEG Power in Beta-Band versus Troxler Task*

Site	Mean	Std. Error	Site	Mean Difference
FZ	10.800	0.349	CZ	1.515*
			PZ	0.335
CZ	9.285	0.361	FZ	-1.515*
			PZ	-1.179*
PZ	10.464	0.371	FZ	-0.335
			CZ	1.179*

Task	Site	Mean	Std. Error
PVT	FZ	11.146	0.338
	CZ	9.733	0.349
	PZ	11.112	0.368
TT	FZ	10.454	0.371
	CZ	8.836	0.388
	PZ	9.817	0.385

Group	Task	Site	Mean	Std. Error
Control	PVT	FZ	10.857	0.478
		CZ	9.360	0.493
		PZ	11.075	0.520
	TT	FZ	10.226	0.524
		CZ	8.560	0.548
		PZ	9.713	0.545
OMM	PVT	FZ	11.434	0.478
		CZ	10.107	0.493
		PZ	11.148	0.520
	TT	FZ	10.682	0.524
		CZ	9.113	0.548
		PZ	9.920	0.545

Note: * denotes significance at $p < .05$, PVT = Psychomotor Vigilance Task, TT = Troxler Task, OMM = Open-Monitoring Mindfulness Group, and all PSD values are in decibels.

IV. DISCUSSION

The purpose of this study was to test the main proposition of the Attention Schema Theory of Consciousness. The theory proposes that an attention schema, equated to awareness, is a model of attention that produces the self-concept and guides/controls our endogenous attention. This theory was tested by implementing an experimental group that conducted a single-session Open-Monitoring Mindfulness meditation compared to a control group that does not practice meditation. By use of this experimental condition, the present study sought to operationalize the training of one's attention schema. Sustained endogenous attention was measured by use of the Psychomotor Vigilance Task and a perceptual task that required participants to sustain attention on an optical illusion, the Troxler Effect. EEG power changes associated with these tasks were also measured. Changes in self-concept were measured by collecting pre-post differences of three surveys where self-reporting involved the act of self-conceptualization and surveys shown to covary with aspects of self-concept (Self-Concept Clarity scale and PWB subscales of Autonomy and Personal Growth). However, the primary analyses for examining how one's training of their theoretical attention schema may affect sustained vigilant attention, sustained attention of perception, Autonomy, Self-Concept Clarity, and Personal Growth did not support the Attention Schema Theory's main proposition. Furthermore, there were no significant effects of group in the EEG PSD analyses indicating there was no significant changes in neural markers of attention provided by the training of their theoretical attention schema.

Training the Attention Schema

One possibility for these null results is that participants did not adequately engage in the meditation training. The meditation technique guides the practitioner in holding awareness of bodily sensation at three points of the body. At the beginning of the session, participants were briefed on the likelihood of failing at the practice of maintaining pure awareness without being distracted by mental phenomena, fatigue, and/or daydreaming. It was expected that subjects may have a difficult time practicing this technique being that most were expected to have relatively low meditation experience. The study did not control for how much effort subjects maintained in their meditative session, but the study did control for perceived stress, resilience, hours of rest prior to the study, meditation experience in one's lifetime and within the past year, age, gender, and years of education (rounded down). Neither of the controls were found to be significantly different between groups, and the informal assessment conducted after the sessions gauged whether the participant slept during the session or not. Only three participants explicitly reported being fatigued, finding it difficult to hold awareness without daydreaming or feeling sleepy. Beyond this informal descriptive assessment, no further indications of poor effortful practice were brought to the attention of the investigator. Additionally, a measure of self-awareness (PSC) did significantly correlate with the practice of meditation, so this partially supports the operationalization of a single-session OMM meditation as the training of one's AS. However, this isolated result occurred in an overall pattern of null-results and thus must be interpreted with caution.

Sustained Attention and Self-Conceptualization

Sustained Attention - Behavioral

There was no statistical significance found in null-hypothesis parametric statistical inferential analyses for the PVT. It could be that if the power of this study, mainly the sample size, was increased, there may have been a statistically significant difference in sustaining attention per the PVT. The univariate between-subject results for the Troxler Task were briefly reported due to the low correlation with the PVT scores. These tasks did not have an equal number of trials, and the change in maintaining the Troxler Effect was expected to have an inverse relationship with the experimental intervention opposed to a negative relationship in PVT durations.

