MEDITATION’S EFFECT ON DETACHMENT

AS AN EMOTION REGULATION STRATEGY

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BY

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PLAGIARISM

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ABSTRACT

Meditation is a highly practiced technique to create emotional balance, cognitive enhancement, and general well-being. The aim of this study is to investigate the benefits of meditation on attentional stability and emotion regulation. We created a psychophysics task consist of number counting Stroop task and played emotionally triggering sounds on the headphones during the experiment. We intended to create cognitive load and emotional trigger with 8 conditions as the combination of 2 visual conditions (congruent and incongruent) and 4 auditory conditions (arousal high- arousal low- pleasure high- pleasure low). We expected the meditation group to respond with higher accuracy rate (percentage) in lower reaction time (ms) than the control group. During the experiment, we recorded the electrophysiological activations of the participants and expected lower beta and gamma oscillations in the meditation group's frontal and temporal regions. The behavioral results fulfilled our expectations with higher accuracy rate and lower reaction time of meditators. Although the analysis of behavioral results showed that congruency had significant effect, there were no effect of affective sounds on participants' accuracy rate and reaction time. Whereas electrophysiological results revealed that both the congruency and sound type affected the participants. As expected, the meditation group generated lower gamma oscillations both in frontal region which is associated with cognitive control and temporal region where the emotion processing occur. Our results indicated that meditation provides higher attentional stability and increase emotion regulation skills especially in neural level.

Keywords: Meditation; attentional stability; emotion regulation; cognitive flexibility

ÖZET

Meditasyon, kişilerin duygusal dengeyi, bilişsel kapasiteyi, ruhsal ve bedensel iyilik durumunu desteklemek için çokça uygulanan bir pratiktir. Bu çalışma, meditasyonun dikkati toplama ve duyguları düzenleme üzerindeki etkisini araştırmayı amaçlamaktadır. Katılımcılar, rakamlardan oluşturulan Stoop testini yanıtlarken, kulaklıklarından duygusal tetiklenme oluşturmasını planladığımız sesleri dinlerken, başlarındaki bant ile elektrofizyolojik aktivitelerini kaydettik. Verilen yanıt süresini en fazla 1 saniye tutarak kişilerde bilişsel yük oluşturmayı planlarken, duygusal tetikleyici seslerin de dikkatlerini dağıtmasını planladık. Uyumlu ve uyumsuz görsel göreve eşlik eden yüksek ve düşük dürtücü, yüksek ve düşük hoşa giden seslerle gerçekteştirdiğimiz deneyde meditasyon yapan katılımcıların daha yüksek doğruluk oranıyla daha düşük sürede yanıt vermesini varsaydık. Davranışsal deneyin sonucu, meditasyon yapan kişilerde daha yüksek başarı olanı ve daha düşük reaksiyon hızı ile hipotezimizi desteklerken, duygusal tetikleyici seslerin iki grubun da başarını oranını ve yanıtlama hızını etkilemediğini gözlemledik. Eletrofizyolojik verileri analiz ettiğimizde altta nöral düzeyde işleyen sistemde hem duygusal hem de görsel koşulların kişiler üzerinde planladığımız etkiyi gösterdiği ve meditasyon yapan kişilerin ön beynindeki elektrotlarda daha düşük gamma salınımları ile daha az çaba ile dikkatlerini koruyabildiklerini ve temporal bölgede de yine daha düşük gamma aktivasyonu ile duygularını düzenlemede daha başarılı olduklarını gözlemledik. Sonuçlarımız, meditasyonun dikkat kapasitesi ve duygusal düzenleme üzerinde olumlu etkileri olduğunu göstermektedir.

Anahtar Kelimeler: Meditasyon; dikkat; duygu düzenleme; bilişsel esneklik

To my dear father Teoman Selek,

We had started this journey together,

I wish you could be here to celebrate.

I hope you are watching us in rest

and be proud of me.

I love you and I’m missing you.

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1. INTRODUCTION

Living a good life is almost what every individual wants. Although the meaning of "good life" is changeable, there are some main principles that constitute contentedness. Having meaningful relationships, balanced emotional states and the ability to stay focused in moments of need are the elements of these principles that we will be interested in in this thesis. Being peaceful has various dimensions, such as being peaceful with self-existence or having peaceful relationships with other beings. Having constructive communication is an important aspect of being peaceful, and its importance reveals itself especially in intense situations. Many spiritual teachings encourage individuals to "step outside of the situation", or to "take a deep breath before reacting" in circumstances that make people feel stuck and react harshly. These methods provide individuals a moment, a space to comprehend and evaluate the condition wisely. Although many people would say that it is easier said than done, these teachings can be implied in our lives. It just requires practice and dedication. Meditation, which is an efficient and intense way of mind training, is an effective tool for self-awareness and mindful living (the elements that provide skill for applying the spiritual teachings above) hence improving well-being and life quality as an outcome. During meditation, maintaining attentional stability is crucial for a desirable session. It is not easy to stay focused, even though there are methods to keep attention stable like counting, feeling the sensations of breath, chanting a mantra, or focusing on an object; depending on the method the meditator prefers at the beginning. Like sports activities, one needs to continue practicing consistently in order to improve attentional skills, which will make staying focused easier in time.

In addition to taking part in numerous important cognitive processes, attention also plays important role in emotion regulation, "paying attention to an emotional stimulus of the situation one encounters, appraisals of this situation" is a part of the emotion processing (Gross, 1998). The way individuals interpret and respond to an event affects the emotion it might generate. So, if one becomes in control of his/her attention by managing how it will be deployed or be aware of his/her cognitive state and manipulate it; regulating emotion could be easier for that person (Dörfel et al., 2014; Goleman & Davidson, 2017; Ochsner & Gross, 2008). The previously mentioned spiritual teachings might have a connection with one of the emotion regulation strategies called detachment, which we will elaborate in detail.

This thesis aims to investigate the relation between meditation practice and detachment ability, which is related to attention and emotion (PF-ACC- amygdala activation) and examine if meditation practitioners are more capable of detaching from unwanted stimuli, the potential reaction it might generate, hence regulate emotion, and keep attention on the task, act with goal supported behavior.

Although research on reappraisal and meditation exists, a few studies are focusing on detachment and meditation. The question is if we can connect the mechanism when a meditator detects the mind wandering during meditation practice, and when a person realizes the sudden reaction during an uneasy conversation or situation. To investigate and understand the question clearly, one needs to understand how brain regions related to meditation, attention, and emotion regulation work; and studying neuronal networks is one of the best ways to start with.

2. NETWORKS

The research of understanding the organization and function of the brain has emerged an approach with a systematic framework identifying networks consist of regions which are in interaction with each other, and working together for specific cognitive tasks. Although there are several major networks have been identified during rest and active conditions, we are going to mention 3 large-scale networks that extensive research has been conducted on, and relevant to our study.

1.1 Default Mode Network

The default mode network is discovered by Shulman and his colleagues during investigating resting-state activations (Raichle et al., 2001). DMN is the large network that is active in rest conditions and becomes deactivated when there is a demanding cognitive task. During DMN, mind wandering occurs showing itself as daydreaming, autobiographic memories, theory of mind (considering the viewpoint of others), and self-related cognitive processes (Bressler & Menon, 2010). The key nodes of DMN are PCC (is known to be active during self-referential and autobiographical processes), VMPFC (active during "social cognitive processes related to self and others"), medial temporal lobe ("episodic and autobiographical memory"), and the angular gyrus ("semantic processing") (Goulden et al., 2014; King & Fresco, 2019; Vinod Menon & Uddin, 2010; Raichle et al., 2001; Frederick Travis & Parim, 2017).

1.2 Central Executive Network

The Central Executive Network is where high-level cognitive functions occur such as "active maintenance" and information modification in working memory, attentional control, judgment, and decision-making mechanism for accomplishing the existing goal (Vinod Menon & Uddin, 2010). CEN consists of the dorsolateral prefrontal cortex (DLPFC) and posterior parietal cortex (PPC). CEN and DMN have opposite relation; when one's activation increases, the other deactivates; since DMN is known to be a resting state hence no task network, whereas CEN is active during processes requiring cognitive control and is called a "task-positive network" (Vinod Menon & Uddin, 2010; Mulders et al., 2016). CEN is also stated as a fronto-parietal attention network by some researchers, associated with top-down cognitive control (Hasenkamp et al., 2012; Mulders et al., 2016).

1.3 Salience Network

The salience network is associated with processes monitoring external stimuli and prioritizing the tasks that are relevant to the homeostatic events (Seeley et al., 2007). Salience Network is also a "task-positive network" and with CEN these two networks are considered "task-activation ensemble" (Uddin, 2017). Salience network combines ongoing sensory data, emotional and cognitive state and has a role in various functions like interaction, manner, self-awareness (V. Menon, 2015). The main regions that constitute the SN are the dorsal anterior cingulate cortex (dACC), anterior insula, ventrolateral PFC, and ventral striatum. The SN is also called "affective network" for being associated with "salience processing" and active during emotion regulation (Mulders et al., 2016). and The DMN and CEN balance is suggested to be coordinated by SN, especially by the anterior insula acting as a switching mechanism between the two networks (Goulden et al., 2014; Mulders et al., 2016; Sridharan et al., 2008). The anterior cingulate cortex is accepted to be the fundamental region for the process of monitoring and assessing if there is any cognitive control required (Ochsner et al., 2002). The anterior insula is also active during signal detection and is called the "brain's error-monitoring system" (Uddin, 2017).

3. ATTENTION

Attention is the essential cognitive mechanism that prioritizes the goal-relevant element through imposed numbers of external stimuli or internal homeostatic signals and "train of thoughts" in order to provide ground for efficient processing (Wells & Matthews, 1994). The attention process that occurs voluntarily by guiding attention is called endogenous attention; whereas attention can be directed towards highly salient stimuli involuntarily, which is called exogenous attention (Posner, 1980). Endogenous attention is goal-driven, top-down, slower, and can continue for longer durations, on the other hand, exogenous attention is automatic, bottom-up, triggered by a salient stimulus (Meyer et al., 2018)

William James is one of the most important psychologists that has a large impact on literature, explains the definition and function of attention as (James, 1890):

> Millions of items … are present to my senses which never properly enter my experience. Why? Because they have no interest for me. My experience is what I agree to attend to. . .. Everyone knows what attention is. It is the taking possession by the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. . .. It implies withdrawal from some things in order to deal effectively with others.

The main insights of James's definition can be explained in 7 points (Serences & Wixted, 2018). These are:

1- Attention is a process that allows us to get the precise contents from mental representations that are originated by awareness or short-term memory "taking by the mind".

2- The process consists of prioritization for selection. It is choosing the relevant item for the purpose among the variety.

3- The number of items chosen at a time is just one.

4- The item can be selected from internal (objects) or external environment (thoughts).

5- The focusing process during attention requires ignoring distracting items.

6- Attention is required for adaptation.

7- Attention is required for healthy cognition.

1.4 Clinical Model of Attention

Attention is suggested to be a “multidimensional cognitive capacity” instead of being a single process. The types of attention are explained in literature through the clinical model of attention which divides into 5 components as focused attention, sustained attention, selective attention, alternating attention, and divided attention as the subcomponents of attention (Abdelrahman et al., 2019; Sohlberg & Mateer, 1987).

1.4.1 Focused attention

The ability to attend to a specific stimulus.

1.4.2 Sustained attention

Maintaining focus on a stimulus for a prolonged period.

1.4.3 Selective attention

The ability to focus on a specific stimulus while inhibiting other distractors.

1.4.4 Alternating attention

The ability to shift focus between tasks that require different cognitive functions.

1.4.5 Divided attention

The ability to respond to multiple stimuli at the same time.

Driving is a good example of explaining the processes. Keeping the focus on the road is focused attention while being able to make it a long period of time is sustained attention. Avoiding distractions of irrelevant stimuli requires selective attention; checking the mirror then focusing back on the road in the front as well as noticing the car passing by for a moment is alternating attention. And finally, being able to control pedals, turn the wheel, and switch gears at the same time is the skill that requires divided attention.

1.5 Levels of Attention and Attention Orienting

The Hierarchical Attentional Model describes two levels of attention based on the required cognitive load. Focused attention and sustained attention are lower/fundamental levels of attention, whereas alternating, selective, and divided attention are higher levels of attention (Abdelrahman et al., 2019; Sohlberg & Mateer, 1987).

Attention orienting has two classifications, covert and overt. In overt attention, the locus of attention can be detected by gaze movement because, for this kind of attention, individuals need to move their eyes to the source of information. In covert connection, there is no connection between gaze movement and shift in attention, so the eyes stay fixed during the switch of attention (Goldstein, 2015).

1.6 Neurocognitive Model of Attention

The neurocognitive model of the human attentional system is a framework for attention research, introduced by Michael Posner and Steven Petersen (1990). The model mentions three "separate yet interrelated networks" such as alertness, orientation, and detection.

1.6.1 Alertness

The process of being ready for incoming stimuli or data. The alertness level of an individual can be assessed or manipulated to create differences in processing or performance during tasks. For example, giving a cue as a warning that indicates a target is about to appear before presenting a stimulus increases the alertness, and switches the individual's cognitive state from resting to a prepared state which results in an increased likelihood of detection and decreased response time. The level of alertness is called arousal, implies the amount of induced trigger (Pfaff, 2014).

With neuroimaging, the alerting process can be observed with the activation in the right frontal and right parietal cortex and the thalamus (Malinowski, 2013; Petersen & Posner, 2012; Posner & Petersen, 1990).

1.6.2 Orientation

Directing attentional resources to a specific type or class of sensory information and excluding the others. Although orienting attention facilitates detection; it is still possible to detect a stimulus that occurs outside of the attentional oriented area (when attention is oriented to another stimulus) but it requires more effort. During orienting, the regions such as the superior parietal cortex, temporal-parietal junction, frontal eye fields are involved (Malinowski, 2013; Petersen & Posner, 2012; Posner & Petersen, 1990).

1.6.3 Detection/Executive

Detection/executive process is the one that a specific bit of information is selected. It also can be explained by "the cognitive registration of stimuli". Alertness and orientation take part in enhancing the chance of detection’s occurrence, while detection makes information processing possible. The process is related to focal attention, which is explained by Posner and Peterson (2012) as “the entry to the conscious state”. Detection is also called conflict monitoring and executive attention. The regions that are activated in detection are also called the executive network; consisting of the superior colliculus and the anterior cingulate cortex (ACC), lateral ventral cortex, prefrontal cortex, and basal ganglia (Brandmeyer et al., 2019; Malinowski, 2013; Petersen & Posner, 2012; Posner & Petersen, 1990).

The research on neural systems of attentional control highly adopts network view. Alerting network, which has a role controlling the amount of arousal and alertness, and Executive Network that is active during goal setting, conflicts resolving functions, and “posterior attention model” are proposed to be elements of the attentional system.

ACC activation is the common feature of functions such as attention, emotion regulation, and cognitive control; which can be interpreted as a critical region for such functions (Petersen & Posner, 2012)

Attention has tendency to “mind wandering, agitation and dullness” and training has importance in preventing this tendency since attentional training ensure the cognitive states to be more “stable and vivid”(B. A. Wallace & Shapiro, 2006).

The improvement of attentional skills results in positive effects on emotion regulation. Especially the inhibition of automatization and increased cognitive flexibility are significant skills in cases of encountering stimuli that might generate unwanted emotional state (Bishop, 2004; Hartkamp & Thornton, 2017; Moore et al., 2012; B. A. Wallace & Shapiro, 2006).

In order to understand the inhibition of automatization further, we should investigate the classification of cognitive processes as controlled and automatic (Schneider & Shiffrin, 1977).

The activation of learned sequences in long-term memory is called automatic processing. This type of processing demands a little part of a person's cognitive resources and got triggered reflexively and because it occurs without intention and the subject does not have control over the process**.** On the other hand, a controlled process is required during unpredictable, unacquainted, and difficult tasks; it is capacity-limited since it uses more of the cognitive resources and obviously can be controlled by the subject (Shiffrin & Schneider, 1984; Wells & Matthews, 1994). The automatic processes can be innate or might become automatic as a result of practice. It was a commonly accepted idea that once a process becomes automatic hence initiated unintentionally and effortlessly, it is not easy to suppress, modify or ignore it (Moore & Malinowski, 2009; Schneider & Shiffrin, 1977).

The "Cognitive Flexibility" term was first introduced to the literature by Jose Cañas and his colleagues (2003) as the ability to reinvest attention and adopt new strategies in the cases of encountering new and unexpected conditions. As cognitive flexibility supports interrupting automatization of responses, it shall be an aspect of emotion regulation as well as being in relation with meditative practice (Moore & Malinowski, 2009).

Meditation, as a practice of attention training, provides performance increases in cognitive tasks as well as rapid attentional alteration by gaining cognitive flexibility ((Brefczynski-Lewis et al., 2007; Hodgins & Adair, 2010; Jha et al., 2007; Moore & Malinowski, 2009).

4. EMOTION REGULATION

As human beings, we differ from animals by being able to act independently from the impulses that push us ahead without thinking about the consequences or hiding ourselves in a box because of feeling stalemated. That difference comes from our ability to be aware of emotions and regulate them. In this study, emotions are accepted to be the reaction inclination (whether physiological, behavioral, or adaptive) of individuals, functioning as enhancement of physical and social status (Wadlinger & Isaacowitz, 2011). As Shakespeare (1954) pointed out in his well-known play Hamlet ; when we change our thoughts we can change our feelings hence modify our emotional state, through the main character Hamlet saying: ‘‘there is nothing either good or bad, but thinking makes it so.’’ (Ochsner et al., 2002).

Emotion Regulation research investigates the techniques people modify their emotions in a limited time, for a specific situation whether positive or negative (McRae & Gross, 2020). In order to regulate emotions, the awareness of that emotion is crucial, and that can be obtained by metacognition.

1.7 Cognitive Monitoring and Metacognition

Metacognition is the knowledge and the ability to reflect on our own ongoing cognitive processes (Schwartz & Perfect, 2002). John Flavell (1979) the first person to use the term metacognition, developed the “A Model of Cognitive Monitoring” by introducing four stages, these are.

1.7.1 Metacognitive knowledge

A person’s own knowledge about himself/herself, the knowledge about the cognitive weakness and strengths. For example, someone might have the belief that he/she is better at English than Mathematics and that is an outcome of metacognitive knowledge.

1.7.2 Metacognitive experiences (awareness)

The feelings that arise about the cognitive experiences, during the ongoing process and the ability to evaluate how well it is going. For example, while listening to someone speaking, suddenly realizing that you do not understand anything they are telling is metacognitive awareness.

1.7.3 Goals (or tasks)

John Flavel explains the goals or tasks as “the objectives of a cognitive enterprise.”

1.7.4 Actions (or strategies)

The operations that are adopted to achieve the goals. For example, applying emotion regulation strategies.

Sometimes attention becomes distracted from the current experience. Cognitive training and meditation which requires bringing the attention back to the present moment constitutes an awareness that the thoughts are not the truth or reflections of the reality and are just the products of the mind. This kind of awareness is claimed to be the core of decentering (Kang et al., 2013; Teasdale, 1999).

Like Shakespeare, Richard Lazarus (1999) who has developed one the most important frameworks in emotion regulation literature with his transactional stress model, states that “the way we evaluate an event determines how we react emotionally.”

Emotion regulation strategies can be applied voluntarily or involuntarily to adjust the intensity of an emotional response (Gross, 1999, 2001). When emotion regulation occurs involuntarily or unconsciously, the processes occur automatically, and is called implicit emotion regulation. Whereas, voluntary regulation which consists of conscious processes, is called explicit emotion regulation (Guendelman et al., 2017).

1.8 Emotion Regulation Strategies

In this study, we will focus on voluntary regulation so when the term “emotion regulation” is used, it refers to “explicit emotion regulation”. The explicit emotion regulation strategies can be explained under four categories (Dörfel et al., 2014; Gross, 1998, 2002; Kalisch et al., 2005, 2006; Lazarus, 1999; Ochsner et al., 2002; Walter et al., 2009). These are,

1.8.1 Distraction,

Directing focus to a secondary task in order to distract from the unwanted emotional stimuli. The secondary task can be non-emotional or emotionally less disturbing. Selective attention is the main element of the distraction strategy.

1.8.2 Reinterpretation

Reinterpretation is a kind of cognitive reappraisal which is applied by modifying the meaning of the situation by composing a different interpretation in face of a disturbing emotional stimulus. For example, seeing a person crying and thinking that these are tears of joy.

1.8.3 Detachment

Detachment is another kind of reappraisal strategy which we will be focusing on in this study. Detachment is also called decentering, the process of taking the perspective of an uninvolved observer by stepping back and “achieving psychological distance”, instead of adopting the emotion (Fresco et al., 2007; Garland et al., 2015).

The process of observing the situation creates an opportunity to decide how to respond, without having an automatic reaction (Kang et al., 2013)

The research on emotions suggests that there when people evaluate the situation from the first-person perspective, they focus on the negative aspects of the experience more, on the other hand, becoming the observer of the situation and the self by taking distance, relieves the burden and creates ground for more constructive reaction (Kross & Ayduk, 2008).

1.8.4 Expressive suppression

Modifying the first expressive response to an emotional stimulus to a more purposive one. For example, instead of frowning, modifying the facial expression to smiling.

A meta-analysis which is conducted with 190 studies on emotion regulation success revealed that detachment is more successful (d+=0.45) than reinterpretation (d+=0.36), followed by suppression expression (d+=0.32), whereas distraction has a very small effect on reducing an emotional reaction (d+=0.27) (Webb et al., 2012). The reason for the difference in regulation success of different strategies can be explained by remembering how the strategies can be distinguished by timing of the regulation. If an individual changes the reaction before the emotional response becomes activated it is called antecedent-focused regulation; and the strategies take part after the emotion is generated are called response-focused regulation (Gross, 2002). Taking from this point, it can be realized that the successful strategies like detachment and reinterpretation are under the category of antecedent-focused strategies; the processes that occur before the emotion arises, so these strategies do not need to aim to alter any negativity; while expressive suppression is a kind of response-focused strategy as it occurs after the emotion arises (Dörfel et al., 2014; Gross, 2002).

When we investigate the study comparing the effects of two cognitive reappraisal strategies, detachment and reinterpretation, which the subjects attend to the stimulus in an unemotional and detached manner or focused on the positive aspects of the stimuli; it is revealed that detachment "turns down the volume of emotion" by "globally reducing the emotional responding" whereas reinterpretation "changes the channel" by "shifting the balance of emotional responding toward positive affect" and has different kinds of benefits.. Detachment is especially useful in situations where people feel overwhelmed by complex emotions or when the positive emotion is not enough to motivate them to initiate something. On the other hand, reinterpretation increases the ratio of positive emotional responses when compared to negative responses (Shiota & Levenson, 2012).

1.9 Neural Correlations of Emotion Regulation

The research conducted so far shows that the emotion regulation process occurs as an interaction between the regulation network that takes part in control and inhibition processes and the regions involved in appraisal and emotion generation.

The specific regions commonly observed to participate in emotion regulation, working as a control mechanism by prioritizing the stimuli or emotional salience relevant to the internal goals are ACC, VMPFC, DMPFC, VLPFC, and IPC (Dörfel et al., 2014; Eippert et al., 2007; Guendelman et al., 2017; Kalisch et al., 2005; Ochsner et al., 2009; Viviani, 2013; Wager et al., 2008)

The regions that effected by the emotion regulation process are the amygdala, anterior insula, nucleus accubens (NAC), and ventral striatum (Buhle et al., 2014; Dörfel et al., 2014; Guendelman et al., 2017; Wager et al., 2008).

After receiving the stimuli, the emotional response occurs by the ongoing processes in the limbic system especially in amygdala and anterior insula (AI). When there is a mismatch between the arising emotion and the goal to feel less negative, it is detected by dorsal anterior cingulate cortex (dACC). In order to control the emotion and response voluntarily, instead of going with the flow of the occurring arousal; the dorsolateral prefrontal cortex (DLPFC) brings the information about the goal from working memory. Then, the ventrolateral prefrontal cortex (VLPFC) and parietal cortex become activated in order to switch attention – regulate emotion (Dörfel et al., 2014; Eippert et al., 2007; Guendelman et al., 2017; Ochsner et al., 2002).

As extra information, the ventral-anterior cingulate cortex (vACC), and the ventromedial prefrontal cortex (VMPFC) take place during implicit emotion regulation (Guendelman et al., 2017).

The 46 neuroimaging studies applying reappraisal as emotion regulation strategy were investigated in a meta-analysis and resulted in common activations in bilateral DLPFC, VLPFC, DMPFC, and PPC and deactivation in bilateral amygdala and ventral striatum; the regions that were previously mentioned in the process of explicit emotion regulation (Buhle et al., 2014).

PFC regions are commonly accepted to be playing an important role during emotion regulation by interacting with subcortical regions which takes part in the emotional responding (Dörfel et al., 2014; Guendelman et al., 2017; Kalisch et al., 2005; Wager et al., 2008).

In emotion regulation's neural correlations literature, there are two different reappraisal pathway hypotheses. These are the mediation hypothesis and the direct pathway hypothesis.

The mediation hypothesis claims that negative emotion is reduced by PFC's effect on subcortical systems. On the other hand, according to the direct pathway hypothesis, the success of the reappraisal is not related to the amount of influence on subcortical systems because it all occurs during the cortical activity (Wager et al., 2008).

The studies investigating emotion regulation commonly mention increase in regions that are claimed to be taking part in the reappraisal process such as dorsomedial PFC, VLPFC, dorsal ACC, VLPFC, and insula. Whereas correlation in participants' emotional reports and decrease in amygdala activation. Also, PFC activation has been observed to be correlated with the success of reappraisal. When two pathways are compared, the activation in right VLPFC and its effect as downregulation on amygdala activity (supporting mediation hypothesis) , and increased activation in Nucleus Accubens (NAC) with nearby ventral striatum (VS) (supporting direct pathway hypothesis) were both correlated with the success of reappraisal strategy (Blair et al., 2007; Goldin et al., 2008; Ochsner & Gross, 2008; Wager et al., 2008).

As there are two different networks both result in successful reappraisal, the researchers claim that the success of reappraisal shall be related to both limiting negative appraisals (by decreasing activity of amygdala) and creating positive emotions by appraising with bringing relevant information from the memory; as the network involving NAC/VS includes regions that take part in memory and action selection (Wager et al., 2008).

What differs in neural processes when different regulation strategies are applied?

Studies on distraction claims that the process activates the ACC, VLPFC, and the Parietal Cortex (Frankenstein et al., 2001; Kalisch et al., 2006; Kanske & Kotz, 2011); reinterpretation is related to the activations of DLPFC and VLPFC. Detachment is commonly observed to be activating dorsal ACC, dorsal and anterior medial PFC, DLPFC, IPC, and reduced amygdala activation, and expressive suppression activates bilateral DMPFC, right DLPFC, and left VLPFC (Dörfel et al., 2014; Kalisch et al., 2005; Ochsner et al., 2012).

In a study conducted to compare activations of the four emotion regulation strategies mentioned above; distraction, detachment, and expressive suppression are observed to share activations in similar regions, such as an increase in DLPFC and right IPC and decreased activation in the left amygdala. On the other hand, during reinterpretation, there was no considerable downregulation in the activation of the amygdala or increased activation in VLPFC and orbitofrontal gyrus was observed (Dörfel et al., 2014).

The activations of dorsal PFC and ACC during reappraisal, suggested to be related to maintaining selective attention and monitoring processes respectively (Ochsner & Gross, 2008).

It is suggested that there is a relation between dorsal ACC, DLPFC, insula and amygdala activity and meta-cognitive ability regarding emotional state, attentional detachment capacity and regulation limbic activity and its connection with Mindfulness (the topic that will be investigated in coming sections) (Farb et al., 2010; Garland et al., 2015).

The question whether the downregulated amygdala activation continues after emotion regulation by detachment or the “return of suppressed” situation, which is the rebound of suppressed emotions with a enormous increase in amygdala activation, occurs drove the researchers conduct a study for investigation. The decrease of amygdala activation was observed to be maintained after 10 minutes and the decrease level was in correlation with increased right DLPFC activation. The researchers interpreted the results as the DLPFC’s effect on top-down regulation by inhibiting amygdala activation which supports the theories on the process of voluntary emotion regulation (Walter et al., 2009).

1.9.1.1 Detachment and Its Various Versions in the Literature

The concept of “Detached Mindfulness” relies on the process of meta-cognition and awareness of mental events that can be evaluated and modified since “the thoughts are not the realities” ” (Wells & Matthews, 1994). Detached mindfulness is suggested to be automatically occurring inner-awareness, and does not require any effort to be aware of the “ebb and flow of internal events, primarily thoughts”, because the individual stays mentally decentered. The elements of detached mindfulness are “mega-cognitive knowledge”, “metacognitive monitoring”, “suspension of conceptual processing”, “attentional flexibility” and “de-centered relationship with thoughts” (Wells, 2005). This kind of awareness provides ground to a person to avoid being triggered by maladaptive beliefs and create flexible responses to “threat” and gives the ability to control and guide cognition (Wells, 2002). The word mindfulness shall not be confused with mindfulness meditation. Wells, the founder of the concept differentiate the process of mindfulness as effortful whereas detached mindfulness as automatic processes (Wells, 2005). The researchers observe the mindfulness in the Buddhist tradition as one of the pathways of implementing the state necessary for detached mindfulness, and define the characteristics as below:

1. Meta-awareness (consciousness of thoughts).

2. Cognitive de-centering (comprehension of thoughts as events, not facts).

3. Attentional detachment (attention is flexible and not anchored to any one event).

4. Low conceptual processing (low levels of analytical and meaning-based appraisals. i.e. inner dialogue).

5. Low goal-directed coping (goals to remove or avoid threat are not paramount).

Although the technique seems close with mindfulness meditation, according to the researchers, the main aim of the concept is to understand how the information is processed in emotional disorders and they especially point out that detached mindfulness is not formed as a coping strategy (Sugiura, 2004; Wells, 2005).

Detachment is the central component of Mindfulness-Based Cognitive Therapy; which is an 8-week group therapy that combines cognitive therapy's techniques for depression and mindfulness meditation's clinical application (Segal et al., 2001). MBCT helps patients or applicants to avoid automatic responses during cognitive processing by becoming more aware and preventing depressed state by relating differently instead of engaging emotions, mental and bodily processes that induce depression (Bieling et al., 2012). The ability to be more aware and disengage can be improved by training that includes body scan, sitting meditations, basic yoga movements, mindfulness in daily activities and information about depressive illness and cognitive patterns, how to non-judgmentally observe everything that arises (Bieling et al., 2012; Eisendrath et al., 2011; van der Velden et al., 2015). The difference between Cognitive Behavioral Therapy and MBCT is that while CBT aims to change the content, MBCT focuses on decentering from “habitual automatic cognitive routines” which results in disengaging from “automatic dysfunctional cognitive patterns”(Eisendrath et al., 2011; Segal et al., 2001)

The MBCT of Segal and his colleagues (2001)combine mindfulness training and some components of CBT, such as:

1) Encouraging clients to catch automatic “habitual dysfunctional cognitive processes”.

2) Detaching from these processes by redirecting attention.

3) Developing the mega-cognitive ability to be aware of the transience of thoughts and feelings as they are not the facts.

4) Realizing how the psychical sensations, thoughts, and emotions change when the “non-judgmental and compassionate attitude” is taken.

When these steps are comprehended and applied in daily life, individuals less likely find themselves in a depressive mood because of the “dysfunctional depressogenic habits” (van der Velden et al., 2015).

Hayes’ (1999) “cognitive diffusion” strategy also uses a similar technique which requires individuals to separate thoughts and actions (Khoury & Lecomte, 2012).

5. MEDITATION

The meditation term is used to describe the practices that regulate the body and mind by engaging a specific attentional set (Cahn & Polich, 2006). Meditation can be practiced with various methods formally or informally. During formal meditation, the practitioner meditates for a defined period of time (like 45 minutes, everyday) and use a specific method, whereas informal meditation can be applied by being mindful during daily activities such as eating, taking a bath or walking (Hindman et al., 2015). An important amount of the research has been conducted on formal meditation and revealed enhanced cognitive capacity, emotional state, and neuropsychological well-being as the result of extensive meditational practice (Cahn & Polich, 2006; Carter et al., 2005; Hartkamp & Thornton, 2017; Moore & Malinowski, 2009). Almost every meditation practice starts with focusing on a specific object, hence attentional training is the common fundamental element of all types of meditation since it increases the ability to focus and reduces proneness of distraction (B. A. Wallace & Shapiro, 2006).

Meditation offers a way to regulate mental activities by meta-cognition and “flexible allocation of highly limited brain activity resources” (Raffone et al., 2019). In recent years, the word meditation has been taking its place in daily conversations. As the number of mediation practitioners and scientific studies increases, information about its benefits as well as myths about meditation practices have been emerged and spread rapidly. As an example of misunderstood concept about a meditation session is that the meditator’s mental state does not stay the same, or become blank like a white screen; so defining the mental states of a practitioner is an important step for creating a research paradigm. In this section, we aim to clarify the knowledge about meditation and reveal evidence on how it can be effective in emotion regulation.

Just like the word “sports”, the word meditation is the combination of various practices that can be applied for mental, psychological, physical wellbeing or spiritual clarity. Regulation of attention is the main common property of all meditation practices. As training the body consistently increases the muscle strength, the individuals feel less forced and more energetic; practicing meditation regularly improves the mental stability and lessens the required cognitive effort for attention regulation (Lutz, Slagter, et al., 2009). With the practice of meditation, one can reach Samadhi, the “deeper levels of insight into the nature of the mind and consciousness” (Brandmeyer et al., 2019; A. Wallace, 2014), and enrich eudemonic well-being (Garland et al., 2015).

The first classification between meditation practices was defined by Cahn and Polich (2006) focusing on the way attentional processes are directed. These are concentrative meditation (focused attention) and open-monitoring meditation (mindfulness). As the research on meditation practices gets more advanced, the classifications become more elaborated. Currently, there are five well-defined categories of meditation in the literature. Although those five different meditation techniques consist of unique practices and benefits, they have overlapped outcomes like “feeling happier, more energized, being more present in the moment, more aware of the body, and better at disengaging from distracting thoughts” (Kok & Singer, 2017) and stay detached. The runner analogy can help us to understand how different meditation practices bring unique benefits as well as having common properties; when researchers observe runners’ path in the city, they see that although they know and use different locations as their route, they develop a similar muscular and cardiovascular system in time (Kok & Singer, 2017).

1.10 Types of Meditation

1.10.1 Concentrative/focused attention meditation (FA)

The techniques involve focusing on a specific sensory or mental activity such as repeated words or sounds, an image created by visual imagery, or specific bodily sensations like breath. This type of meditation is suggested to enhance concentration and develop meta-awareness (Dahl et al., 2015) since it develops regulatory skills such as monitoring by staying sharp to avoid distractions, being able to disengage from current distractions, and bringing the focus back (Slagter et al., 2011). The mental process of FA is called Samatha (quiescence, focusing on an object to reach tranquility) in the Buddhist tradition (B. A. Wallace, 1999). Wallace (1999) explained the stability and vividness of attention during FA or Samatha with a telescope metaphor "mounting a telescope on a firm platform and obtaining clear focus by polishing the lenses". Development of attentional vividness is like polishing the lenses and bringing the telescope into clear focus. As a mental training, focusing on a single object supports the absorption skill, which is the ability to "fully engage attention in an experience" (Brandmeyer et al., 2019; Wenk-Sormaz, 2005).

Practices like Pranayama and the Buddhist Samatha meditations are the examples of yogic meditation techniques that focus on the sensation breath. In addition, yantra (which is a mystical diagram used in Tantric traditions) or candle gazing, and mantra meditation (there is an ongoing debate whether meditating with mantra, which is called transcendental meditation, is a kind of FA meditation or not) are the types of focused attention meditation techniques (Brandmeyer et al., 2019; Cahn & Polich, 2006; Frederick Travis & Parim, 2017).

1.10.2 Open Monitoring meditation (OM)

During open-monitoring meditation, the practitioner does not focus on a specific object. These practices allow any thoughts, feelings, and sensations to arise and monitor them as an "unattached observer" / "witnessing observer by being aware of the process without judging or analyzing (Cahn & Polich, 2006; Kabat-Zinn, Lipworth, & Medicine, 1985; Lutz, Slagter, et al., 2008). At the beginning of open-monitoring meditation, the practitioner starts with FA meditation to cultivate a calm and focused state then expands the scope of attention to monitoring internal and external experiences (Slagter et al., 2011). The main difference between open monitoring meditation and focused attention meditation is the wideness of the attention. In open monitoring meditation, attention is applied in an open perceptivity while concentrative meditation requires intense focus by narrowing the attention (Cahn & Polich, 2006). Focused attention keeps playing an important role in open monitoring meditation by providing stability hence "accurate monitoring and introspective awareness" (Lutz, Slagter, et al., 2008; Raffone et al., 2019).

Meta-awareness and absence of reactivity are the important aspects of open-monitoring meditation. Zen, Vipassana, and the Western adaptation of mindfulness meditations are in this category (Kabat-Zinn, 2003).

The most popular form of open monitoring meditation is mindfulness meditation, which involves acceptance and awareness, has been brought to the West by Jon Kabat-Zinn. The origin of the technique comes from Buddhist contemplative traditions like satipatana vipassana/insight meditation (Theravada Buddhism), Zen meditation (Mahayana Buddhism), and Yogic traditions explained by J.Krishnamurti, Thakar, and Marajah (Kabat-Zinn, Lipworth, & Medicine, 1985). The term mindfulness is chosen for the translation of the word "sati" in the Pali language. Sati is the state of mental stability where individuals are able to sustain attention without being affected by distractions (Wielgosz et al., 2019). Buddhists explain the path to the state of mindfulness by cultivating “bare attention” and “detached observation” (Nyanaponika, 1962). It can be established by observing every moment with full awareness and staying away from the efforts of the observer’s ego to add meaning to the phenomenon that is currently perceived (Ornstein & Naranjo, 1971). Jon Kabat-Zinn (2005) points out that practicing meditation is basically a framework to cultivate the skill of mindfulness, which is a state of consciousness (Shapiro et al., 2006). The four components that are essentially mentioned in mindfulness meditation are; awareness sustained attention, non-judgmental acceptance, and focusing on the present moment (Kabat-Zinn, Lipworth, & Burney, 1985; Kang et al., 2013)

Kabat-Zin(1985) created the Mindfulness-Based Stress Reduction (MBSR) technique in order to bring mindfulness’ benefits to clinical settings and support patients reduce their chronic pain; and explains MBSR as “highly developed, coherent, systematic, and multimodal utilization of attention.”(Kabat-Zinn, Lipworth, & Medicine, 1985).

1.10.2.1 The Body Scan Practice

The body scan practice is an important element of MBSR in extending awareness and focusing attention on every individual part of the body one by one and observing the sensations in the targeted body part (Kabat-Zinn, 1990). As it can be understood from the definition, this element of MBSR is a type of focused attention meditation which uses body parts for the object to be focused. Body scan practice with controlled breath has significant benefits on interoceptive awareness and is a good way of attentional training (Kok & Singer, 2017; Mirams et al., 2013).

1.10.2.2 Observing Thought Meditation

Observing mental activities is an important element of mindfulness meditation hence is thought in MBSR and MBCT courses. This method consists of decentering, by allowing thoughts to come and go (rise and fall) by not identifying and not being affected by these thoughts' content and generated emotions (Fjorback & Walach, 2012). It can be interpreted as being in a detached state. In order to practice observing thought meditation, the practitioners need to develop two meta-cognitive skills; how to categorize and label the thought they have (like "future"," positive"," self"," other"), and observing these thoughts without clinging or reacting (Kok & Singer, 2017). The observing thought meditation practice especially improves non-judgmental consideration skill (Sauer-Zavala et al., 2013).

1.10.3 Compassion and Loving Kindness Meditation

Loving-kindness meditation and compassion meditation have also their roots in Buddhist meditation (Buddharakkhita, 1989; Lama, 2001; Raffone et al., 2019) Practitioners traditionally use mental imagery techniques to generate feelings of love, kindness and compassion expand those feelings toward specific individuals, and to all beings (Dahl et al., 2015). The main aim of this meditation is to enhance a positive emotional state, beyond training attention (Wadlinger & Isaacowitz, 2011). Compassion meditation creates a state that aims to ease the suffering of other individuals and loving meditation creates a loving state and the practitioner "wishes wellness and happiness" to all beings (Raffone et al., 2019). During meditation, the object of focus is not a specific memory or image; instead, the meditator concentrates on people or beings (Lutz, Brefczynski-Lewis, et al., 2008). The state cultivated by compassion meditation is called "dmigs med snying rje" in Tibetian, translated as pure compassion or non-referential compassion (Lutz, Brefczynski-Lewis, et al., 2008; Lutz, Greischar, et al., 2009). During compassion and loving kindness meditation, practitioners start by thinking about someone or some being that they love and care about and let the feeling of love and compassion fill their minds. The second step is generating love and compassion for all beings, without thinking about a specific person or being (Lutz, Brefczynski-Lewis, et al., 2008; Lutz, Greischar, et al., 2009). The commonly used phrase during meditation is "may that person/being be safe, peaceful and healthy". It's claimed that while open monitoring meditation practice increases metacognitive skills, loving kindness and compassion meditation increases the warm feelings and positive thoughts towards others (Kok & Singer, 2017).

1.10.4 Transcendental meditation

Mantras, the words or syllables which are generally obtained from Sankrit (Shriram Sharma Acharya, 2003) are the main elements of the practice. During the meditation process which consists of repeating a mantra, the experience of the mantra disappears, and self-awareness arises. This state is called transcendence. Transcendence is having awareness beyond physical senses like the perception of the environment, senses coming from the body, sense of time or space, and even beyond mental objects (Brandmeyer et al., 2019; Frederick Travis & Parim, 2017; Yogi, 1963). As we mentioned in the FA section, some researchers claim transcendence meditation is a type of focused attention since the practitioner keeps on repeating the mantra which seems to be a practice that requires attention to be focused on a single object; on the other hand, there are several researchers point out that during the meditation the mantra does not stay clear in the awareness, it is "a vehicle for transcending". Travis and Parim conducted a study by investigating Default Mode Network activation during focused attention meditation and transcendence meditation, and observed decreased activation of DMN during focused attention meditation, while transcendental meditation practice increased the DMN activation; and concluded that this can be an evidence for the TM is not a type of FA (Frederick Travis & Parim, 2017).

1.10.5 Non-dual meditation (nda)

This kind of meditation is claimed to be different than the other meditation types in terms of working memory load, in addition to attention regulation strategy by not employing the “subject-observing-object” technique (Josipovic, 2010). According to Zoran Josipovic (2014) who is a researcher studying Non-dual meditation, NDA has its origins in Buddhist, Vedic, and Hindu tradition. NDA is suggested to decrease the attachment or control, and create a “more unified reality” since there are no separate parts like an observer and the object (observed) (Brandmeyer et al., 2019; Josipovic, 2014)

1.11 Neural Correlates of Meditation

Lazar et al. (2005) had conducted the first fMRI study which investigated how meditation affects cortical thickness, and observed that experienced meditators have a thicker prefrontal cortex and right anterior insula, the regions that are associated with attention, interoception, and sensory processing.

Although each meditation style has unique brain activity patterns, overlapped regions exist. The commonly active region observed in fMRI studies with all types of meditations is the dorsal anterior cingulate cortex, predicted to take part in attention and emotion regulation (Brandmeyer et al., 2019; Cahn & Polich, 2006; Lazar et al., 2005; Tang et al., 2015a). Insula is also the most observed region, associated with interoception, metacognition, and memory (Brandmeyer et al., 2019). Anterior cingulate cortex and fronto-insular regions are suggested to detect conflicts with executive attention (Brandmeyer et al., 2019).

Studies show that practicing meditation regularly, reduces default mode network's activity which is associated with self-referential thinking and mind wandering. The decrease in DMN activity results in better attentional performance and emotion regulation (Brewer et al., 2011; Garrison et al., 2015; Pagnoni, 2012; Raffone et al., 2019). Especially focused attention, open monitoring, and loving-kindness meditations are reported to induce deactivation in DMN regions in experienced meditators (Brewer et al., 2011; Frederick Travis & Parim, 2017). On the other hand, DMN has been observed to be active during transcendental meditation in one study (Fred Travis & Shear, 2010).

1.11.1 Specific Neural Correlations of Meditation Types

During focused attention meditation, the meditators' brain activations increase in regions for cognitive control, which provide sustained attention and avoid mind-wandering (Brandmeyer et al., 2019). Dorsal anterior cingulate cortex and dorsolateral prefrontal cortex are predicted to be active for conflict monitoring; whereas ventrolateral prefrontal cortex, temporal-parietal junction, frontal eye fields, and intraparietal sulcus for selective attention, and right frontal and parietal areas for sustaining attention (Lutz, Slagter, et al., 2008).

Open monitoring meditation activates the areas involving thought regulation, introspection, monitoring the sensations and feelings (Brandmeyer et al., 2019). Studies conducted with mindfulness meditation reveal increased activity in dorsal ACC and insula (Salience Network) (King & Fresco, 2019).

The studies reveal that loving kindness and compassion meditation activates the brain regions related to "somatosensory processing, empathy and theory of mind (mentalizing)" (Brandmeyer et al., 2019). While the orienting network is required to attend positive emotion, the alerting network is required for maintaining the created state, whereas the executive network supports disengagement from distractors (Wadlinger & Isaacowitz, 2011).

During transcendental meditation, regions involve in motor control such as Broca's area, primary and supplementary motor areas and basal ganglia are increased, whereas activations in somatosensory cortex and primary auditory cortex are decreased (Brandmeyer et al., 2019).

1.12 Neural Oscillations of Meditation

EEG (electroencephalogram) is an electrophysiological method that has been used in meditation research that monitors and records the post-synaptic electrical activity of the brain. In EEG studies, the electrical activity can be investigated with two approaches. Power, as the extent of specific frequency band's activation, and coherence for observing ongoing connections between the regions (Xiao et al., 2018).

The oscillations are classified into 5 categories in terms of their frequency range.

Delta frequency ranges between 0.5Hz - 4Hz and mostly associated with deep sleep. Although when compared to the other waves the amount of studies investigating delta in cognitive processes is quite low; there is a view among some researchers that delta oscillations are interrelated with motivation (Alper et al., 2006; Harmony, 2013; Knyazev, 2012).

Theta frequency is between 4Hz – 8Hz. Studies with focused attention, open monitoring, transcendental meditation, and loving-kindness compassion meditation, have revealed an increase in theta frequency (Baijal & Srinivasan, 2010; Cahn et al., 2010; Pasquini et al., 2015). The increase in theta oscillations has been observed to be positively correlated with meditators' experience level (Lee et al., 2018). During FA and OM studies, theta power increase has been observed in frontal midline regions such as PFC and ACC (Lee et al., 2018; Takahashi et al., 2005). Fm theta is stated to be increased during internal attention (Lippelt et al., 2014).