Sustained Attention - Perceptual

There also was no statistical significance found in null-hypothesis parametric statistical inferential analyses for the Troxler maintenance times. This may be due to the Troxler Task simply being an insufficient measure of sustained attention, as indicated by the low correlation of TEM with the PVT RTs. However, the average duration to initiate the Troxler Effect was significantly correlated with the average duration in maintaining the optical illusion but only in the control group. This could be interpreted as suggesting a potential effect of AS training on the influence of endogenous attention during the initiation of troxler-fading, an effect that may be stronger in a future study conducted with a larger sample. Nevertheless, this isolated result must be interpreted with caution because it occurred in the context of no evidence that AS training can reduce the average duration of vigilant attention and reduce the onset of endogenously altered perception.

Only seven participants reported issues with perceiving and reporting the troxler-fading. Their reports either consisted of error in accurately reporting, or difficulty differentiating the beginning and end of the optical illusion. The other participants showed potential evidence for inaccurate subjective reporting due to blinking and unusually long durations of maintenance. Although few participants reported being able to hold the Troxler Effect through blinking, past studies have reasoned this optical illusion occurs partly due to pupil stabilization (Martinez-Conde et al., 2004). Being that this was a perceptual self-report, it is difficult to claim one can or cannot hold the optical illusion through blinking. The nature of self-reporting also presents a possible limitation in the valid assessment of sustained selective attention per the Troxler Task. Additionally, the subjects who did report difficulty in perceiving the optical illusion mainly reported an issue with the luminosity of the presented colors despite the lights being dimmed to provide a more salient presentation. It is still interesting to see that the control group's duration to onset significantly predicted their duration of maintenance while the AS training seems to reduce the correlation up to being statistically non-significant. This may suggest that training awareness does influence perception to an extent while also indicating that sustained attention improves in some capacity as onset of the optical illusion requires one to fixate on the centered dot.

Autonomy, Personal Growth, and Self-Concept Clarity

The other component of AST's main proposition suggests that the AS produces our self-concept. It explains this relationship by a logical assessment that awareness in sensing a body that receives input should naturally arrive at a conclusion that there is a self. This study sought to assess changes in self-concept based on pre-post survey responses in two PWB subscales (Autonomy and Personal Growth) and a modified version of the Revised Self-Concept Clarity Scale to provide a state-measure. However, only minimal changes occurred in these post-tests between groups, and neither measure presented a significant difference between groups. The greatest changes occurred in Autonomy and Self-Concept Clarity survey responses.

It was initially thought these measures would produce sufficiently robust correlations that a composite measure could be created out of their linear combination. This composite measure would encapsulate the complex nature of self-concept and self-conceptualization. Unfortunately, the correlations were insufficient to conduct such an analytic approach. Past studies found these measures to significantly covary with theoretical aspects of self-concept and these measures were theoretically reasonable as constructs, so it was assumed that a linear combination could be reasonably analyzed. However, it may have been more prudent to assess how Open-Monitoring Mindfulness intervention, Mindfulness intervention, and/or trait mindfulness may have covaried with assessments that can be reasonably considered as an index of self-concept and/or self-conceptualization instead. Such an investigation was part of the a-priori power estimation, but further research into long-term and short-term interventions may have produced other construct considerations. The lack of findings in single-session effects may have potentially limited the scope of consideration for other variables, so this brings to question this study's construct validity for representing changes in self-concept.

EEG Power Spectral Density

Consistent with previous findings, alpha activity did attenuate from resting with eyes open to resting with eyes closed. Additionally, engagement with sustained vigilant attention produced the usual theta amplification and alpha attenuation. These findings support the integrity of the resting state and PVT data in the present study.

However, the Troxler Task did not elicit the same trend usually observed in sustaining attention at sites CZ and PZ as theta activity was decreased at these sites but not at FZ. The Troxler Task did elicit theta amplification and alpha/beta attenuation at site FZ indicating there was a sign of observable engagement with sustained attention at the medial-frontal, and the Troxler Task did reveal slight amplification of alpha and beta activity when compared to the PVT as expected and consistent with prior studies showing alpha/beta amplification when perceiving similar optical illusions to the Troxler Effect. However, the changes of TT EEG power in both the alpha and beta-bands compared from resting with eyes open had greater change in the control group compared to experimental, opposite to what was predicted. It was predicted that engaging in the phenomenon of perceiving an optical illusion similar to perceptual filling-in after meditating would result in greater changes in alpha and beta activity when compared to control, but that was not the case. Again, this may be due to the lack of validity in perceptual self-reporting. Additionally, no significant effects of group were present, suggesting the experimental intervention did not provide significant variance in EEG spectral power across all sites and frequency bands of interest. However, EEG power is only one marker that may be used to index hypothetical attentional changes as predicted by the AST; thus further investigation/elaboration of other EEG markers of sustained attention that index differences arising from perceptual phenomena and/or single-session OMM meditation will be analyzed and disseminated in future studies.