Lutz and Davidson (2009) investigated the participants' EEG recordings as they were performing a listening task before and after three months of meditation training and observed enhancement of theta phase in anterior regions as well as a decrease in reaction time and response variability. The researchers interpreted the result as FA meditation may increase attentional stability, hence related brain functions.

Cahn and his colleagues (2010) conducted a study with long-term Vipassana meditators comparing practitioners with the control group while meditating and the study resulted in an increase of theta power in the frontal regions while parieto-occipital regions showed an increase of gamma.

Not only amplitude of theta frequency, but also its coherence changes with open-monitoring meditation in the frontal and regions, which is associated with executive functions (Cahn et al., 2013; Lee et al., 2018). Also during transcendental meditation, increased theta coherence is observed between central, temporal, and occipital regions (Lee et al., 2018; Tomljenović et al., 2016).

Bailjal and Srinivasan (2018) compared Sahaja meditation teachers (focused attention meditation) with the control group during meditation vs eyes closed and observed increased theta power and coherence on the frontal regions.

Alpha frequency ranges between 8Hz- 13Hz. These oscillations have been observed to increase in PFC and left parietal regions during FA and OM, and positively correlated with experience (Dentico et al., 2016; Lee et al., 2018). Braboszcz and her colleagues (2017) conducted a study to compare neural oscillations between three meditations (a focused meditation on mantra repetition: Himalayan Yoga Tradition), an open-monitoring meditation focusing on body sensations (Vipassana), and an open awareness meditation ("Shoonya" meditation, a practice part of Isha Yoga tradition), and reported increased alpha power in OM practitioners compared to control group (meditative naive participants) and FA practitioners. Various studies resulted in increased frontal alpha activation during Zen meditation (Chiesa & Serretti, 2010; Yu et al., 2011).

Richard Davidson and his colleagues (1990, 2003) observed asymmetric alpha oscillations towards the left side of PFC which is associated with positive emotions, as an effect of MBSR.

Travis and his colleague's study (2010) resulted in higher alpha1, beta1, and gamma power in TM practitioners compared to the control group who stayed eyes closed while the TM group was meditating.

Both alpha and theta activations are suggested to be the "key biological signatures that potentially facilitate a successful meditative state" even though the contribution of the waves to the meditation process is still a mystery; Tang and his colleagues (2019) proposed that frontal midline theta takes part in preserving the meditative state whereas alpha activity indicates the “preparation needed to achieve the meditative state”

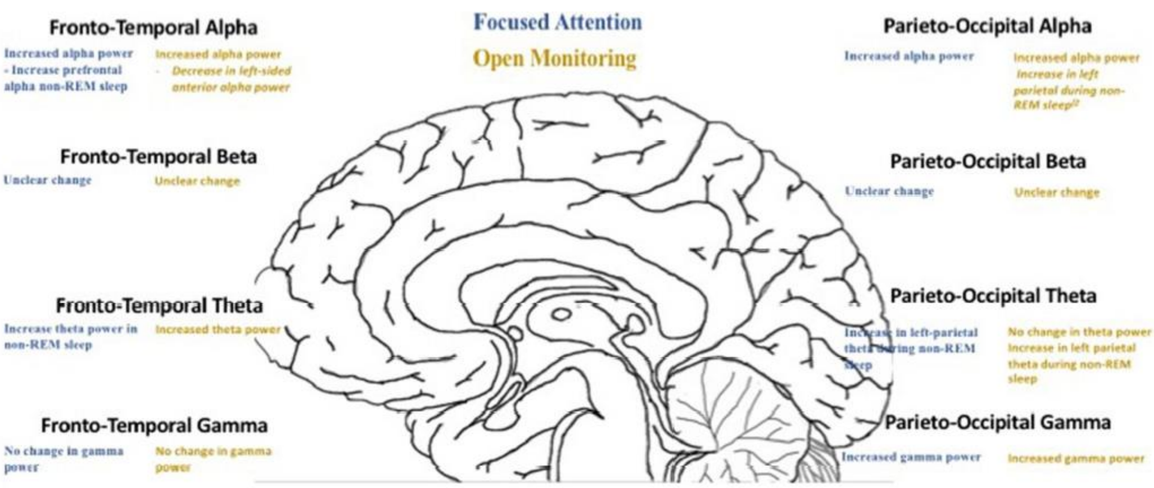
Beta Frequency is between 13Hz – 32Hz, associated with cognitive control, attention, and emotion as well as sensorimotor processing (Güntekin et al., 2013; Lee et al., 2018; Symons et al., 2016). There are studies showing a decrease in the angular gyrus, posterior cingulate, and parietal regions during OM and occipital regions during TM (Faber et al., 2015; Lee et al., 2018; Tomljenović et al., 2016). Beta 2 activation has been observed also during loving-kindness meditation (Fred Travis & Shear, 2010).

Gamma Frequency ranges between 32Hz and 100Hz. This frequency is associated with high level cognitive functions like attention, memory, object recognition, as well as perception(Herrmann et al., 2004; Ray & Maunsell, 2015; Tiitinen et al., 1993). Gamma frequency has been observed in advanced practitioners who participated in studies conducted with focused attention, open monitoring, loving kindness compassion and transcendental meditation. The oscillations were observed in parieto-occipital region during OM and FA, and frontoparietal regions while Tibetan Buddhist meditators were practicing compassion meditation (Braboszcz et al., 2017; Fell et al., 2010; Lutz et al., 2004; Fred Travis & Shear, 2010). Lutz and Davidson (2004) conducted a study with advanced Buddhist practitioners and observed high amplitude gamma waves around latera frontoparietal regions when the practitioners were in a meditative state. Cahn and his colleagues (2010) related the gamma power increase in posterior regions to be the “enhanced perceptual clarity”, the state which is often mentioned during open-monitoring meditation. Gamma activity is hypothesized to be taking part in neuroplasticity with repetition, since it has been observed in advanced meditators in various styles (Braboszcz et al., 2017; Lee et al., 2018).

A detailed representation of oscillations observed during focused attention and open monitoring meditations from Darrin Lee and his colleagues' review paper can be seen in **Figure 1**.

Figure 1.

Oscillations observed during Focused Attention and Open Monitoring Meditations



Note: Taken from Lee et al. (2018)

1.13 Meditation Proces and Neural Mechanisms of Meditation

The main common instruction for all meditation techniques is keeping attention on specific stance in accordance with the meditation style that is being practiced while letting thoughts and sensations show up and leave with the flow without focusing and holding on to them by detecting the fluctuation and bringing attention back; being a *"*witnessing observer*"* (Cahn & Polich, 2006).

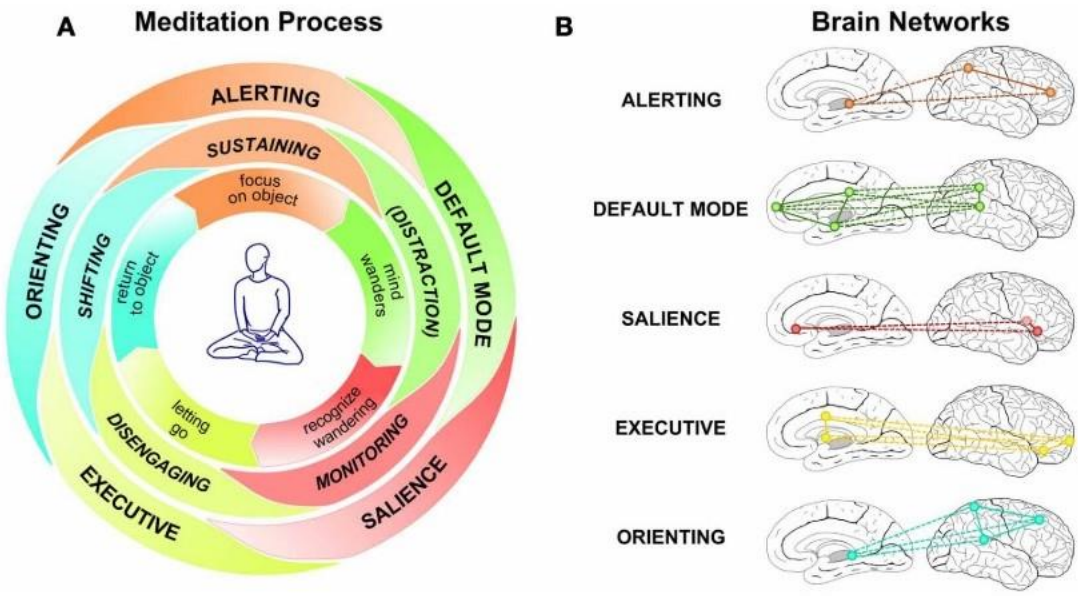
Staying in a position of "witnessing observer" or "unjudgmental place" is the core element of almost every meditational practice. We will be focusing on this aspect by combining the emotion regulation strategy called detachment.

During meditation, depending on the experience level, the meditator's practice process shifts between states. Investigating and defining those mental states is essential for establishing a research paradigm. The first framework model that explains the mental states ("mind wandering, awareness of mind wandering, shifting of attention and sustained attention") of meditation was created by Wendy Hasenkamp (2012), and analyzed with the fMRI study they conducted with meditators practicing focused attention meditation through the scan and pressing a button when they notice mind wandering. The model assigns each state to a specific brain network. Central Executive Network is active through focusing on a present experience and in the process of shifting attention back, Default Mode Network is active during mind wandering and Salience Network is active in the process of realizing the wandering and activating Executive Network to re-focus (Hasenkamp & Barsalou, 2012).

Malinowski (2013) combines the attentional model of Posner and Petersen (1990) with the model for states in a meditative session of Hasenkamp and Barsalou (2012). Within this framework, the processes that a meditator experiences during a meditation session are explained in **Figure 2** as below:

Figure 2

Meditation Process and Related Networks



Note. Taken from Malinowski (2013)

1- The meditator focuses on the relevant object or the sensation. This is the phase of sustaining attention when the Alerting Network is involved (the right frontal and right parietal cortex and the thalamus).

2- When the mind loses the focus from the object, the mind starts to wander, and the Default Mode Network becomes active (posterior cingulate cortex, the medial prefrontal cortex, the posterior lateral parietal/temporal cortices, and the parahippocampal gyrus).

3- The meditator recognizes the mind wandering by attention monitoring function. This is the time when Salience Network is active. (dorsal ACC, the ventrolateral prefrontal cortex, and the neighboring anterior insula)

4- Subsequently detecting mind wandering, the meditator lets go of the distracting chain of thought or experience by attentional disengagement. That's when, the Executive Network is active (the anterior cingulate cortex (ACC), lateral ventral cortex, prefrontal cortex, and basal ganglia)

5- The meditator finally shifts the focus back to the object. This function of attention involves the orienting and executive network (orienting network: the superior parietal cortex, temporal-parietal junction, frontal eye fields, and superior colliculus)

The length of the processes depends on the level of expertise. As the meditator practices regularly, the sustained focus and attentional stability period become more extensive.

The coordination between salience network, executive network, and default mode network shall reveal the improved meta-awareness and detachment ability by catching self-related thoughts or mind-wandering of DMN, disengaging and shifting attention with flexibility as a result of meditation practice (King & Fresco, 2019). Which is an important skill for emotion regulation.

6. CONNECTION BETWEEN MEDITATION AND EMOTION REGULATION

As meditation is an effective attention training practice, and the capacity of attention allocation is the fundamental skill for voluntary emotion regulation by "prefrontal regulation of limbic responses", meditation shall play an important role in enhancing emotion regulation abilities of individuals (Cahn & Polich, 2006; Lazar et al., 2000; Lutz, Slagter, et al., 2008). For example, the labeling qualities of current experience during Vipassana (monitoring meditation) like "this is frustrating" or "this lovely smell makes me happy" detaches the individual from the experience and this process has been observed in neuroimaging studies as an increased activation of the ventrolateral prefrontal cortex and decreased response in amygdala activity (Lieberman et al., 2007; Raffone et al., 2019; Wells, 2005)

A number of respected studies support the view that that meditation practices generate neuroplasticity by improving connectivity in regions associated with attention and emotion regulation (Davidson & Lutz, 2008; Hölzel et al., 2011; Lazar et al., 2005; Lutz et al., 2004; Tang et al., 2015b; B. A. Wallace & Shapiro, 2006). We suggest that the meditation practitioners would be better at sustaining attention in the face of emotional and cognitive load by detaching/decentering from irrelevant stimuli whether internal or external.

As meditation practices increase cognitive flexibility, the ability to "engage and disengage" becomes improved so the practitioners are less likely to "get stuck" on stimuli, emotion, target, or internal process (Kabat-Zinn, 1990; Lutz, Slagter, et al., 2008; Moore & Malinowski, 2009; Slagter et al., 2011). The flexibility with increased awareness and metacognition also makes catching and modifying automatic habitual responses more applicable, provides a ground for individuals to evaluate alternatives, hence creates more desired mental and emotional state (Garland et al., 2015; Gecht et al., 2014; Kang et al., 2013; Teasdale, 1999; Wadlinger & Isaacowitz, 2011).

Studies show the more practitioners spend time meditating (FA and open monitoring), the more activity is observed in the anterior insula and ACC which is interpreted as increased attentional control, involvement of salience, and executive networks consequently improved emotional skills (Malinowski, 2013). These improved skills allow individuals noticing mind wandering and shifting mind state to maintain current task, which we suggest there is a significant similarity in the emotion regulation process.

The connection between frontal regions such as ventromedial PFC, ventrolateral PFC, left frontoparietal (central executive network) and amygdala is suggested to be increased by meditation and emotion regulation system (Brandmeyer et al., 2019; King & Fresco, 2019; Tang et al., 2019).

There are notable similarities in the brain regions that are influenced by mindfulness meditation and the ones involved in mediating fear extinction, namely the hippocampus, amygdala, medial PFC, and the ventromedial PFC (Goldin and Gross, 2010; H€olzel et al., 2007; Lazar et al., 2000; Lou et al., 1999; Luders et al., 2009; Newberg et al., 2001). During mindfulness meditation, practitioners allow themselves to be affected by the experience, cultivating acceptance to the bodily and internal responses as well as avoiding themselves from clinging on that experience. This is supported by findings which suggest that meditation practice may help to facilitate enhanced awareness and reduced reactivity to the content of our ongoing internal dialogue (Hart, 1987; H€olzel et al., 2011b).

7. GOALS AND HYPOTHESIS

This thesis aims to investigate the effect of meditation on regulating emotion (by detachment) and consequently attentional stability. Although the number of research on meditation has been currently increasing, to our knowledge, there is no study which questions and compares the differences in detachment ability between meditation practitioners' and meditation naïve individuals with both psychophysics and electrophysiological studies. The experiment paradigm has been designed to impose participants' cognitive load by creating pressure with a time-limited task that requires high attentional stability. To create a more intensive situation, affective sounds that are categorized according to their pleasure (high-low) and arousal (high-low) points were played during the experiment. The sounds were expected to alter the emotional state of the participants in ways that their distraction and cognitive load would increase during the task. As meditation is correlated with enhanced attentional control and disengagement "from emotionally salient stimuli" and increases "reorienting capacity", we expected our participants to disengage from emotional stimuli and reorient their focus on an ongoing task. The meditation group was expected to be able to detach from the emotional distractors and perform with higher accuracy and lower reaction time. In addition, we expected differences in electrophysiological activations of the participants. The power of meditation group's neural frequency bands such as beta and gamma expected to be lower than the control group in frontal regions since the outcome attentional training would provide the meditation practitioners maintain their focus with less effort. Also, we expected the same high frequency bands to be lower in meditation practitioners' temporal region since the enhanced detachment skills of practitioners from the emotional stimuli would result in less activated limbic region. The research question of this thesis is whether meditation practitioners are more capable of regulating their emotions by detaching from unwanted stimuli and keeping their attention on the task.

8. EXPERIMENT

1.14 Methods

1.14.1 Participants

Thirty participants (*n* = 30, 25 female 5 male) volunteered in this study. The participants' age ranged between 22 to 56 (*M* = 38.77, *SD* = 11.01) The meditation group's participants were chosen from experienced meditation practitioners (have been meditating for at least 2 years) who practice the types mainly requires attentional stability like Focused Attention and Mindfulness (open monitoring) (*n* = 13) and transcendental meditation (*n* = 2). The meditation naïve, control group participants had never been meditated before (15 meditation, 15 naïve). All participants were interviewed about their practice routine in order to check eligibility and categorization. The experiment was approved by the Science-Ethics Committee of Yeditepe University.

1.14.2 Stimuli and apparatus

In this study, we created and presented a version of Stroop Task (Stroop R, 1935) that focuses on the numbers and requires correct counting, instead of the classic Stroop Task which expects participants to respond according to the painted colors of the words, by PsychoPy Builder v2021.1.2 (Peirce et al., 2019). During and between the number counting task trials, participants heard 28 different sounds that are obtained from The International Affective Digitized Sounds Database 2, for 6 seconds per session (Bradley & Lang, 2007). The sounds were chosen from the highest and the lowest ranks and categorized as high pleasure, low pleasure, high arousal, and low arousal according to their pleasure and arousal points, which are stated in the database tech report. 7 individual sounds are presented in each category. The experiment was presented in a dark room by Lenovo Thinkpad Laptop with 1920 1080 screen, %80 screen brightness, and headphones %26 volume. Trial visuals consisted of a 4x4 matrix composed of numbers (1 to 7) and asterisks (*) in the places not occupied by numbers. The congruent trials (**Figure 3, A**) were the ones where the quantity of the numeric symbol is consistent with the presented number of that symbol (e.g. when there are two 2s, seven 7s), and the incongruent trials (**Figure 3, B**) were with the inconsistency (e.g. five 2s, four 7s).

***Figure 3**.*

A represents Visual of a Congruent Task, B represents Visual of an Incongruent Task

1.14.3 Psychophysics procedure

The current paradigm was aimed to observe and compare subjects' emotion and attention regulation skills. The experiment was created with a block design consisting of 112 trials, each having 3 different tasks (336 tasks in total), constituted by 8 conditions (2 visual conditions: congruent and incongruent x 4 audio conditions: high arousal, low arousal, high pleasure, low pleasure). Each sound was presented 4 times. The number of congruent and incongruent tasks and the number of every digit's (1 to 7) appearance are equalized (168 congruent and 168 incongruent tasks, where each digit is presented 48 times). In the task's first 2 seconds, participants only heard the sound which is played in random order, and were instructed to stare at the fixation point. After 2 seconds of sound listening; 3 unique tasks lasting 1 sec, separated by 0,5 sec breaks with fixation point appeared respectively on the screen. The participants were asked to respond to every task by pressing "C" for congruent and "M"' for incongruent on the keyboard. The participants attended the experiment individually. The instructions were displayed on the screen at the beginning of the experiment in written form, as well as explained by the experimenter before the procedure. Before the experiment, participants were practiced with 1 trial (3 tasks) without hearing the sounds. The experiment duration was approximately 12 minutes.

Figure 4.

Example Trial Sequences

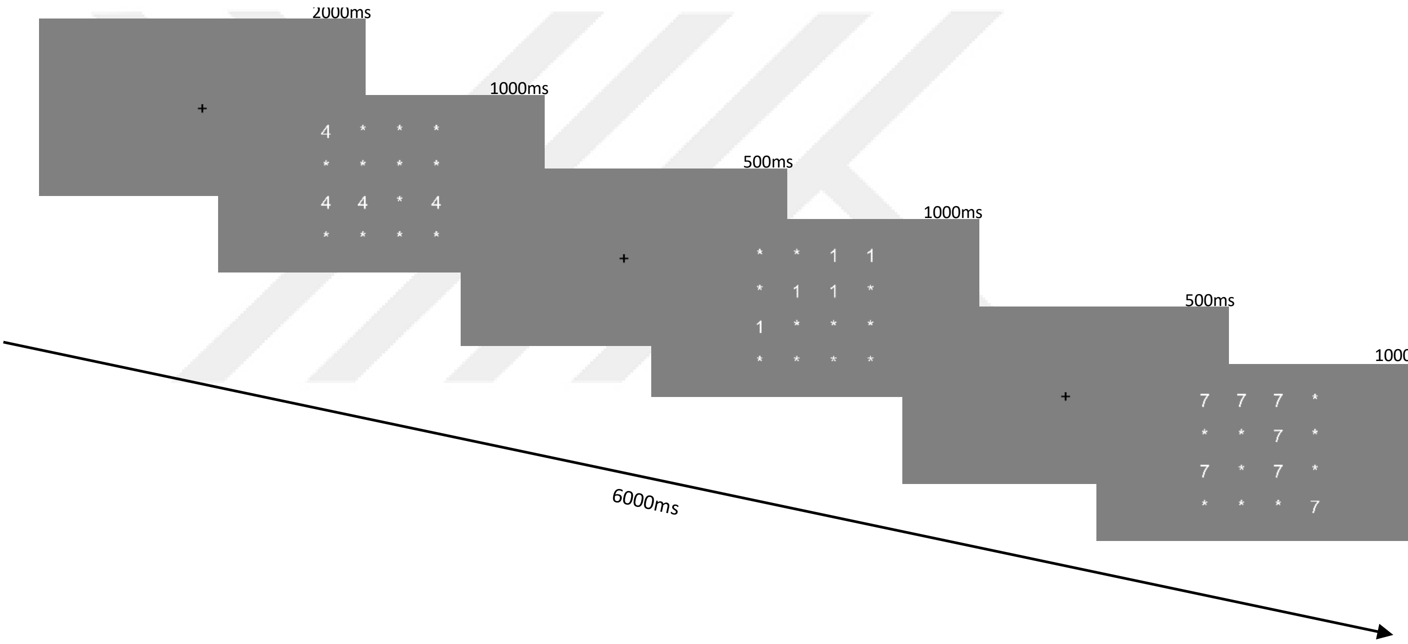


Fig 4. The experiment consisted of 112 trials, each had started with a black fixation cross for 2000 milliseconds followed by 3 randomly presented tasks (336 tasks in total) lasting 1000 milliseconds (congruent or incongruent) which are separated by screens with a black fixation cross for 500 milliseconds. Each trial started with a randomly played effective sound (high pleasure, low pleasure, high arousal, low arousal) along with the first fixation cross, and lasted for 6000milliseconds (the whole duration of each trial).

1.14.4 Behavioral data analysis

Analysis of psychophysics experiment conducted with IBM SPSS version 22 software. The study consisted of 2 x 4 design (congruent-high arousal, congruent-low arousal, congruent-high pleasure, congruent-low pleasure, incongruent-high arousal, incongruent-low arousal, incongruent-high pleasure, incongruent-low pleasure). Z-score was calculated for each trial's accuracy and RT data, no outliners were detected. Analysis of variance (ANOVA) was performed for dependent variables (Accuracy and RT) by independent variables (Congruency, Mode, Series, Digit, and Count) with alpha= .05.

1.14.5 Electropsychological data collection

20 of the participants' neural electrical activities were collected via Interaxon Inc.'s Muse 2 (RRID:SCR_014418) wireless EEG headset (**FIGURE 5**) during the psychophysics task and exported as CSV by Mind-Monitor app which was connected wirelessly to the headset by Bluetooth on iPhone7 (Apple, Inc.). The headset has 2 electrodes over the ears (TP9- TP10), 2 electrodes placed on the forehead (AF7 – AF8) and Fpz as the reference electrode. Data were sampled at 256 Hz and 60 Hz notch filtered while recording.

Figure 5

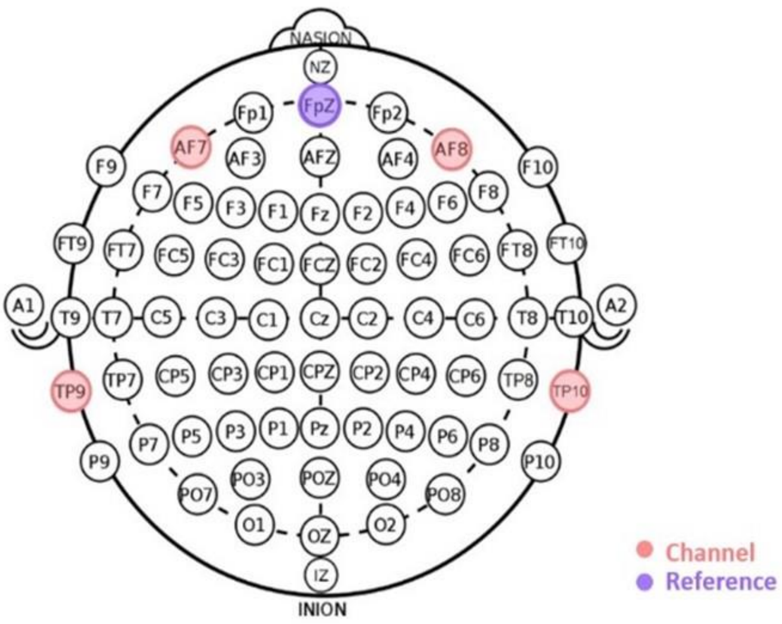
Muse 2 EEG Headset

1.14.6 Electropsychological data processing

Collected EEG data were preprocessed offline with EEGLab toolbox (Delorme & Makeig, 2004) running under MATLab (The Mathworks, Inc.). The data loaded and the channel locations were identified in accordance with the international 10-20 positioning system, as shown in **Figure 6,** by EEGLab's Muse extension. Bandpass filter was applied 1 Hz to 50 Hz and epoch baseline was removed. After conducting independent component analysis and artifact rejection, filtered continuous signals were epoched calculating 500ms before the onset and the latency of each task (1500ms in total) by identifying each event's condition. Finally, the signals were translated into frequency spectrum for each participant, each 4 electrode and each of the 8 conditions (congruent-incongruent x arousal high- arousal low- pleasure high – pleasure low) by applying Fast Fourier Transform to investigate the amplitude of the frequencies.

Figure 6

Muse 2 electrode locations by International 10-20 Positioning



1.14.7 Electropsychological data analysis

ANOVA and independent sample t-test was separately computed for power spectral density (PSD) of frequencies for each 8 conditions, each 5 frequency interval (theta, delta, alpha, beta and gamma) and each 2 region: frontal (AF7-AF8) and temporal (TP9-TP10) by using JASP with alpha= .05.

9. RESULTS

1.14.8 Accuracy analysis

The accuracy rate (%) analysis by ANOVA revealed there was a significant effect of meditation practice on accuracy rate, *meditation M = 72, SD = .45, control M = 56, SD = .50. Between subject /group analysis F (1, 10076) = 248. 55, p < .001, partial η2 = .002.* The tasks' congruency had a significant effect on accuracy rates of both groups, *meditation: congruent M= 67, SD = .47, incongruent M= 77, SD= .42; control: congruent M= 50, SD= .50, incongruent M = 65, SD= .65; F(1, 10076)= 170.19, p < .001, partial η2 = .002 .*

An interaction of group and congruency on accuracy was detected *F(1, 10076) = 7.63, p= .006, partial η2 = .001.*

The accuracy rate (%) analysis by independent t-test showed a significant effect of meditation practice on accuracy rate, as *the meditation group (M = 72, SD = .45)* responded more accurately than *the control group(M = 56, SD = .50),* t(5038) = 16.86, p < .001. The tasks' congruency had a significant effect on accuracy rate of the both groups. The meditation group responded *incongruent trials (M= 77, SD= .42)* more accurately than *congruent trials (M= 67, SD = .47)* t(5038) = 7.62, p < .001; and the control group answered *incongruent trials (M = 65, SD= .65)* more correctly than *congruent trials (M= 50, SD= .50),* t(5038) = 11.32, p < .001.

The analysis of variances revealed that there was no significant effect of sound category (mode) on accuracy rate (%) of groups (p= .85).

Figure 7

Congruency Effect on Accuracy Rates (%) of Groups

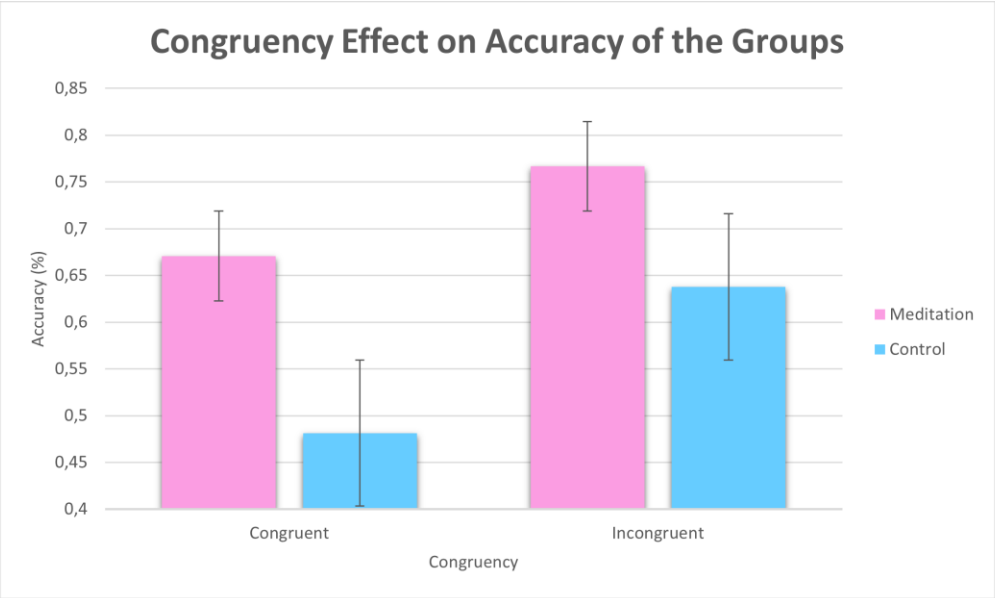
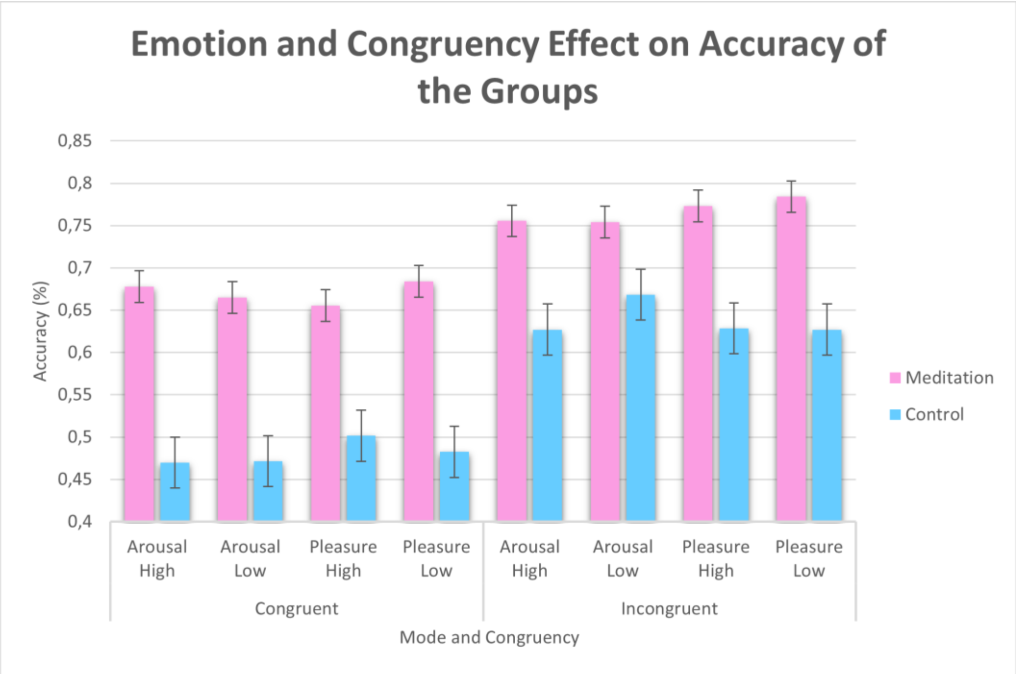


Figure 8

Emotion and Congruency Effect on Accuracy Rates (%) of Groups



1.14.9 Response time (rt) analysis

The response time (ms) analysis was conducted with ANOVA (4 x 2 conditions) and the results indicated that meditation has significant effect on reaction time (ms) of the participants, *control M = .74 SD = .15, meditation M = .71 SD = .13.* Between subject/group analysis *F(1, 7869)= 104.06, p < .001, partial η2 = .01*

The response time (ms) analysis by independent t-test was revealed that meditation had a significant effect on reaction time (ms) of the participants. The meditation group (*M = .71 SD = .13)* had lower response time than the control group (*M = .74 SD = .15),* t(7869)= 10.20, p < .001.

Figure 9

Congruency Effect on Reaction Time (ms) of Groups

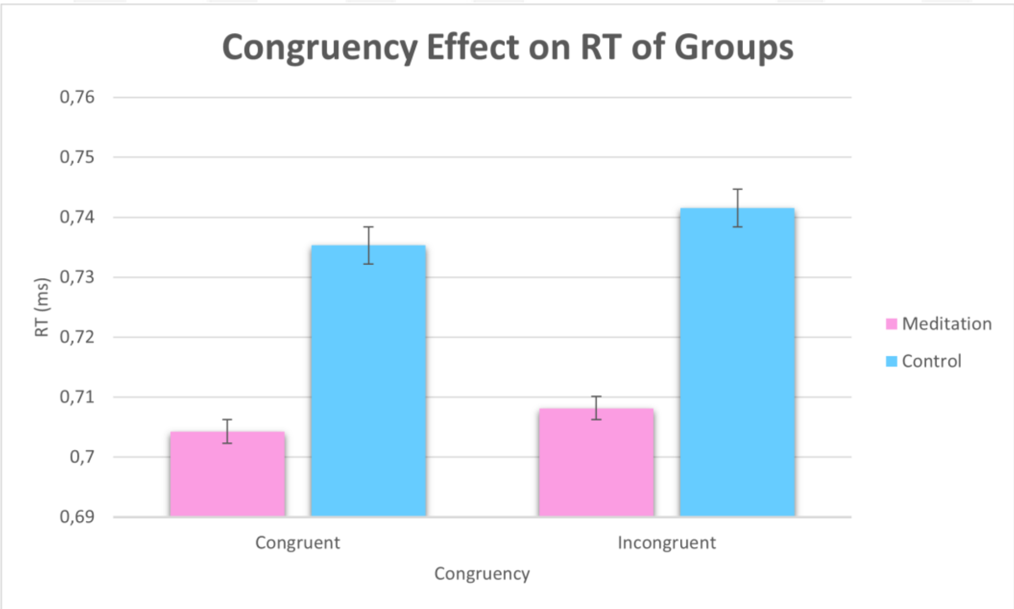
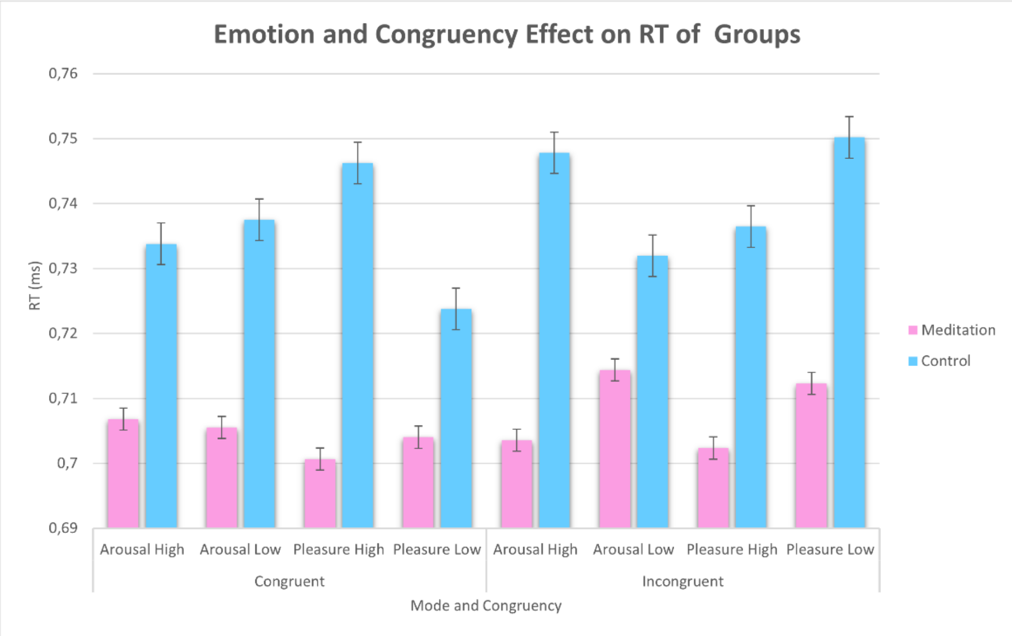


Figure 10.

Emotion and Congruency Effect on Reaction Time (ms)of Groups



However, the analysis showed no significant effect of congruency on reaction times (*p* = *.11).*

In addition, there was no significant effect of sound categories (mode) on RT *(p = .99).*

1.14.10 Exploratory analyses

As each trial consisted of 3 tasks, in order to see if the practice had affected the results, the order of the tasks was tagged as series (1,2,3) and ANOVA was conducted for accuracy. No significant effect was detected on the participants' accuracy rate (%) by the series(*p* = *.827*).

To investigate the differences between digits and their presented number's effect the accuracy rate (%), the symbol of the number was labeled as "Digit" and the amount of the presented digit was labeled as "Count". ANOVA indicated that digit and count had significant effect on the accuracy rate (%); digit *F(6,10073) = 52.425, p= .00, partial η2 = .030* and count *F(6,10073) = 63.827, p= .00, partial* η^2 *= .037*. Digit and count joint analysis *F(36,10031) = 16.890, p= .00, partial* η^2 *= .057*.

There was no significant effect between accuracy of groups when analyzed by digit *(p = .157)* and count (*p = .060*).

Figure 11.

Accuracy Rate (%) by Digit

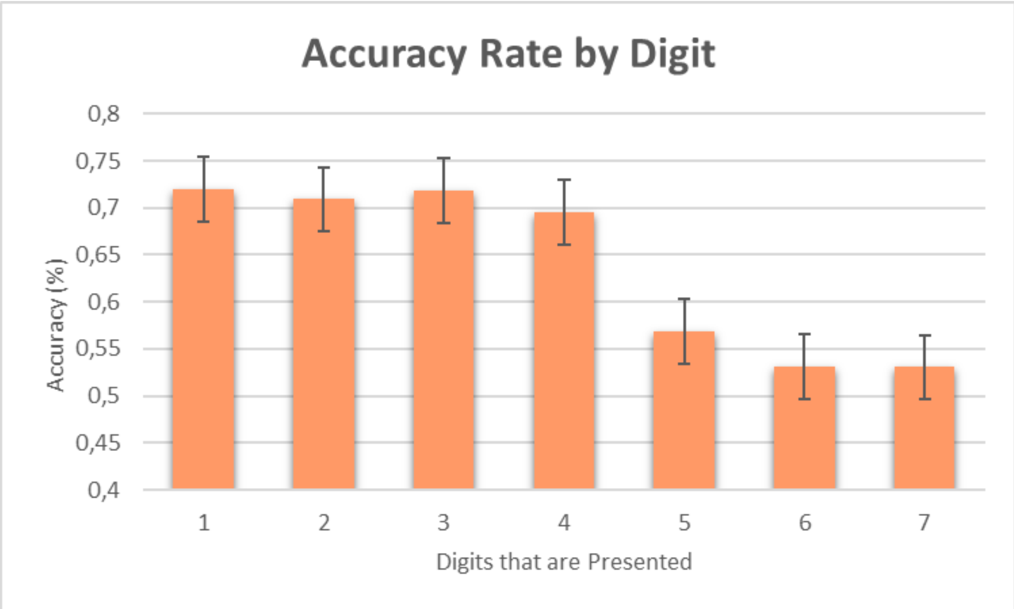
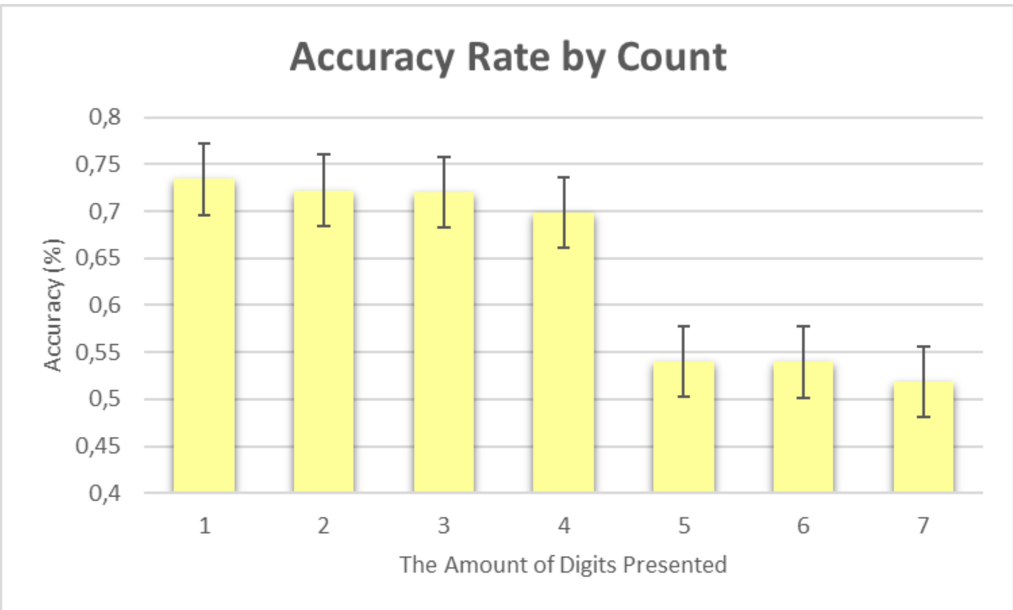


Figure 12

Accuracy Rate by Count



In addition, the results revealed that digit and count have significant effect on RT(ms); digit *F(6,7864) = 15.606, p = .00, partial* η^2 *= .012*, count *F(6,7864) = 12.988, p = .00, partial* η^2 *= .021*. Digit x count together have significant effect F(36,7822)= 3.007, p= .00, partial η^2 = .014.

Conducting ANOVA for group x digit and group x count, revealed that meditation group responded faster with less reaction time *F(6,7857) = 6.203, p = .00, partial η2 = .005* and *F(6,7857)= 2.420, p = .024, partial* η^2 *= .002* respectively. Group x Digit x Count *F(36,7773) = 1.492, p = .03, partial* η^2 *= .007*

Figure 13

Count's Effect on Reaction Time (ms)of Groups

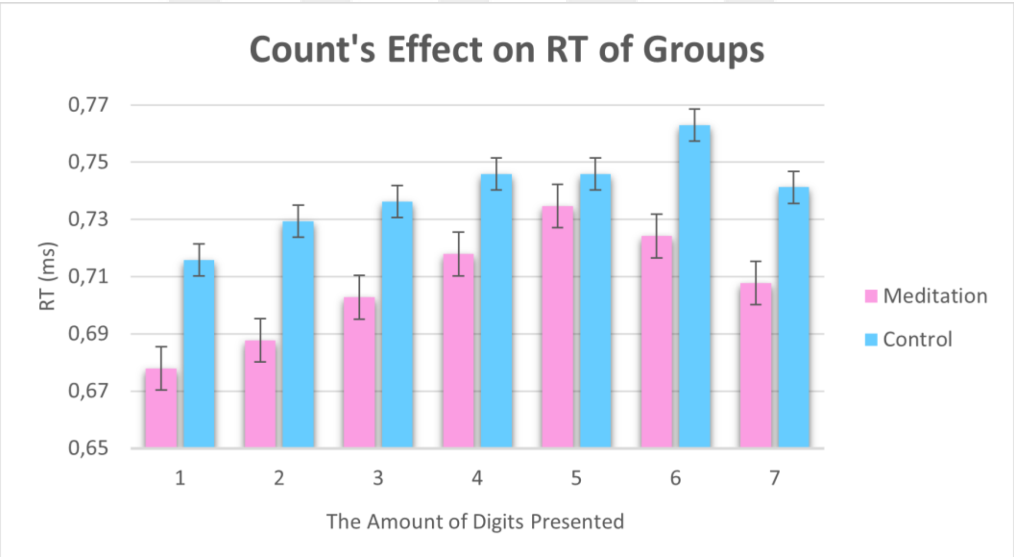
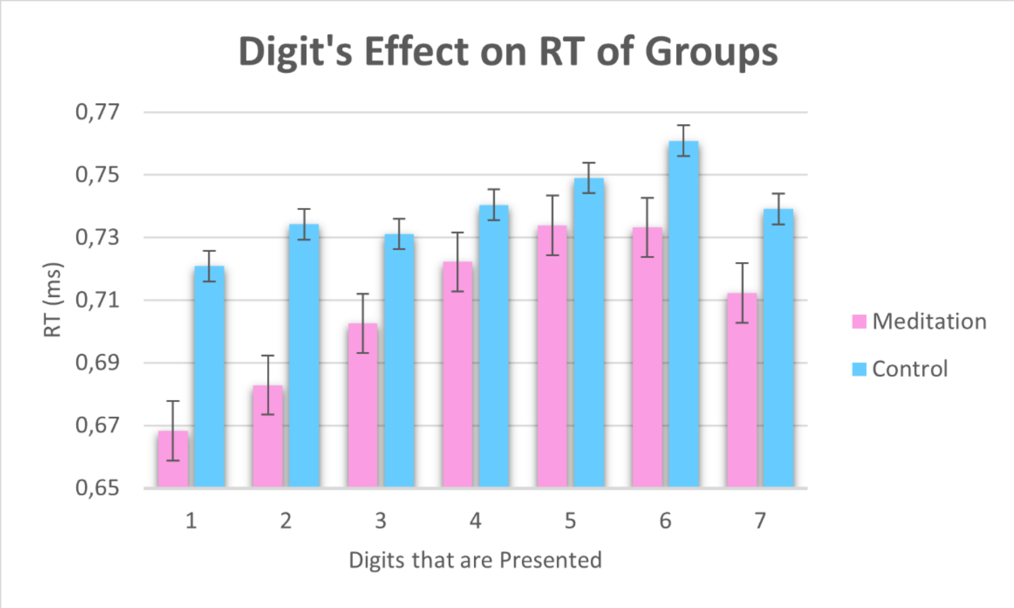


Figure 14.