Conclusions and Future Directions

The inferential testing in the present study did not support Graziano's theory; however, it may be that modifications of the present study design and analysis may yield supportive evidence. Certainly, a more thorough review of literature needs to be conducted to implement a more reasonable linear combination of self-conceptualization variables. Personality traits, SCD, self-concept coherence, or even conducting relational data analysis (RDA) (Eichas et al., 2017) for qualitative analysis may be additional ways to assess changes in self-concept. Also, the small effect sizes may indicate that a small sample size limited this study's ability to statistically detect effects. Furthermore, other variables may be affecting these relationships. For example, it was originally considered to include survey instruments indexing perceived social desirability, absorption, daily mindfulness, and trait mindfulness as additional control variables for this study. However, the number of surveys and survey completion time was limited in order to reduce participant attrition as much as possible. Another concern is that the control group did not perform a control task over a similar timeframe as the meditation group; instead, the control participants immediately performed the two attention tasks after completion of the Resting task. Essentially, it was difficult to provide a task for the control group that would not be considered a period of time in which participants trained their awareness in some way. However, the additional time in training the theoretical AS for the meditators was considered to be theoretically sound in that this additional time was considered to be an extension of the intervention of AS training. Nevertheless, future studies might try to find a control task that would minimally engage awareness and attention while simultaneously controlling for the possible confounding effect of training time.

Future replication efforts should find better self-conceptualization measures to utilize, such as measures shown to covary with some form of awareness exercise. Other considerations might be to examine neural changes in self-referential processing. Moreover, it may be that the single session of meditation training used here was not sufficient to produce changes to the attention schemas of the participants. Thus, it may be that to observe statistically significant changes in self-concept, a longitudinal design would be best in detecting changes in constructs often considered to be traits than states (such a design was originally considered for this study, but funding limits precluded its implementation). A longitudinal design should also implement awareness training over the course of the study while collecting measurements at various timepoints, not only at pre and post. Although this study seems to suggest that the Troxler Task could be a poor measure for sustained attention, it may still be useful to incorporate this in perception investigations. If the Troxler Task is utilized as a measure of sustained attention in future studies, the image display should be modified to control for luminosity to ensure the effect can be consistently reliably perceived with minimal effort. It may also be useful to implement eye-tracking methodology to control for participants' perceptual self-reporting. For further consideration in implementing the Troxler Task in future studies, a common EEG marker for sustained attention was observed when experiencing the Troxler Effect.

Furthermore, it would be interesting to tease apart the awareness exercise from exercise of attention in some way. Collecting event-related potentials (ERP) may elucidate the function of awareness and attention during meditation, perhaps by fixing the time-lock of ERP processing to self-reported clicks when a participant subjectively reorients their awareness to a bodily anchor per the meditation technique used in this study. ERP data and EEG source localization techniques may also elucidate subtle aspects of awareness that may not be considered in theory and expand on effects on brain connectivity, including effects on synchronicity.

There seems to be degrees or aspects of awareness based on the result of AS training on perceptual onset in the Troxler Task. Even though the training of awareness influenced sustained vigilant attention, it did not affect the maintenance of perceiving troxler-fading yet it did influence the duration of onset to some extent. The Troxler results seem to support previous inferences (Devyatko et al., 2017) that attention modulates the illusory disappearance of the optical illusion, but it adds that training of awareness improves this modulation. This also speaks to the question about the nature of the mechanism in meditation most effectual for attentional benefits (Sumantry & Stewart, 2021) – the mechanism could be awareness.

Another way forward might be to perform a conceptual comparison of AST to other theories describing conscious awareness in an effort to formulate additional testable hypotheses. For example, some studies have already started unveiling the finer aspects of awareness such as in the examination of nondual awareness (Mills et al., 2020), distinct states of embodied self-awareness (Fogel, 2019), and subliminal perceptual processing (Dresp-Langley, 2022). Chaturvedi (2022) elaborates in detail on Sebastian Watz's contribution to the debate over the "Ubiquity of Inner Awareness" (UIA) thesis and, in a way, seems to explain the finer aspects of what the AST is presenting. The UIA thesis explains a reflective nature of awareness where a subject has awareness of a mental state and a higher-order representation of the mental state as an inner awareness of said mental state, as attention provides a structure for organization. This reflective nature is like awareness "looking" back at itself. This is generally thought to be what is occurring in nondual awareness.