Digit's Effect on Reaction Time(ms)of groups



1.14.11 Results of Electropsychological Data Analysis

1.14.11.1 Congruency Effect on Oscillations of Groups

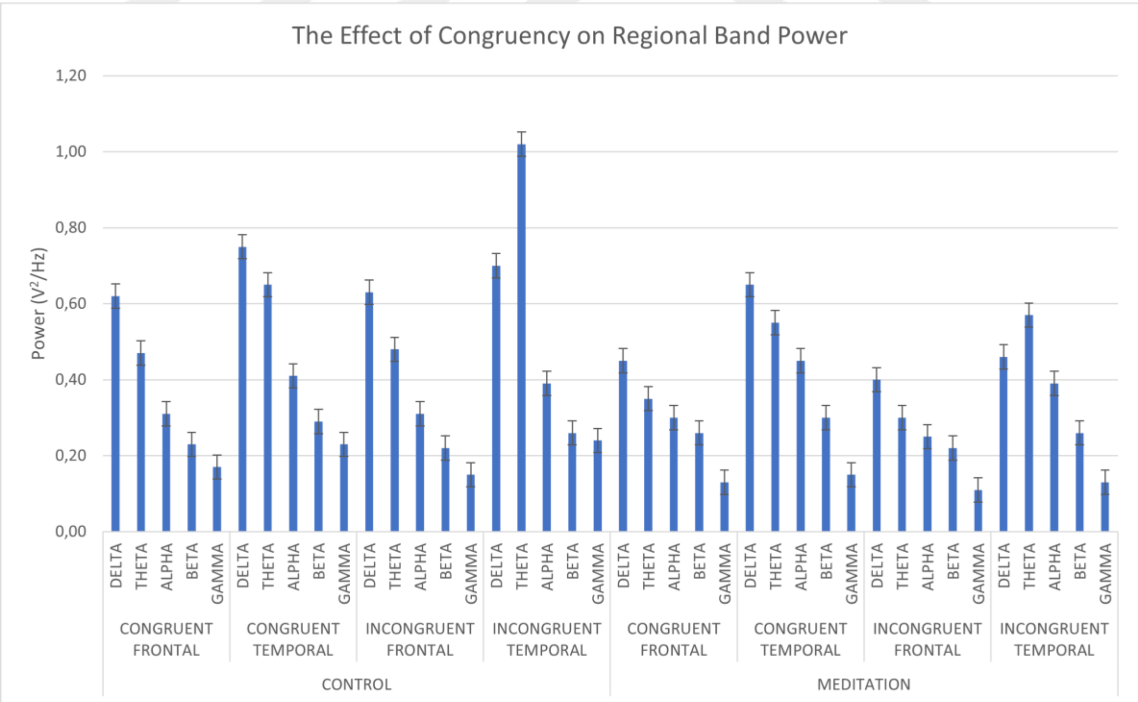
In order to see how congruency effected frontal region activity, we conducted independent sample t-test for the frequency band power of the groups during congruent and incongruent trials. The results revealed that participants generated higher activations in frontal regions during congruent trials *(M= .25, SD= .36)*than incongruent trials *(M= .23, SD= .35) t(319219)= 18.31, p< .001, d= .07.*

To investigate the effect of congruency between groups and regions (frontal-temporal), we conducted independent sample t-test for all region congruency combinations (congruent frontal, congruent temporal, incongruent frontal and incongruent temporal). During congruent trials, in frontal region, the mean power *(V^2/Hz)* of *control group (M= .26, SD= .40)* was significantly higher than *meditation* *practitioners (M= .23, SD= .29)*, t(142543)= 13.38, p< .001, d= .07. Temporal region (TP9, TP10) activation during congruent trials was also significantly higher in *control group (M= .34, SD= .54)* than *meditation group (M= .30, SD= .32)*, t(143027) = 12.70, p< .001, d= .07.

When we observe the activation during incongruent trials in frontal region (AF7, AF8), *control group's (M= .25, S= .41)* mean power was significantly greater than *meditation group (M= .20, S= .24)*, t(176674)= 31.15, p < .001, d= .15. And, *control group (M= .35, SD= .68)* generated higher power in all frequencies than meditators *(M= .26, SD = .28)*, t(177183)= 32.25) , p< .001, d= .15 in temporal region. The effect of congruency on regional band power of the groups can be seen on **Figure 15.**

Figure 15

The Effect of Congruency on Regional Band Power



1.14.11.2 Effect of Emotionally Triggering Sounds on Oscillations of Groups

To investigate sounds' effect in limbic regions, we ran independent sample t-tests with the data gathered from temporal channels (TP9 and TP10) for each the sound category. When the participants were hearing sounds in arousal high category, the mean power of *control group (M= .35, SD= .53)* was higher than *meditation group (M= .26, SD= .26)*, t(80882)= 30.81, p < .001; d= 0.22. While hearing arousal low sounds, the *control group (M= .32, SD= .54)* generated higher activation than the meditation group *(M= .31, SD= .33)*, t(77084)= 2.49, p= .001; d= .02. The activation of control group during *pleasure high (M= .33, SD= .54)* and *pleasure low (M= .31, SD= .49)* was higher than meditation group's power during *pleasure high (M= .28, SD= .31)* and *pleasure low (M= .27, SD= .29)* sound conditions; *plasure high* t(80766) = 14.39, p< .001, d= .10; *pleasure low* t(80947)= 11.14, p< .001, d= .08.

The graph showing the effect of emotion on temporal band power of groups is shown on **Figure 16**. The frequency power of groups in frontal region with each sound can be found on **Table 1.**

Figure 16

Effect of Emotion on Temporal Band Power

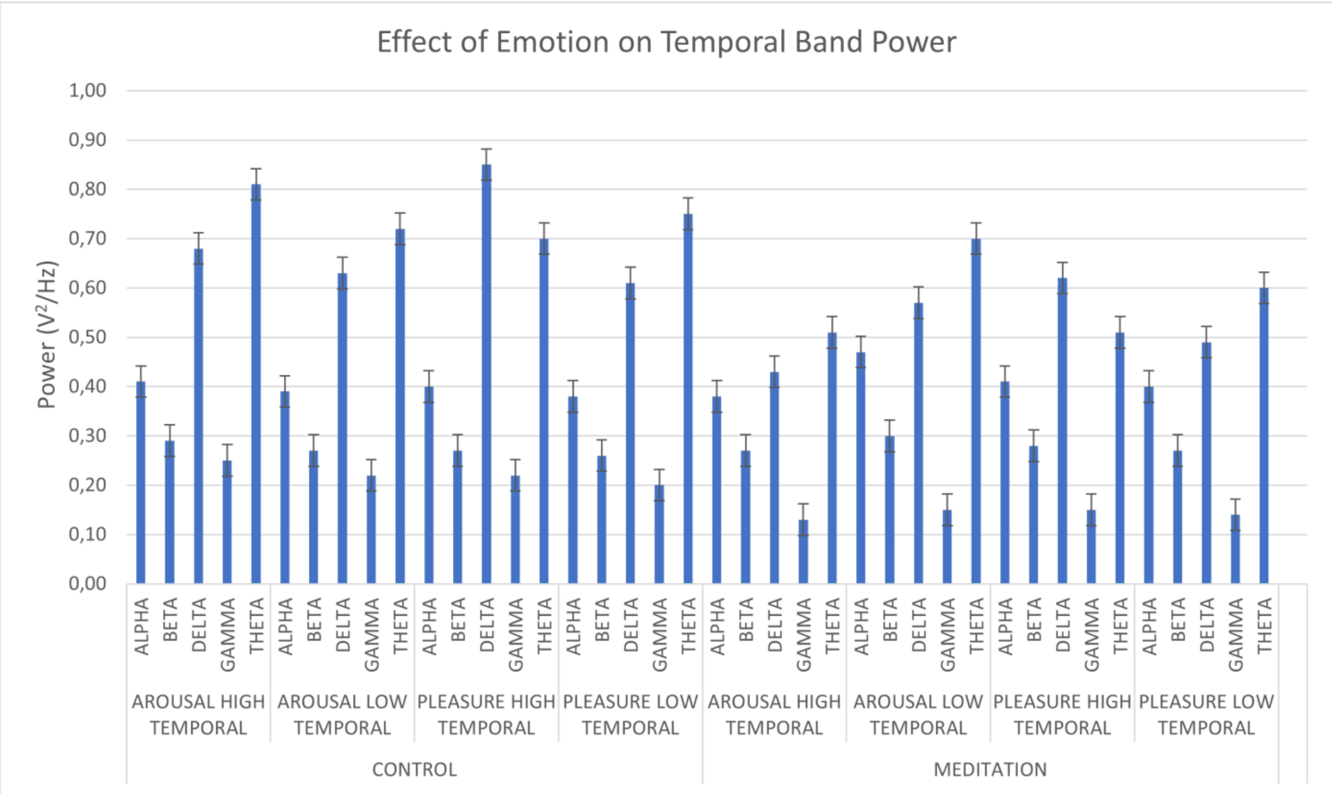


Table 1.

Frontal region power(V^2/Hz) of groups according to the different sounds.

Independent Samples T-Test

	t	df	p	Cohen's d
AROUSAL HIGH FRONTAL	22.68	80387	< .001	0.16
AROUSAL LOW FRONTAL	9.05	77097	< .001	0.07
PLEASURE HIGH FRONTAL	25.29	80493	< .001	0.18
PLEASURE LOW FRONTAL	5.61	80808	< .001	0.04

Group Descriptives

	Group	N	Mean	SD	SE
AROUSAL HIGH FRONTAL	CONTROL	44949	0.24	0.33	1.56e-3
	MEDITATION	35440	0.20	0.25	1.31e-3
AROUSAL LOW FRONTAL	CONTROL	47202	0.25	0.42	1.93e-3
	MEDITATION	29897	0.23	0.26	1.53e-3
PLEASURE HIGH FRONTAL	CONTROL	46490	0.28	0.48	2.21e-3
	MEDITATION	34005	0.21	0.25	1.36e-3
PLEASURE LOW FRONTAL	CONTROL	47656	0.22	0.32	1.45e-3
	MEDITATION	33154	0.21	0.23	1.28e-3

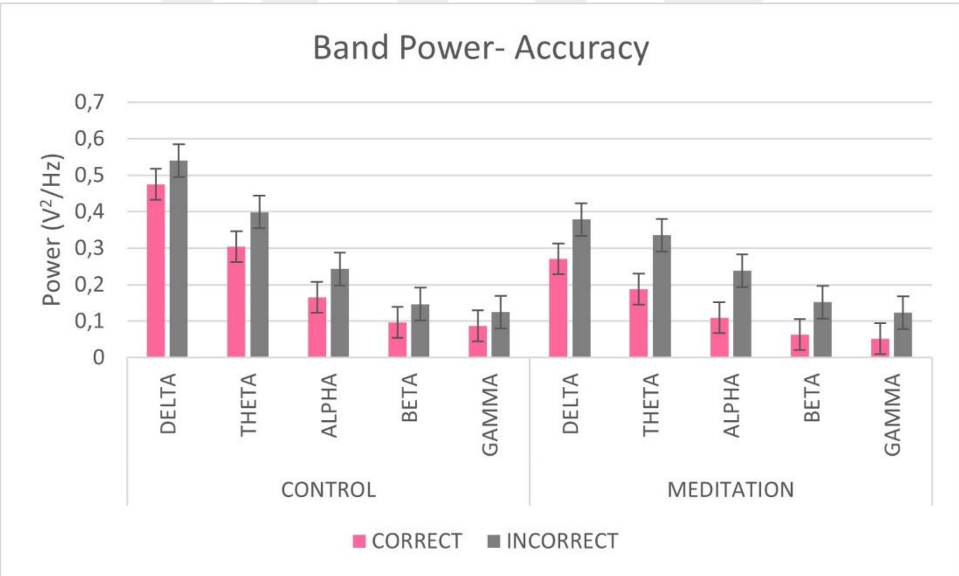
1.14.11.3 Band Power Differences of Groups in Correct and Incorrect Trials

In order to observe if there is any differences between the group's frequency power, we ran independent sample t-test for each frequency band in correct and incorrect trials on **Table 2**. Mean band power of groups for each band during correct and incorrect trials are shown on **Figure 17**.

Table 2.
Band power (V^2/Hz) of each band during correct and incorrect trials.

	t	df	p	Cohen's d	Control		Meditation	
					Mean	SD	Mean	SD
CORRECT DELTA	82.73	72275	< .001	0.62	0.48	0.42	0.27	0.23
INCORRECT DELTA	36.45	31405	< .001	0.42	0.54	0.44	0.38	0.25
CORRECT THETA	73.71	102129	< .001	0.46	0.30	0.32	0.19	0.17
INCORRECT THETA	20.20	47353	< .001	0.19	0.40	0.38	0.34	0.24
CORRECT ALPHA	73.23	129654	< .001	0.41	0.17	0.18	0.11	0.09
INCORRECT ALPHA	2.95	63355	3.18e-3	0.02	0.24	0.25	0.24	0.19
CORRECT BETA	139.03	492643	< .001	0.40	0.10	0.11	0.06	0.04
INCORRECT BETA	-8.62	243578	< .001	-0.04	0.15	0.17	0.15	0.11
CORRECT GAMMA	113.53	465759	< .001	0.33	0.09	0.14	0.05	0.05
INCORRECT GAMMA	1.75	236727	0.08	7.35e-3	0.12	0.18	0.12	0.11

Figure 17.
Band power (V^2/Hz) of groups for each band during correct and incorrect trials.

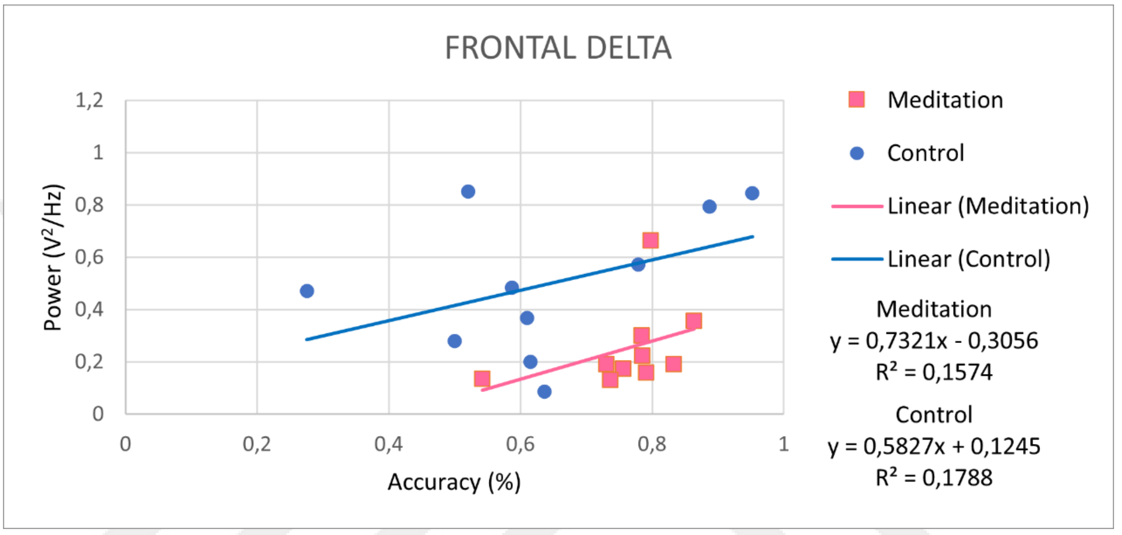


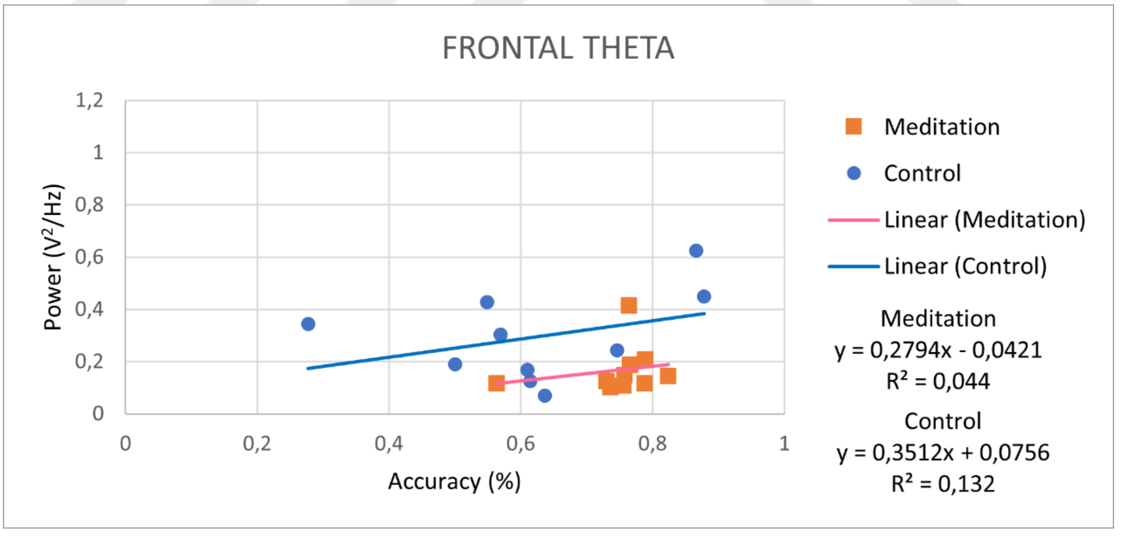
1.14.11.4 Band Power – Accuracy Correlation

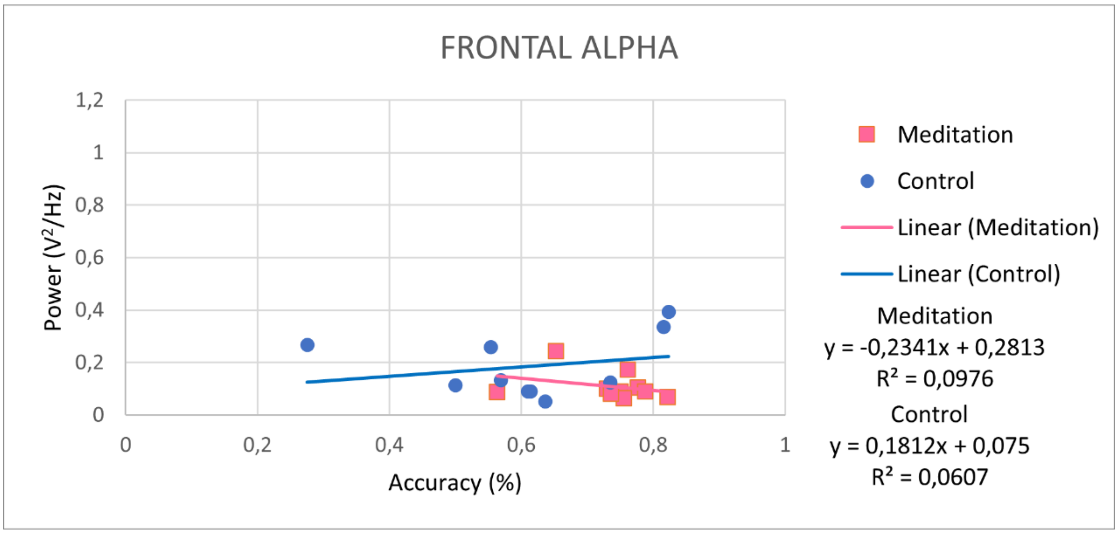
When we analyzed accuracy power correlation (Pearson's) for each frequency band and region for the participants by their groups, we did not observe any significant linear correlation between the band frequency power and accuracy of the participants. Our results reveal a strong positive correlation trendline with no significance between the *temporal delta power* r(8) = 0.58, p> .05; temporal theta power r(8) = 0.59, p > .05; temporal alpha power r(8) = 0.56, p> .05 and accuracy, and a strong negative correlation trendline with no significance between *frontal beta* and accuracy of meditation practitioners r(8) = 0.54, p> .05. The scatter plot of each band power of the groups can be found in **Figure 18.**

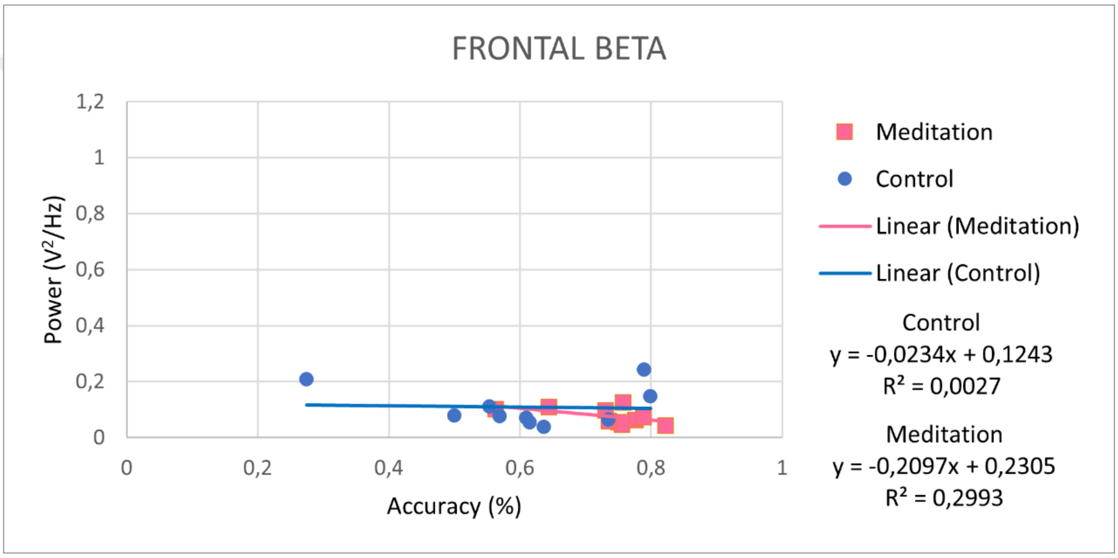
Figure 18

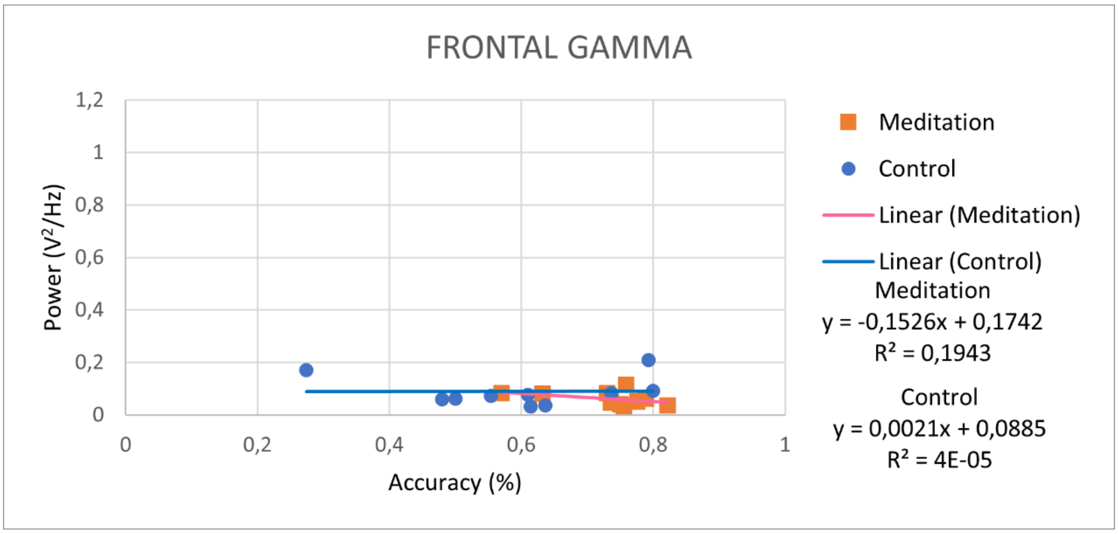
Regional band power - accuracy correlation graphs of groups.

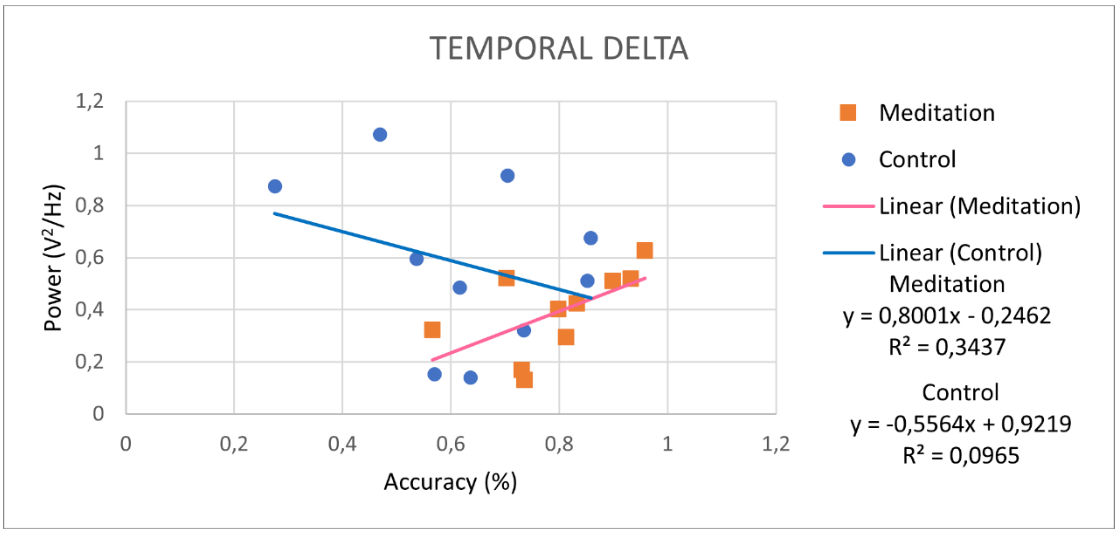


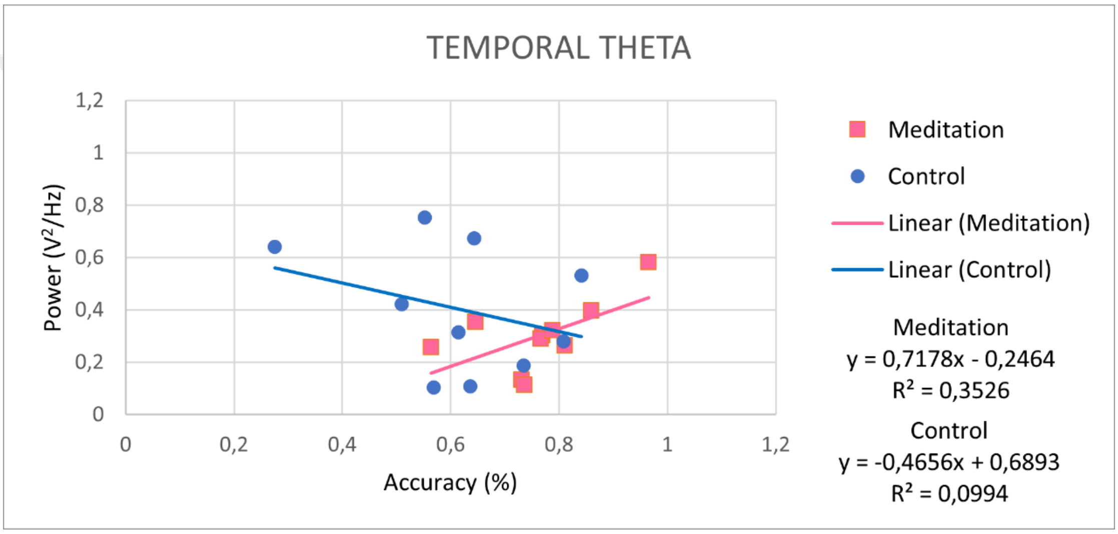


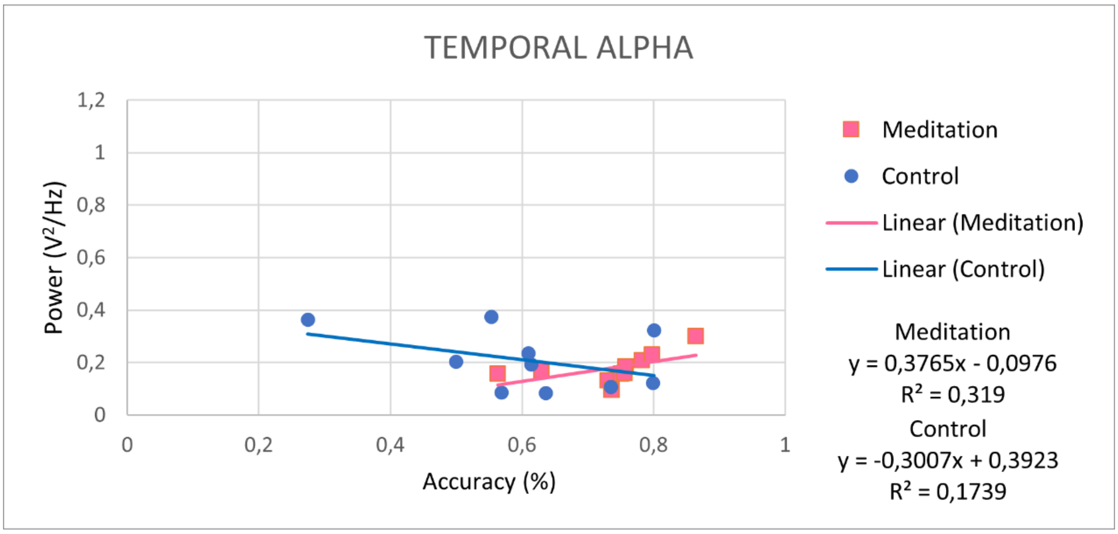

FRONTAL ALPHA
1,2
1
0,8
0,6
0,4
0,2
0
Power (V²/Hz)
0
0,2
0,4
0,6
0,8
1
Accuracy (%)
Meditation
Control
Linear (Meditation)
Linear (Control)
Meditation
y = -0,2341x + 0,2813
R² = 0,0976
Control
y = 0,1812x + 0,075
R² = 0,0607

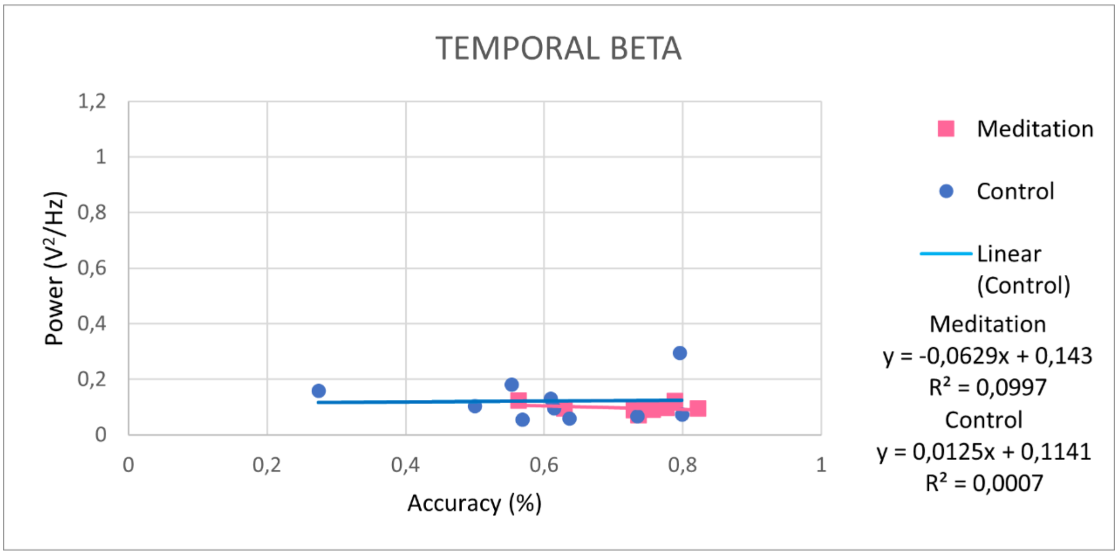

FRONTAL BETA
1,2
1
0,8
0,6
0,4
0,2
0
Power (V²/Hz)
0
0,2
0,4
0,6
0,8
1
Accuracy (%)
Meditation
Control
Linear (Meditation)
Linear (Control)
Control
y = -0,0234x + 0,1243
R² = 0,0027
Meditation
y = -0,2097x + 0,2305
R² = 0,2993

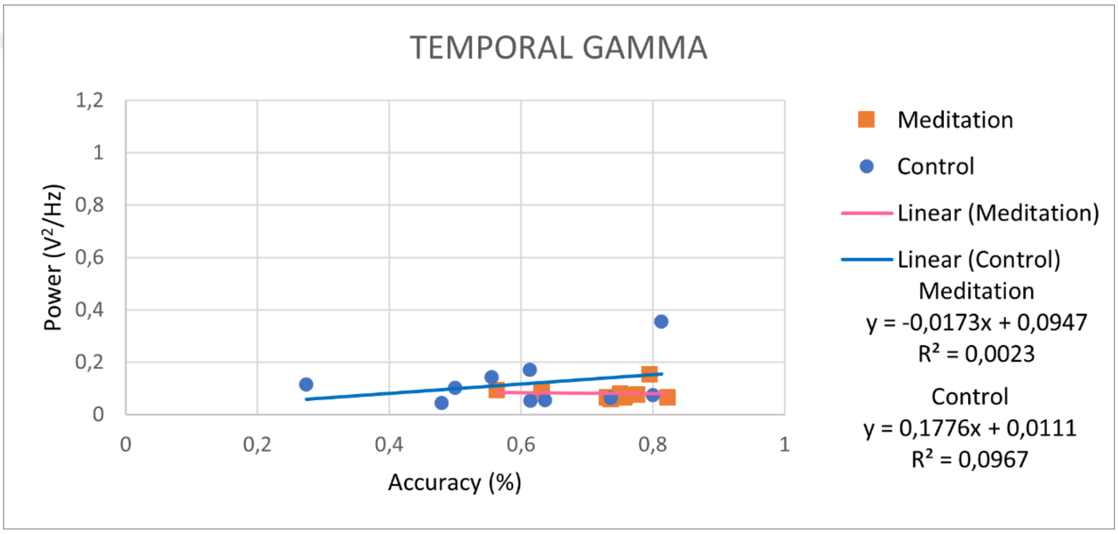

FRONTAL GAMMA
1,2
1
0,8
0,6
0,4
0,2
0
Power (V²/Hz)
0
0,2
0,4
0,6
0,8
1
Accuracy (%)
Meditation
Control
Linear (Meditation)
Linear (Control)
Meditation
y = -0,1526x + 0,1742
R² = 0,1943
Control
y = 0,0021x + 0,0885
R² = 4E-05


TEMPORAL DELTA
Power (V²/Hz)
1,2
1
0,8
0,6
0,4
0,2
0
0
0,2
0,4
0,6
0,8
1
1,2
Accuracy (%)
Meditation
Control
Linear (Meditation)
Linear (Control)
Meditation
y = 0,8001x - 0,2462
R² = 0,3437
Control
y = -0,5564x + 0,9219
R² = 0,0965


TEMPORAL THETA
Power (V²/Hz)
1,2
1
0,8
0,6
0,4
0,2
0
0
0,2
0,4
0,6
0,8
1
1,2
Accuracy (%)
Meditation
Control
Linear (Meditation)
Linear (Control)
Meditation
y = 0,7178x - 0,2464
R² = 0,3526
Control
y = -0,4656x + 0,6893
R² = 0,0994


TEMPORAL ALPHA
Power (V²/Hz)
1,2
1
0,8
0,6
0,4
0,2
0
0
0,2
0,4
0,6
0,8
1
Accuracy (%)
Meditation
Control
Linear (Meditation)
Linear (Control)
Meditation
y = 0,3765x - 0,0976
R² = 0,319
Control
y = -0,3007x + 0,3923
R² = 0,1739


TEMPORAL BETA
1,2
1
0,8
0,6
0,4
0,2
0
Power (V²/Hz)
0
0,2
0,4
0,6
0,8
1
Accuracy (%)
Meditation
Control
Linear (Control)
Meditation
y = -0,0629x + 0,143
R² = 0,0997
Control
y = 0,0125x + 0,1141
R² = 0,0007


TEMPORAL GAMMA
1,2
1
0,8
0,6
0,4
0,2
0
Power (V²/Hz)
0
0,2
0,4
0,6
0,8
1
Accuracy (%)
Meditation
Control
Linear (Meditation)
Linear (Control)
Meditation
y = -0,0173x + 0,0947
R² = 0,0023
Control
y = 0,1776x + 0,0111
R² = 0,0967

10. DISCUSSION

In this study, we investigated if the meditation practitioners are more successful at detaching from unwanted stimuli and the potential reaction it might arise, hence regulating emotion. In order to do that, we conducted a psychophysics experiment which consists of the number counting Stroop test while playing emotionally triggering sounds and recorded the electrophysiological activities of the participants. The participants were expected to detach from the triggering auditory stimuli and keep their attention on the task which also induces a high cognitive load. Both the behavioral and electrophysiological results showed that meditation has a significant effect on an individual's attentional control in the face of cognitively demanding situations. As we hypothesized, the meditation practitioners performed with a higher accuracy rate and lower reaction time when compared to the meditation naïve participants, also the EEG analysis indicated that meditation practitioners generate lower gamma activation in both regions compared to the control group. In line with previous studies, which investigated meditators' attentional control by behavioral tasks such as Stroop (Classic, emotional, counting), visual attention tasks (change blindness, perspective-shifting, sustained attention) combined with EEG or fMRI (Hodgins & Adair, 2010; Kozasa et al., 2012; Moore et al., 2012), as well as studies investigating attentional systems by neuroimaging while participants were meditating as well as long term plasticity effect of meditation on the attentional system (Brefczynski-Lewis et al., 2007; Hölzel et al., 2007; Malinowski, 2013) our results revealed that meditation increases attentional control and enhance performance in cognitive tasks which provides less cognitive effort requirement, hence less gamma power activation in the frontal region.

In addition, our results confirmed that the task's congruency status affects accuracy since both groups (meditation and control) detected incongruent tasks more accurately when compared to congruent tasks. Not always the higher accuracy rate in incongruent tasks is the case since Adam Moore and his colleagues observed higher accuracy in congruent tasks in their study (Moore et al., 2012). As expected, the meditation group had a higher accuracy rate both in congruent and incongruent tasks. When we investigated neural activities of both groups by comparing congruency conditions, we observed that congruent conditions generated higher beta and gamma power both in frontal and temporal regions (temporal activation was even higher than frontal) which might be interpreted as the participants found the cognitive tasks harder to answer and they created the stress we intended.

On the other hand, our behavioral results indicated any impact of the emotionally triggering sounds that were acquired from International Effective Sound Database 2 (Bradley & Lang, 2007) on the accuracy and reaction time of the participants, whether the task was congruent or incongruent. The behavioral results reminded us of the debated question below.

Does Cognitive Load Inhibit Emotion Processing?

Tasks with high cognitive load have the possibility to prevent participants' from being emotionally triggered. The cognitive load- emotion research have mainly two lines, one mentioning that cognitive load decreases negative emotional feelings because of the working memory resource allocation (Van Dillen et al., 2009); whereas another view suggests that working memory performs domain-specific so it is possible to maintain current emotional state along with cognitive load (Mikels et al., 2008).

Van Dillen and Koole conducted a study where the participants categorize the genders of the people in the images and observed that while there's no cognitive loading task; the participants responded slower to angry faces compared to happy faces; on the other hand, when the participants were performing a digit task which induces working memory load; no deceleration in reaction time observed in angry faces (Van Dillen & Derks, 2012). In order to investigate these two views and test the hypothesis that: the intensity of the emotions which are generated in working memory can be maintained if prioritized, even in the face of ongoing tasks demand resources; on the other hang if maintaining the emotion is not prioritized, the intensity decreases; DeFrain conducted a study by asking one group of participants to view negative emotional pictures passively and the other group expected to sustain the emotions that are generated by the images, then, both groups performed a math task to stimulate cognitive load and rated the emotional intensity.

The study resulted with the observation that, the intensity of the emotions lessened after the math task in the passive viewer group; whereas the group who was instructed to maintain the emotion had the same amount of emotion after the math task (DeFraine, 2016). Supporting the view of Van Dillen and Koole by showing that as the cognitive load increases, the emotional density decreases (Van Dillen et al., 2009; Van Dillen & Derks, 2012).

Neuroimaging studies have demonstrated that activity in regions related to emotional processing, such as the amygdala and orbitofrontal cortex, ventral striatum are decreased with a high cognitive load while the difficulty of the task was positively correlated with the activity in CEN, especially PFC (DeFraine, 2016; Erk et al., 2007; Kellermann et al., 2012).

In addition, performing tasks -such as EMDR eye movements, drawing, auditory shadowing, holding numbers in mind, tapping- during recalling unpleasant memories are suggested to decrease the “vividness, emotionality, and completeness of those memories” since these activities engage in the attentional resources that might have been directed to the trauma. The researchers explain the process as being in a detached perspective from the traumatizing memories (Gunter & Bodner, 2008).

When we investigate our EEG analyses, the emotional triggering was not inhibited by cognitive load since the beta and gamma power was observed to be the highest in arousal high condition in the temporal region of control group, the group which we expected to be affected by the sounds, when compared to the other three affective sounds we used in the experiment. Also, the gamma and beta oscillation of the control group in temporal region was higher than the frontal region in all sound types which can be interpreted as the sounds generated emotional processing. When we compared meditation and control group in terms of gamma oscillations, the meditation group showed lower activation both in temporal and frontal regions during all 4 affective sounds which support our hypothesis in increased detachment ability of meditation practitioners.

We also wanted to see if there is any correlation between the regional band power and accuracy rate of the participants. Although we could observe some strong positive and negative trendlines, we could not find any significance which can be interpreted as the disadvantage of having a small sample size in the experiment.

11. CONCLUSION

This study investigated meditation practice's benefits in terms of attentional control, emotion regulation especially detachment capacity from unwanted emotional triggers in order to maintain goal-oriented behavior. To do so, we asked participants to respond to the tasks as congruent or incongruent according to the consistency of the visualized numeric symbol's quantity and the displayed number, while recording their electrophysiological activities; expected them to detach from the emotions that are generated by triggering sounds. Limiting the duration of the tasks for 1 second was also intended to create additional cognitive load by forcing the participants to comprehend and respond faster while regulating their emotions.

Since the meditation research points out ACC as the common active region during all kinds of meditation practices, whereas ACC is at the center of the attentional processes; it is highly reasonable to expect meditation practitioners to maintain their attention in the face of internal and external distractions. Hence, our findings in both psychophysics and electrophysiological studies have shown that meditation practices enhance the attentional skills of individuals. When compared to the control group, meditation practitioners were more capable of preserving attention and achieving higher scores by responding faster to the tasks that induce cognitive load, while generating lower gamma power in frontal regions.

Although the behavioral results did not fulfill our expectations about the emotion regulation ability of meditation practitioners in this study, the electrophysiological results revealed an underlying activation because of the emotional triggers. Meditation practitioners were observed to regulate their emotions by showing less activation in temporal area, while the results also revealed that the tasks required the practitioners make less effort for focusing in the face of cognitive demanding tasks.

Hence, current study clearly supported the view that meditation has positive effect on the attentional stability as well as detachment ability (Brefczynski-Lewis et al., 2007).

1.15 Limitations

One of the main confounding factors in meditation research with psychophysical methods is the evaluating efficiency of meditation practice of the participants. Researchers still looking for the answer to “Is there a way to evaluate how well someone is meditating beyond their lifetime practice hours or daily practice time?” (Brandmeyer et al., 2019). There are models that have been developed in order to assess individuals’ practice efficiency by using EEG, respiration, or fMRI however, the subject is still in progress (Ahani et al., 2014; Davidson & Lutz, 2008; Dickenson et al., 2013; Hasenkamp et al., 2012; Hasenkamp & Barsalou, 2012; Schoenberg & Vago, 2019). The time has spent meditation daily or lifetime needed to be tracked by practitioners since the neural alterations and performance in attention tasks vary, depending on experience (Cahn & Polich, 2006; Davidson & Lutz, 2008). Clearing and well defining the indistinct area between types of meditation practices will advance the research field of meditation. In addition, having a small sample size in our study kept us from having robust results.

1.16 Future Studies

Results of the current experiment revealed meditation’s effect on attention and emotion regulation capacity. For further investigation, the paradigm can be modified by adding neutral sessions where it becomes possible to compare with the trials with emotional triggers. Increasing the sample size is essential. Furthermore, in order to overcome the low sensitivity issue of psychophysical studies, the advantage of neuroimaging techniques with fMRI, fNIRS or extensive electrophysiological monitoring should be taken to reveal deeper neural signatures of attention and emotion regulation.

REFERENCES

Abdelrahman, Y., Khan, A. A., Newn, J., Velloso, E., Safwat, S. A., Bailey, J., Bulling, A., Vetere, F., & Schmidt, A. (2019). Classifying Attention Types with Thermal Imaging and Eye Tracking. *Proceedings of the ACM on Interactive, Mobile, Wearable and Ubiquitous Technologies*, *3*(3), 1–27. https://doi.org/10.1145/3351227

Ahani, A., Wahbeh, H., Nezamfar, H., Miller, M., Erdogmus, D., & Oken, B. (2014). Quantitative change of EEG and respiration signals during mindfulness meditation. *Journal of NeuroEngineering and Rehabilitation*, *11*(1), 87. https://doi.org/10.1186/1743-0003-11-87

Alper, K. R., John, E. R., Brodie, J., Günther, W., Daruwala, R., & Prichep, L. S. (2006). Correlation of PET and qEEG in normal subjects. *Psychiatry Research: Neuroimaging*, *146*(3), 271–282. https://doi.org/10.1016/J.PSCYCHRESNS.2005.06.008

Baijal, S., & Srinivasan, N. (2010). Theta activity and meditative states: Spectral changes during concentrative meditation. *Cognitive Processing*, *11*(1), 31–38. https://doi.org/10.1007/s10339-009-0272-0

Bieling, P. J., Hawley, L. L., Bloch, R. T., Corcoran, K. M., Levitan, R. D., Trevor Young, L., MacQueen, G. M., & Segal, Z. V. (2012). Treatment-specific changes in decentering following mindfulness-based cognitive therapy versus antidepressant medication or placebo for prevention of depressive relapse. *Journal of Consulting and Clinical Psychology*, *80*(3), 365–372. https://doi.org/10.1037/a0027483

Bishop, S. R. (2004). Mindfulness: A Proposed Operational Definition. *Clinical*

Psychology: Science and Practice, *11*(3), 230–241. https://doi.org/10.1093/clipsy/bph077

Blair, K. S., Smith, B. W., Mitchell, D. G. V., Morton, J., Vythilingam, M., Pessoa, L., Fridberg, D., Zametkin, A., Sturman, D., Nelson, E. E., Drevets, W. C., Pine, D. S., Martin, A., & Blair, R. J. R. (2007). Modulation of emotion by cognition and cognition by emotion. *NeuroImage*, *35*(1), 430–440. https://doi.org/10.1016/j.neuroimage.2006.11.048

Braboszcz, C., Rael Cahn, B., Levy, J., Fernandez, M., & Delorme, A. (2017). Increased gamma brainwave amplitude compared to control in three different meditation traditions. *PLoS ONE*, *12*(1), 1–27. https://doi.org/10.1371/journal.pone.0170647

Bradley, M. M., & Lang, P. J. (2007). The International Affective Digitized Sounds (2nd Edition; IADS-2): Affective ratings of sounds and instruction manual. Technical report B-3. *Technical Report B-3*.