HaLevey (2020) has also contributed to this discussion of awareness. In his view, awareness tends to fall into the delusion of being an egoic identity and takes on the body's intrinsic suffering and lack as a result. He suggests "awareness is the infinite constant which witnesses senses, feelings, and thoughts" (R. HaLevey, personal communication, October 24, 2021) as if the self is a transient phenomenon that does not truly exist while only awareness exists. Further investigations into the neural effects of long-term maintenance of nondual awareness on self-referential, perceptual, and emotional processing may contribute answers here. For example, nondual awareness may be similar to the state of flow; experience of flow includes a balance between perceived challenge and skill, merging of action and awareness, can be defined as an optimal state, and is facilitated through intrinsically rewarding activity (Csikszentmihalyi, 1990; Nakamura & Csikszentmihalyi, 2014; Tse et al., 2020). In flow states, action and awareness are merged and individuals enter into a state of being for the sake of being, whereas nondual awareness is considered to lack active exertion of attention and a letting go of identity similar to being for the sake of being without an active referencing of self (Mills et al., 2020). Experiencing flow is also considered as a common attribute of self-actualization and B-cognition (or cognition of being) (Heylighen, 1992; Maslow, 1964). Interestingly, major findings between neural correlates of theoretical attributes of B-cognition (including experiencing flow, peak experiences, and high well-being) indicate that the medial prefrontal cortex, posterior cingulate cortex (both MPFC and PCC are integral parts of the default mode network), and the left dorsolateral prefrontal cortex tend to be less activated while the anterior inferior frontal gyrus, inferior frontal gyrus, and the anterior cingulate cortex are more activated in experiences that are theoretically common to self-actualizers (Bartlett & Griffiths, 2018; Khoshnoud et al., 2020; King, 2019; Krause, 2018; Maslow, 1943; Ulrich et al., 2014; Ulrich et al., 2018; van Elk et al., 2018). Most notable is the prominent decrease in parts of the default mode network where self-referential processing is thought to occur. Further meta-analytic approaches in this line of investigation may provide further elaboration.

Aspects of awareness like nondual awareness are garnering further discussion and investigation, fortunately. Mills et al. (2020) are embarking on a necessary research direction into understanding nondual awareness for the improvement of well-being. Nondual awareness is putatively what the OMM meditation implemented in this study aims to produce, but this study intentionally removes the last two steps of the original technique to focus mainly on training awareness. The overall goal of the technique is to reflect on what is perceiving the bodily anchors, and eventually, it is thought that this conceptualization leads to a direct experience of a nondual, nonconceptual awareness where one begins to know what seems to be their true self, awareness – Mills et al. (2020) similarly state, “knowing oneself as awareness enables the letting go of less authentic, ego-driven, protective organizations of identity” (p. 3).

Returning to the AST, the theory could be accurately representing a form of awareness that mistakenly attributes itself to a self-concept in lieu of potentially subliminal perceptual processing. The AS being described as the producer of the self-concept and controller of endogenous attention is reasonable, but this study fails to support this main proposition. Interestingly, nondual awareness is thought to lack any active exertion of attentional control (Chaturvedi, 2022). If the AS produces the concept of self and guides endogenous attention, maybe AS is distinct from nondual awareness (NDA) since NDA lacks the attribute of attentional control. Or AS has the ability to shift from directing endogenous attention and producing self to being simply present without acting in its theoretical attributions. Perhaps even AS is a functional aspect of a much broader or deeper awareness merely meant to support a transient self by producing and fitting its habitual nature. Could it be that the self-concept sets parameters for AS to control/guide endogenous attention to further sustain the sense of self-concept? Perhaps innovations in neuroscientific methodology can contribute answers here, but this is beyond the scope of this manuscript.

There could also be deeper aspects of awareness we may have not considered thus far, but how would experimental investigation attempt to test this? Further empirical investigations may be difficult as both attention and awareness still seem to be inextricably linked in some way. HaLevey (2020) seems to suggest attention is solely a bodily mechanism that can be controlled and trained, whereas awareness is beyond the body implicitly constructing the role of the physical biological organism in the will of a universal inclination somehow. Further use of neuroscientific methodology and meta-analytic approaches to the broad study of consciousness, meditation, and even nondual awareness may be quite useful for clarifying the relationship between attention and awareness. Since the EEG data for novice meditators was collected in this study, it may be useful to compare their data in a between-groups comparison with EEG data from a group of experienced practitioners who practice invoking the state of NDA, a control that only practices ocean breathing for relaxation then conducts the PVT, and another group of experienced practitioners who go beyond establishing NDA by implementing an active insight/observation and intentional manipulation of what may be referred to as subtle energy or subliminal perceptual processing. Implementing clickers for each participant to subjectively report their experiences of subtle energy, NDA, and feelings of distinct relaxation can provide a means for between-group comparisons, which may also elucidate any possible ERP markers or changes in brain connectivity as it relates to novice meditational training of awareness, relaxation, sustained attention, NDA, and intentional manipulation of “subtle energy”.

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