Brandmeyer, T., Delorme, A., & Wahbeh, H. (2019). The neuroscience of meditation: classification, phenomenology, correlates, and mechanisms. *Progress in Brain Research*, *244*, 1–29. https://doi.org/10.1016/bs.pbr.2018.10.020

Brefczynski-Lewis, J. A., Lutz, A., Schaefer, H. S., Levinson, D. B., & Davidson, R. J. (2007). Neural correlates of attentional expertise in long-term meditation practitioners. *Proceedings of the National Academy of Sciences*, *104*(27), 11483–11488. https://doi.org/10.1073/pnas.0606552104

Bressler, S. L., & Menon, V. (2010). Large-scale brain networks in cognition: emerging methods and principles. *Trends in Cognitive Sciences*, *14*(6), 277–290. https://doi.org/10.1016/j.tics.2010.04.004

Brewer, J. A., Worhunsky, P. D., Gray, J. R., Tang, Y.-Y., Weber, J., & Kober, H. (2011). Meditation experience is associated with differences in default mode network activity and connectivity. *Proceedings of the National Academy of Sciences*, *108*(50), 20254–20259. https://doi.org/10.1073/pnas.1112029108

Buddharakkhita, A. (1989). *METTA The Philosophy and Practice of Universal Love*.

Buhle, J. T., Silvers, J. A., Wager, Tor D., Lopez, R., Onyemekwu, C., Kober, H., Webe, J., & Ochsner, K. N. (2014). Cognitive reappraisal of emotion: A meta-analysis of human neuroimaging studies. *Cerebral Cortex*, *24*(11), 2981–2990. https://doi.org/10.1093/cercor/bht154

Cahn, B. R., Delorme, A., & Polich, J. (2010). Occipital gamma activation during Vipassana meditation. *Cognitive Processing*, *11*(1), 39–56. https://doi.org/10.1007/s10339-009-0352-1

Cahn, B. R., Delorme, A., & Polich, J. (2013). Event-related delta, theta, alpha and gamma correlates to auditory oddball processing during vipassana meditation. *Social Cognitive and Affective Neuroscience*, *8*(1), 100–111. https://doi.org/10.1093/scan/nss060

Cahn, B. R., & Polich, J. (2006). Meditation states and traits: EEG, ERP, and neuroimaging studies. *Psychological Bulletin*, *132*(2), 180–211. https://doi.org/10.1037/0033-2909.132.2.180

Cañas, J., Quesada, J., Antolí, A., & Fajardo, I. (2003). Cognitive flexibility and adaptability to environmental changes in dynamic complex problem-solving tasks. *Ergonomics*, *46*(5), 482–501. https://doi.org/10.1080/0014013031000061640

Carter, O. L., Presti, D. E., Callistemon, C., Ungerer, Y., Liu, G. B., & Pettigrew, J. D. (2005). Meditation alters perceptual rivalry in Tibetan Buddhist monks. *Current Biology*, *15*(11), R412–R413. https://doi.org/10.1016/j.cub.2005.05.043

Chiesa, A., & Serretti, A. (2010). A systematic review of neurobiological and clinical features of mindfulness meditations. *Psychological Medicine*, *40*(8), 1239–1252. https://doi.org/10.1017/S0033291709991747

Dahl, C. J., Lutz, A., & Davidson, R. J. (2015). Reconstructing and deconstructing the self: Cognitive mechanisms in meditation practice. *Trends in Cognitive Sciences*, *19*(9), 515–523. https://doi.org/10.1016/j.tics.2015.07.001

Davidson, R. J., Ekman, P., Saron, C. D., Senulis, J. A., & Friesen, W. V. (1990). Approach-Withdrawal and Cerebral Asymmetry: Emotional Expression and Brain Physiology I. *Journal of Personality and Social Psychology*, *58*(2), 330–341. https://doi.org/10.1037/0022-3514.58.2.330

Davidson, R. J., Kabat-Zinn, J., Schumacher, J., Rosenkranz, M., Muller, D., Santorelli, S. F., Urbanowski, F., Harrington, A., Bonus, K., & Sheridan, J. F. (2003). Alterations in brain and immune function produced by mindfulness meditation. *Psychosomatic Medicine*, *65*(4), 564–570. https://doi.org/10.1097/01.PSY.0000077505.67574.E3

Davidson, R. J., & Lutz, A. (2008). Buddha's Brain: Neuroplasticity and Meditation [In the Spotlight]. *IEEE Signal Processing Magazine*, *25*(1), 176–174. https://doi.org/10.1109/msp.2008.4431873

DeFraine, W. C. (2016). Differential effects of cognitive load on emotion: Emotion maintenance versus passive experience. *Emotion*, *16*(4), 459–467. https://doi.org/10.1037/emo0000140

Dentico, D., Ferrarelli, F., Riedner, B. A., Smith, R., Zennig, C., Lutz, A., Tononi, G., & Davidson, R. J. (2016). Short Meditation Trainings Enhance Non-REM Sleep Low-Frequency Oscillations. *PLoS ONE*, *11*(2), 1–18. https://doi.org/10.1371/journal.pone.0148961

Dickenson, J., Berkman, E. T., Arch, J., & Lieberman, M. D. (2013). Neural correlates of focused attention during a brief mindfulness induction. *Social Cognitive and Affective Neuroscience*, *8*(1), 40–47. https://doi.org/10.1093/scan/nss030

Dörfel, D., Lamke, J. P., Hummel, F., Wagner, U., Erk, S., & Walter, H. (2014). Common and differential neural networks of emotion regulation by detachment, reinterpretation, distraction, and expressive suppression: A comparative fMRI investigation. *NeuroImage*, *101*, 298–309. https://doi.org/10.1016/j.neuroimage.2014.06.051

Eippert, F., Veit, R., Weiskopf, N., Erb, M., Birbaumer, N., & Anders, S. (2007). Regulation of emotional responses elicited by threat-related stimuli. *Human Brain Mapping*, *28*(5), 409–423. https://doi.org/10.1002/hbm.20291

Eisendrath, S., Chartier, M., & McLane, M. (2011). Adapting mindfulness-based cognitive therapy for treatment-resistant depression. *Cognitive and Behavioral Practice*, *18*(3), 362–370. https://doi.org/10.1016/j.cbpra.2010.05.004

Erk, S., Kleczar, A., & Walter, H. (2007). Valence-specific regulation effects in a working memory task with emotional context. *NeuroImage*, *37*(2), 623–632. https://doi.org/10.1016/j.neuroimage.2007.05.006

Faber, P. L., Lehmann, D., Gianotti, L. R. R., Milz, P., Pascual-Marqui, R. D., Held, M., & Kochi, K. (2015). Zazen meditation and no-task resting EEG compared with LORETA intracortical source localization. *Cognitive Processing*, *16*(1), 87–

96. https://doi.org/10.1007/s10339-014-0637-x

Farb, N. A. S., Anderson, A. K., Mayberg, H., Bean, J., McKeon, D., & Segal, Z. V. (2010). Minding One's Emotions: Mindfulness Training Alters the Neural Expression of Sadness. *Emotion*, *10*(1), 25–33. https://doi.org/10.1037/a0017151

Fell, J., Axmacher, N., & Haupt, S. (2010). From alpha to gamma: Electrophysiological correlates of meditation-related states of consciousness. *Medical Hypotheses*, *75*(2), 218–224. https://doi.org/10.1016/j.mehy.2010.02.025

Fjorback, L. O., & Walach, H. (2012). Meditation based therapies-a systematic review and some critical observations. *Religions*, *3*(1), 1–18. https://doi.org/10.3390/rel3010001

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. In *American Psychologist* (Vol. 34, Issue 10, pp. 906–911). American Psychological Association. https://doi.org/10.1037/0003-066X.34.10.906

Frankenstein, U. N., Richter, W., McIntyre, M. C., & Rémy, F. (2001). Distraction modulates anterior cingulate gyrus activations during the cold pressor test. *NeuroImage*, *14*(4), 827–836. https://doi.org/10.1006/nimg.2001.0883

Fresco, D. M., Segal, Z. V., Buis, T., & Kennedy, S. (2007). Relationship of Posttreatment Decentering and Cognitive Reactivity to Relapse in Major Depression. *Journal of Consulting and Clinical Psychology*, *75*(3). https://doi.org/10.1037/0022-006X.75.3.447

Garland, E. L., Farb, N. A., R. Goldin, P., & Fredrickson, B. L. (2015). Mindfulness

Broadens Awareness and Builds Eudaimonic Meaning: A Process Model of Mindful Positive Emotion Regulation. *Psychological Inquiry*, *26*(4), 293–314. https://doi.org/10.1080/1047840X.2015.1064294

Garrison, K. A., Zeffiro, T. A., Scheinost, D., Constable, R. T., & Brewer, J. A. (2015). Meditation leads to reduced default mode network activity beyond an active task. *Cognitive, Affective and Behavioral Neuroscience*, *15*(3), 712–720. https://doi.org/10.3758/s13415-015-0358-3

Gecht, J., Kessel, R., Forkmann, T., Gauggel, S., Drueke, B., Scherer, A., & Mainz, V. (2014). A mediation model of mindfulness and decentering: sequential psychological constructs or one and the same? *BMC Psychology*, *2*(1), 1–13. https://doi.org/10.1186/2050-7283-2-18

Goldin, P. R., McRae, K., Ramel, W., & Gross, J. J. (2008). The Neural Bases of Emotion Regulation: Reappraisal and Suppression of Negative Emotion. *Biological Psychiatry*, *63*(6), 577–586. https://doi.org/10.1016/j.biopsych.2007.05.031

Goldstein, E. B. (2015). *Cognitive Psychology: Connecting Mind, Research, and Everyday Experience* (4th ed.).

Goulden, N., Khusnulina, A., Davis, N. J., Bracewell, R. M., Bokde, A. L., McNulty, J. P., & Mullins, P. G. (2014). The salience network is responsible for switching between the default mode network and the central executive network: Replication from DCM. *NeuroImage*, *99*, 180–190. https://doi.org/10.1016/j.neuroimage.2014.05.052

Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. Journal of Personality and. *Social Psychology*, *74*(1), 224–237.

Gross, J. J. (1999). Emotion regulation: Past, present, future. *Cognition and Emotion*, *13*(5), 551–573. https://doi.org/10.1080/026999399379186

Gross, J. J. (2001). Emotion regulation in adulthood: Timing is everything. *Current Directions in Psychological Science*, *10*(6), 214–219. https://doi.org/10.1111/1467-8721.00152

Gross, J. J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology*, *39*(3), S0048577201393198. https://doi.org/10.1017/S0048577201393198

Guendelman, S., Medeiros, S., & Rampes, H. (2017). Mindfulness and emotion regulation: Insights from neurobiological, psychological, and clinical studies. *Frontiers in Psychology*, *8*(MAR). https://doi.org/10.3389/fpsyg.2017.00220

Güntekin, B., Emek-Savaş, D. D., Kurt, P., Yener, G. G., & Başar, E. (2013). Beta oscillatory responses in healthy subjects and subjects with mild cognitive impairment. *NeuroImage: Clinical*, *3*, 39–46. https://doi.org/10.1016/j.nicl.2013.07.003

Gunter, R. W., & Bodner, G. E. (2008). How eye movements affect unpleasant memories: Support for a working-memory account. *Behaviour Research and Therapy*, *46*(8), 913–931. https://doi.org/10.1016/j.brat.2008.04.006

Harmony, T. (2013). The functional significance of delta oscillations in cognitive processing. *Frontiers in Integrative Neuroscience*, *0*(DEC), 83. https://doi.org/10.3389/FNINT.2013.00083

Hartkamp, M., & Thornton, I. M. (2017). Meditation, Cognitive Flexibility and Well-

Being. *Journal of Cognitive Enhancement*, *1*(2), 182–196. https://doi.org/10.1007/s41465-017-0026-3

Hasenkamp, W., & Barsalou, L. W. (2012). Effects of Meditation Experience on Functional Connectivity of Distributed Brain Networks. *Frontiers in Human Neuroscience*, *6*(MARCH 2012), 1–14. https://doi.org/10.3389/fnhum.2012.00038

Hasenkamp, W., Wilson-Mendenhall, C. D., Duncan, E., & Barsalou, L. W. (2012). Mind wandering and attention during focused meditation: A fine-grained temporal analysis of fluctuating cognitive states. *NeuroImage*, *59*(1), 750–760. https://doi.org/10.1016/j.neuroimage.2011.07.008

Hayes, S. C., Strosahl, K. D., & Wilson, K. G. (1999). Acceptance and commitment therapy: An experiential approach to behavior change. In *Acceptance and commitment therapy: An experiential approach to behavior change.* (pp. xvi, 304–xvi, 304). Guilford Press.

Herrmann, C. S., Munk, M. H. J., & Engel, A. K. (2004). Cognitive functions of gamma-band activity: Memory match and utilization. *Trends in Cognitive Sciences*, *8*(8), 347–355. https://doi.org/10.1016/j.tics.2004.06.006

Hindman, R. K., Glass, C. R., Arnkoff, D. B., & Maron, D. D. (2015). A Comparison of Formal and Informal Mindfulness Programs for Stress Reduction in University Students. *Mindfulness*, *6*(4), 873–884. https://doi.org/10.1007/s12671-014-0331-1

Hodgins, H. S., & Adair, K. C. (2010). Attentional processes and meditation. *Consciousness and Cognition*, *19*(4), 872–878. https://doi.org/10.1016/j.concog.2010.04.002

Hölzel, B. K., Carmody, J., Vangel, M., Congleton, C., Yerramsetti, S. M., Gard, T., & Lazar, S. W. (2011). Mindfulness practice leads to increases in regional brain gray matter density. *Psychiatry Research - Neuroimaging*, *191*(1), 36–43. https://doi.org/10.1016/j.pscychresns.2010.08.006

Hölzel, B. K., Ott, U., Hempel, H., Hackl, A., Wolf, K., Stark, R., & Vaitl, D. (2007). Differential engagement of anterior cingulate and adjacent medial frontal cortex in adept meditators and non-meditators. *Neuroscience Letters*, *421*(1), 16–21. https://doi.org/10.1016/j.neulet.2007.04.074

James, W. (1890). The Principles Of Psychology Volume I By William James (1890). *The Principles of Psychology*.

Jha, A., Krompinger, J., & Baime, M. (2007). Mindfulness training modifies. *Cognitive, Affective, & Behavioural Neuroscience*, *7*(2), 109–119. https://doi.org/10.1111/lapo.12054

Josipovic, Z. (2010). Duality and nonduality in meditation research. *Consciousness and Cognition*, *19*(4), 1119–1121. https://doi.org/10.1016/j.concog.2010.03.016

Josipovic, Z. (2014). Neural correlates of nondual awareness in meditation. *Annals of the New York Academy of Sciences*, *1307*(1), 9–18. https://doi.org/10.1111/nyas.12261

Kabat-Zinn, J. (1990). *Full Catastrophe Living: Using the Wisdom of Your Body and Mind to Face Stress, Pain, and Illness*.

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice*, *10*(2), 144–156. https://doi.org/10.1093/clipsy/bpg016

Kabat-Zinn, J. (2005). *Coming to our senses : healing ourselves and the world through mindfulness /*. Hyperion.

Kabat-Zinn, J., Lipworth, L., & Burney, R. (1985). The clinical use of mindfulness meditation for the self-regulation of chronic pain. *Journal of Behavioral Medicine*, *8*(2), 163–190. https://doi.org/10.1007/BF00845519

Kabat-Zinn, J., Lipworth, L., & Medicine, R. B. (1985). The clinical use of mindfulness meditation for the self-regulation of chronic pain. *Springer*, *8*(2). https://doi.org/10.1007/BF00845519

Kalisch, R., Wiech, K., Critchley, H. D., Seymour, B., O'Doherty, J. P., Oakley, D. A., Allen, P., & Dolan, R. J. (2005). Anxiety reduction through detachment: Subjective, physiological, and neural effects. *Journal of Cognitive Neuroscience*, *17*(6), 874–883. https://doi.org/10.1162/0898929054021184

Kalisch, R., Wiech, K., Herrmann, K., & Dolan, R. J. (2006). Neural correlates of self-distraction from anxiety and a process model of cognitive emotion regulation. *Journal of Cognitive Neuroscience*, *18*(8), 1266–1276. https://doi.org/10.1162/jocn.2006.18.8.1266

Kang, Y., Gruber, J., & Gray, J. R. (2013). Mindfulness and de-automatization. *Emotion Review*, *5*(2), 192–201. https://doi.org/10.1177/1754073912451629

Kanske, P., & Kotz, S. A. (2011). Emotion triggers executive attention: Anterior cingulate cortex and amygdala responses to emotional words in a conflict task. *Human Brain Mapping*, *32*(2), 198–208. https://doi.org/10.1002/hbm.21012

Kellermann, T. S., Sternkopf, M. A., Schneider, F., Habel, U., Turetsky, B. I., Zilles, K., & Eickhoff, S. B. (2012). Modulating the processing of emotional stimuli by cognitive demand. *Social Cognitive and Affective Neuroscience*, *7*(3), 263–273. https://doi.org/10.1093/scan/nsq104

Khoury, B., & Lecomte, T. (2012). Emotion regulation and schizophrenia. *International Journal of Cognitive Therapy*, *5*(1), 67–76. https://doi.org/10.1521/ijct.2012.5.1.67

King, A. P., & Fresco, D. M. (2019). A neurobehavioral account for decentering as the salve for the distressed mind. *Current Opinion in Psychology*, *28*, 285–293. https://doi.org/10.1016/j.copsyc.2019.02.009

Knyazev, G. G. (2012). EEG delta oscillations as a correlate of basic homeostatic and motivational processes. *Neuroscience & Biobehavioral Reviews*, *36*(1), 677–695. https://doi.org/10.1016/J.NEUBIOREV.2011.10.002

Kok, B. E., & Singer, T. (2017). Phenomenological Fingerprints of Four Meditations: Differential State Changes in Affect, Mind-Wandering, Meta-Cognition, and Interoception Before and After Daily Practice Across 9 Months of Training. *Mindfulness*, *8*(1), 218–231. https://doi.org/10.1007/s12671-016-0594-9

Kozasa, E. H., Sato, J. R., Lacerda, S. S., Barreiros, M. A. M., Radvany, J., Russell, T. A., Sanches, L. G., Mello, L. E. A. M., & Amaro, E. (2012). Meditation training increases brain efficiency in an attention task. *NeuroImage*, *59*(1), 745–749. https://doi.org/10.1016/j.neuroimage.2011.06.088

Kross, E., & Ayduk, O. (2008). Facilitating adaptive emotional analysis: Distinguishing distanced-analysis of depressive experiences from immersed-analysis and distraction. *Personality and Social Psychology Bulletin*, *34*(7), 924–938. https://doi.org/10.1177/0146167208315938

Lama, D. (2001). *An open heart: Practicing compassion in everyday life*. https://books.google.com/books?hl=en&lr=&id=nI1cDwAAQBAJ&oi=fnd&pg=PT3&ots=CiWaCEKIOO&sig=h980GI-ZIxqNq0N26fV-QwtMRZc

Lazar, S. W., Bush, G., Gollub, R. L., Fricchione, G. L., Khalsa, G., & Benson, H. (2000). Functional brain mapping of the relaxation response and meditation. *NeuroReport*, *11*(7), 1581–1585. https://doi.org/10.1097/00001756-200005150-00042

Lazar, S. W., Kerr, C. E., Wasserman, R. H., Gray, J. R., Greve, D. N., Treadway, M. T., McGarvey, M., Quinn, B. T., Dusek, J. A., Benson, H., Rauch, S. L., Moore, C. I., & Fischl, B. (2005). Meditation experience is associated with increased cortical thickness. *NeuroReport*, *16*(17), 1893–1897. https://doi.org/10.1097/01.wnr.0000186598.66243.19

Lazarus, R. S. (1999). *Stress and Emotion: A New Synthesis*. Springer Publishing Company.

Lee, D. J., Kulubya, E., Goldin, P., Goodarzi, A., & Girgis, F. (2018). Review of the neural oscillations underlying meditation. *Frontiers in Neuroscience*, *12*(MAR), 1–7. https://doi.org/10.3389/fnins.2018.00178

Lieberman, M. D., Eisenberger, N. I., Crockett, M. J., Tom, S. M., Pfeifer, J. H., & Way, B. M. (2007). Putting feelings into words: Affect labeling disrupts amygdala activity in response to affective stimuli: Research article. *Psychological Science*, *18*(5), 421–428. https://doi.org/10.1111/j.1467-9280.2007.01916.x

Lippelt, D. P., Hommel, B., & Colzato, L. S. (2014). Focused attention, open monitoring and loving kindness meditation: Effects on attention, conflict monitoring, and creativity - A review. *Frontiers in Psychology*, *5*(SEP), 1–5. https://doi.org/10.3389/fpsyg.2014.01083

Lutz, A., Brefczynski-Lewis, J., Johnstone, T., & Davidson, R. J. (2008). Regulation of the neural circuitry of emotion by compassion meditation: Effects of meditative expertise. *PLoS ONE*, *3*(3), 1–10. https://doi.org/10.1371/journal.pone.0001897

Lutz, A., Greischar, L. L., Perlman, D. M., & Davidson, R. J. (2009). BOLD signal in insula is differentially related to cardiac function during compassion meditation in experts vs. novices. *NeuroImage*, *47*(3), 1038–1046. https://doi.org/10.1016/j.neuroimage.2009.04.081

Lutz, A., Greischar, L. L., Rawlings, N. B., Ricard, M., & Davidson, R. J. (2004). Long-term meditators self-induce high-amplitude gamma synchrony during mental practice. *Proceedings of the National Academy of Sciences*, *101*(46), 16369–16373. https://doi.org/10.1073/pnas.0407401101

Lutz, A., Slagter, H. A., Dunne, J. D., & Davidson, R. J. (2008). Attention regulation and monitoring in meditation. *Trends in Cognitive Sciences*, *12*(4), 163–169. https://doi.org/10.1016/j.tics.2008.01.005

Lutz, A., Slagter, H. A., Rawlings, N. B., Francis, A. D., Greischar, L. L., & Davidson, R. J. (2009). Mental training enhances attentional stability: Neural and behavioral evidence. *Journal of Neuroscience*, *29*(42), 13418–13427. https://doi.org/10.1523/JNEUROSCI.1614-09.2009

Malinowski, P. (2013). Neural mechanisms of attentional control in mindfulness meditation. *Frontiers in Neuroscience*, *7*(7 FEB), 1–11. https://doi.org/10.3389/fnins.2013.00008

Manjunatha, U., Bhat, J. S., Radish, K. B., Bajaj, G., Shruthi, P., Suresh Nayak, P., & Rasheeka, S. M. (2018). Effect of Bhramari Pranayama on the Acoustic and Aerodynamic Parameters of Voice in Normophonic Females. In *Evidence-based Complementary and Alternative Medicine* (Vol. 2018). https://doi.org/10.1155/2018/4176803

McRae, K., & Gross, J. J. (2020). Emotion regulation. *Emotion (Washington, D.C.)*, *20*(1), 1–9. https://doi.org/10.1037/emo0000703

Menon, V. (2015). Salience Network. In *Brain Mapping: An Encyclopedic Reference* (Vol. 2). Elsevier Inc. https://doi.org/10.1016/B978-0-12-397025-1.00052-X

Menon, Vinod, & Uddin, L. Q. (2010). Saliency, switching, attention and control: a network model of insula function. *Brain Structure and Function*, *214*(5–6), 655–667. https://doi.org/10.1007/s00429-010-0262-0

Meyer, K. N., Du, F., Parks, E., & Hopfinger, J. B. (2018). Exogenous vs. endogenous attention: Shifting the balance of fronto-parietal activity. *Neuropsychologia*, *111*, 307–316. https://doi.org/10.1016/j.neuropsychologia.2018.02.006

Mikels, J. A., Reuter-Lorenz, P. A., Beyer, J. A., & Fredrickson, B. L. (2008). Emotion and Working Memory: Evidence for Domain-Specific Processes for Affective Maintenance. *Emotion*, *8*(2), 256–266. https://doi.org/10.1037/1528-3542.8.2.256

Mirams, L., Poliakoff, E., Brown, R. J., & Lloyd, D. M. (2013). Brief body-scan meditation practice improves somatosensory perceptual decision making. *Consciousness and Cognition*, *22*(1), 348–359. https://doi.org/10.1016/j.concog.2012.07.009

Moore, A., Gruber, T., Derose, J., & Malinowski, P. (2012). Regular, brief mindfulness meditation practice improves electrophysiological markers of attentional control. *Frontiers in Human Neuroscience*, *6*(JANUARY 2012), 1–15. https://doi.org/10.3389/fnhum.2012.00018

Moore, A., & Malinowski, P. (2009). Meditation, mindfulness and cognitive flexibility. *Consciousness and Cognition*, *18*(1), 176–186. https://doi.org/10.1016/j.concog.2008.12.008

Mulders, P. C., Van Eijndhoven, P. F., & Beckmann, C. F. (2016). Identifying Large-Scale Neural Networks Using fMRI. In *Systems Neuroscience in Depression*. Elsevier Inc. https://doi.org/10.1016/B978-0-12-802456-0.00007-8

Nyanaponika, T. (1962). The heart of Buddhist meditation. In *San Francsico: Weiser*.

Ochsner, K. N., Bunge, S. A., Gross, J. J., & Gabrieli, J. D. E. (2002). Rethinking Feelings: An fMRI Study of the Cognitive Regulation of Emotion. *Journal of Cognitive Neuroscience*, *14*(8), 1215–1229. https://doi.org/10.1162/089892902760807212

Ochsner, K. N., & Gross, J. J. (2008). Cognitive Emotion Regulation. *Current Directions in Psychological Science*, *17*(2), 153–158. https://doi.org/10.1111/j.1467-8721.2008.00566.x

Ochsner, K. N., Ray, R. R., Hughes, B., Mcrae, K., Cooper, J. C., Weber, J., Gabrieli, J. D. E., & Gross, J. J. (2009). Bottom-up and top-down processes in emotion generation: Common and distinct neural mechanisms. *Psychological Science*, *20*(11), 1322–1331. https://doi.org/10.1111/j.1467-9280.2009.02459.x

Ochsner, K. N., Silvers, J. A., & Buhle, J. T. (2012). Functional imaging studies of emotion regulation: a synthetic review and evolving model of the cognitive control of emotion. *Annals of the New York Academy of Sciences*, *1251*(1), E1–E24. https://doi.org/10.1111/j.1749-6632.2012.06751.x

Ornstein, R. E., & Naranjo, C. (1971). *On the Psychology of Meditation*. https://doi.org/10.1177/0040571x7407700816

Pagnoni, G. (2012). Dynamical properties of BOLD activity from the ventral posteromedial cortex associated with meditation and attentional skills. *Journal of Neuroscience*, *32*(15), 5242–5249. https://doi.org/10.1523/JNEUROSCI.4135-11.2012

Pasquini, H. A., Tanaka, G. K., Basile, L. F. H., Velasques, B., Lozano, M. D., & Ribeiro, P. (2015). Electrophysiological correlates of long-term soto zen meditation. *BioMed Research International*, *2015*, 2–8. https://doi.org/10.1155/2015/598496

Peirce, J., Gray, J. R., Simpson, S., MacAskill, M., Höchenberger, R., Sogo, H., Kastman, E., & Lindeløv, J. K. (2019). PsychoPy2: Experiments in behavior made easy. *Behavior Research Methods*, *51*(1), 195–203. https://doi.org/10.3758/s13428-018-01193-y

Petersen, S. E., & Posner, M. I. (2012). The Attention System of the Human Brain: 20 Years After. *Annual Review of Neuroscience*, *35*(1), 73–89. https://doi.org/10.1146/annurev-neuro-062111-150525

Pfaff, H. U. (2014). *Psychophysiological reactivity to auditory Binaural Beats stimulation in the alpha and theta EEG brain-wave frequency bands: A randomized, double–blind and placebo–controlled study in human healthy young adult subjects*. 1–171. https://repositorio.uam.es/xmlui/handle/10486/663948

Posner, M. I. (1980). Quarterly Journal of Experimental Psychology Orienting of attention ORIENTING OF ATTENTION*. *Quarterly Journal of Experimental Psychology Quarterly Journal of EJrperimental Psychology*, *32*(32), 3–25. http://www.tandfonline.com/action/journalInformation?journalCode=pqje20%0A https://doi.org/10.1080/00335558008248231

Posner, M. I., & Petersen, S. E. (1990). The Attention System of the Human Brain. *Annual Review of Neuroscience*, *13*(1), 25–42. https://doi.org/10.1146/annurev.ne.13.030190.000325

Raffone, A., Marzetti, L., Del Gratta, C., Perrucci, M. G., Romani, G. L., & Pizzella, V. (2019). Toward a brain theory of meditation. In *Progress in Brain Research* (1st ed., Vol. 244). Elsevier B.V. https://doi.org/10.1016/bs.pbr.2018.10.028

Raichle, M. E., MacLeod, A. M., Snyder, A. Z., Powers, W. J., Gusnard, D. A., & Shulman, G. L. (2001). A default mode of brain function. *Proceedings of the National Academy of Sciences*, *98*(2), 676–682. https://doi.org/10.1073/pnas.98.2.676

Ray, S., & Maunsell, J. H. R. (2015). Do gamma oscillations play a role in cerebral cortex? *Trends in Cognitive Sciences*, *19*(2), 78. https://doi.org/10.1016/J.TICS.2014.12.002

Sauer-Zavala, S. E., Walsh, E. C., Eisenlohr-Moul, T. A., & Lykins, E. L. B. (2013). Comparing Mindfulness-Based Intervention Strategies: Differential Effects of Sitting Meditation, Body Scan, and Mindful Yoga. *Mindfulness*, *4*(4), 383–388. https://doi.org/10.1007/s12671-012-0139-9

Schneider, W., & Shiffrin, R. M. (1977). Controlled and automatic human information processing: I. Detection, search, and attention. *Psychological Review*, *84*(1), 1–

66. https://doi.org/10.1037/0033-295X.84.1.1

Schoenberg, P. LA, & Vago, D. R. (2019). Mapping meditative states and stages with electrophysiology: concepts, classifications, and methods. *Current Opinion in Psychology*, *28*, 211–217. https://doi.org/10.1016/j.copsyc.2019.01.007

Schwartz, B. L., & Perfect, T. J. (2002). Introduction: toward an applied metacognition. In B. L. Schwartz & T. J. Perfect (Eds.), *Applied Metacognition* (pp. 1–12). Cambridge University Press. https://doi.org/DOI: 10.1017/CBO9780511489976.002

Seeley, W. W., Menon, V., Schatzberg, A. F., Keller, J., Glover, G. H., Kenna, H., Reiss, A. L., & Greicius, M. D. (2007). Dissociable intrinsic connectivity networks for salience processing and executive control. *The Journal of Neuroscience : The Official Journal of the Society for Neuroscience*, *27*(9), 2349–2356. https://doi.org/10.1523/JNEUROSCI.5587-06.2007

Segal, Z. V., Teasdale, J. D., & Williams, J. M. G. (2001). Mindfulness-Based Cognitive Therapy for Depression. In *The Guildford Press*. http://connect.springerpub.com/lookup/doi/10.1891/0889-8391.28.2.147

Serences, J. T., & Wixted, J. T. (2018). *Stevens' Handbook of Experimental Psychology and Cognitive Neuroscience - Sensation, Perception and Attention* (J. T. Wixted (ed.)). John Wiley & Sons, Inc. https://doi.org/10.1002/9781119170174

Shakespeare, W. (1954). *The tragedy of Hamlet, Prince of Denmark*. [London] : The Folio Society, 1954. https://search.library.wisc.edu/catalog/9910207547902121

Shapiro, S. L., Carlson, L. E., Astin, J. A., & Freedman, B. (2006). Mechanisms of mindfulness. *Journal of Clinical Psychology*, *62*(3), 373–386. https://doi.org/10.1002/jclp.20237

Shiffrin, R. M., & Schneider, W. (1984). Automatic and controlled processing revisited. *Psychological Review*, *91*(2), 269–276. https://doi.org/10.1037/0033-295X.91.2.269

Shiota, M. N., & Levenson, R. W. (2012). Turn down the volume or change the channel? Emotional effects of detached versus positive reappraisal. *Journal of Personality and Social Psychology*, *103*(3), 416–429. https://doi.org/10.1037/a0029208

Shriram Sharma Acharya, -Pt. (2003). *ETERNITY OF SOUND AND THE SCIENCE OF MANTRAS (Ïabda Brah®: Mantra Vijó³na)*. http://www.awgp.org

Slagter, H. A., Davidson, R. J., & Lutz, A. (2011). Mental training as a tool in the neuroscientific study of brain and cognitive plasticity. *Frontiers in Human Neuroscience*, *5*(FEBRUARY), 1–12. https://doi.org/10.3389/fnhum.2011.00017

Sohlberg, M. M., & Mateer, C. A. (1987). Effectiveness of an attention-training program. *Journal of Clinical and Experimental Neuropsychology*, *9*(2), 117–130. https://doi.org/10.1080/01688638708405352

Sridharan, D., Levitin, D. J., & Menon, V. (2008). A critical role for the right fronto-insular cortex in switching between central-executive and default-mode networks. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(34), 12569–12574. https://doi.org/10.1073/pnas.0800005105

Stroop R. (1935). Studies of Interference in Serial Verbal Reactions. *Journal of Experimental Psychology*, *18*(6), 643–661.

Sugiura, Y. (2004). Detached mindfulness and worry: A meta-cognitive analysis. *Personality and Individual Differences*, *37*(1), 169–179. https://doi.org/10.1016/j.paid.2003.08.009

Symons, A. E., El-Deredy, W., Schwartze, M., & Kotz, S. A. (2016). The functional role of neural oscillations in non-verbal emotional communication. *Frontiers in Human Neuroscience*, *10*(MAY2016), 1–14. https://doi.org/10.3389/fnhum.2016.00239

Takahashi, T., Murata, T., Hamada, T., Omori, M., Kosaka, H., Kikuchi, M., Yoshida, H., & Wada, Y. (2005). Changes in EEG and autonomic nervous activity during meditation and their association with personality traits. *International Journal of Psychophysiology*, *55*(2), 199–207. https://doi.org/10.1016/j.ijpsycho.2004.07.004

Tang, Y. Y., Hölzel, B. K., & Posner, M. I. (2015a). The neuroscience of mindfulness meditation. *Nature Reviews Neuroscience*, *16*(4), 213–225. https://doi.org/10.1038/nrn3916

Tang, Y. Y., Hölzel, B. K., & Posner, M. I. (2015b). The neuroscience of mindfulness meditation. *Nature Reviews Neuroscience*, *16*(4), 213–225. https://doi.org/10.1038/nrn3916

Tang, Y. Y., Tang, R., Rothbart, M. K., & Posner, M. I. (2019). Frontal theta activity and white matter plasticity following mindfulness meditation. *Current Opinion in Psychology*, *28*, 294–297. https://doi.org/10.1016/j.copsyc.2019.04.004

Teasdale, J. D. (1999). Metacognition, mindfulness and the modification of mood disorders. *Clinical Psychology & Psychotherapy*, *6*(2), 146–155. https://doi.org/10.1002/(SICI)1099-0879(199905)6:2<146::AID-

CPP195>3.0.CO;2-E

Tiitinen, H. T., Sinkkonen, J., Reinikainen, K., Alho, K., Lavikainen, J., & Näätänen, R. (1993). Selective attention enhances the auditory 40-Hz transient response in humans. *Nature 1993 364:6432*, *364*(6432), 59–60. https://doi.org/10.1038/364059a0

Tomljenović, H., Begić, D., & Maštrović, Z. (2016). Changes in trait brainwave power and coherence, state and trait anxiety after three-month transcendental meditation (TM) practice. *Psychiatria Danubina*, *28*(1), 63–72.

Travis, Fred, Haaga, D. A. F., Hagelin, J., Tanner, M., Arenander, A., Nidich, S., Gaylord-King, C., Grosswald, S., Rainforth, M., & Schneider, R. H. (2010). A self-referential default brain state: Patterns of coherence, power, and eLORETA sources during eyes-closed rest and transcendental meditation practice. *Cognitive Processing*, *11*(1), 21–30. https://doi.org/10.1007/s10339-009-0343-2

Travis, Fred, & Shear, J. (2010). Focused attention, open monitoring and automatic self-transcending: Categories to organize meditations from Vedic, Buddhist and Chinese traditions. *Consciousness and Cognition*, *19*(4), 1110–1118. https://doi.org/10.1016/j.concog.2010.01.007

Travis, Frederick, & Parim, N. (2017). Default mode network activation and Transcendental Meditation practice: Focused Attention or Automatic Self-transcending? *Brain and Cognition*, *111*, 86–94. https://doi.org/10.1016/j.bandc.2016.08.009

Uddin, L. Q. (2017). Functions of the Salience Network. *Salience Network of the Human Brain*, 11–16. https://doi.org/10.1016/b978-0-12-804593-0.00003-5 van der Velden, A. M., Kuyken, W., Wattar, U., Crane, C., Pallesen, K. J., Dahlgaard, J., Fjorback, L. O., & Piet, J. (2015). A systematic review of mechanisms of change in mindfulness-based cognitive therapy in the treatment of recurrent major depressive disorder. *Clinical Psychology Review*, *37*, 26–39. https://doi.org/10.1016/j.cpr.2015.02.001

Van Dillen, L. F., & Derks, B. (2012). Working memory load reduces facilitated processing of threatening faces: An ERP study. *Emotion*, *12*(6), 1340–1349. https://doi.org/10.1037/a0028624

Van Dillen, L. F., Heslenfeld, D. J., & Koole, S. L. (2009). Tuning down the emotional brain: An fMRI study of the effects of cognitive load on the processing of affective images. *NeuroImage*, *45*(4), 1212–1219. https://doi.org/10.1016/j.neuroimage.2009.01.016

Viviani, R. (2013). Emotion regulation, attention to emotion, and the ventral attentional network. *Frontiers in Human Neuroscience*, *7*(NOV), 1–24. https://doi.org/10.3389/fnhum.2013.00746

Wadlinger, H. A., & Isaacowitz, D. M. (2011). Fixing our focus: Training attention to regulate emotion. *Personality and Social Psychology Review*, *15*(1), 75–102. https://doi.org/10.1177/1088868310365565

Wager, T. D., Davidson, M. L., Hughes, B. L., Lindquist, M. A., & Ochsner, K. N. (2008). Prefrontal-Subcortical Pathways Mediating Successful Emotion Regulation. *Neuron*, *59*(6), 1037–1050. https://doi.org/10.1016/j.neuron.2008.09.006

Wallace, A. (2014). *Mind in the balance: meditation in science, Buddhism, & Christianity* (paperback). Columbia University Press.

Wallace, B. A. (1999). The Buddhist tradition of Samatha: Methods for refining and examining consciousness. *Journal of Consciousness Studies*, *6*(3), 175–187.

Wallace, B. A., & Shapiro, S. L. (2006). Mental balance and well-being: Building bridges between Buddhism and Western psychology. *American Psychologist*, *61*(7), 690–701. https://doi.org/10.1037/0003-066X.61.7.690

Walter, H., von Kalckreuth, A., Schardt, D., Stephan, A., Goschke, T., & Erk, S. (2009). The temporal dynamics of voluntary emotion regulation. *PLoS ONE*, *4*(8). https://doi.org/10.1371/journal.pone.0006726

Webb, T. L., Miles, E., & Sheeran, P. (2012). Dealing with feeling: A meta-analysis of the effectiveness of strategies derived from the process model of emotion regulation. *Psychological Bulletin*, *138*(4), 775–808. https://doi.org/10.1037/a0027600

Wells, A. (2002). GAD, Meta-cognition, and Mindfulness: An Information Processing Analysis. *Clinical Psychology: Science and Practice*, *9*(1), 95–100. https://doi.org/10.1093/clipsy.9.1.95

Wells, A. (2005). Detached mindfulness in cognitive therapy: A metacognitive analysis and ten techniques. *Journal of Rational - Emotive and Cognitive - Behavior Therapy*, *23*(4), 337–355. https://doi.org/10.1007/s10942-005-0018-6

Wells, A., & Matthews, G. (1994). *Attention and Emotion: A Clinical Perspective*. https://doi.org/10.1080/713755683

Wenk-Sormaz, H. (2005). Meditation can reduce habitual responding. *Alternative Therapies in Health and Medicine*, *11*(2), 42–58.

Wielgosz, J., Goldberg, S. B., Kral, T. R. A., Dunne, J. D., & Davidson, R. J. (2019).

Mindfulness Meditation and Psychopathology. *Annual Review of Clinical Psychology*, *15*, 285–316. https://doi.org/10.1146/annurev-clinpsy-021815-093423

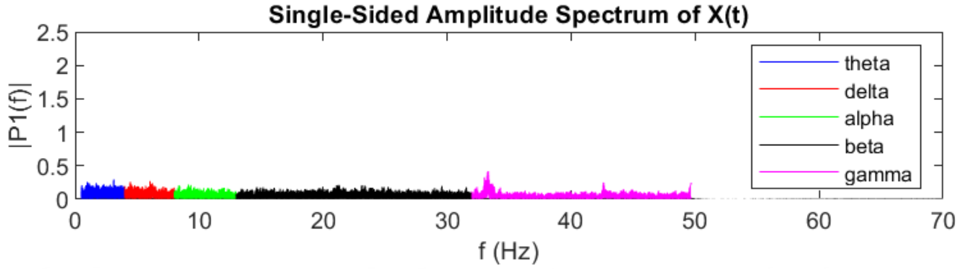
Xiao, R., Shida-Tokeshi, J., Vanderbilt, D. L., & Smith, B. A. (2018). Electroencephalography power and coherence changes with age and motor skill development across the first half year of life. *PLoS ONE*, *13*(1). https://doi.org/10.1371/JOURNAL.PONE.0190276

Yogi, M. (1963). *The Science of Being and Art of Living*. New American Library.

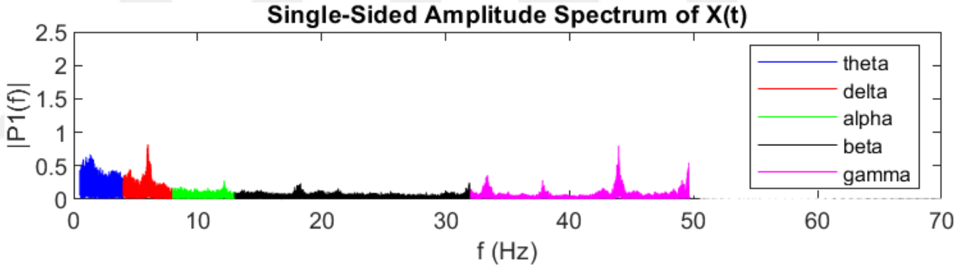
Yu, X., Fumoto, M., Nakatani, Y., Sekiyama, T., Kikuchi, H., Seki, Y., Sato-Suzuki, I., & Arita, H. (2011). Activation of the anterior prefrontal cortex and serotonergic system is associated with improvements in mood and EEG changes induced by Zen meditation practice in novices. *International Journal of Psychophysiology*, *80*(2), 103–111. https://doi.org/10.1016/j.ijpsycho.2011.02.004

APPENDIX A: FFT GRAPHICS ACCORDING TO CONGRUENCY

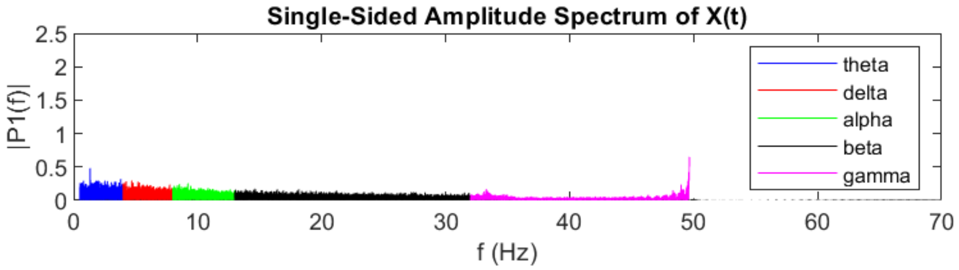
Congruent – Frontal Region – Meditation



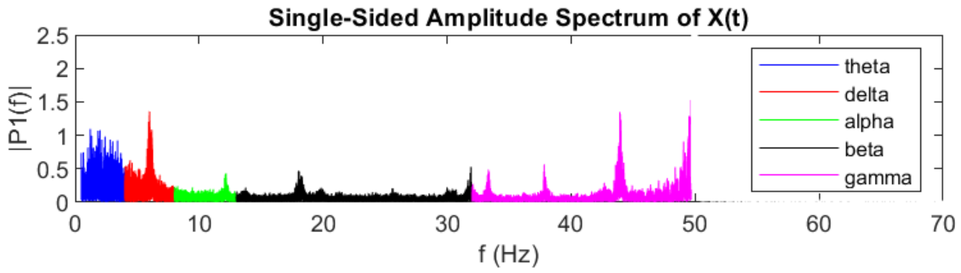
Congruent – Frontal Region - Control



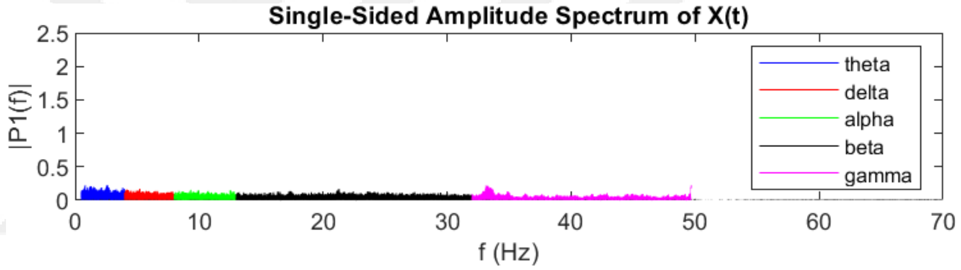
Congruent – Temporal Region – Meditation



Congruent – Temporal Region – Control



Incongruent – Frontal Region – Meditation



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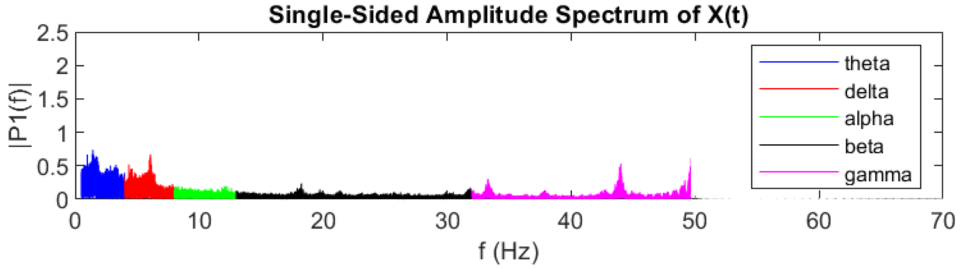
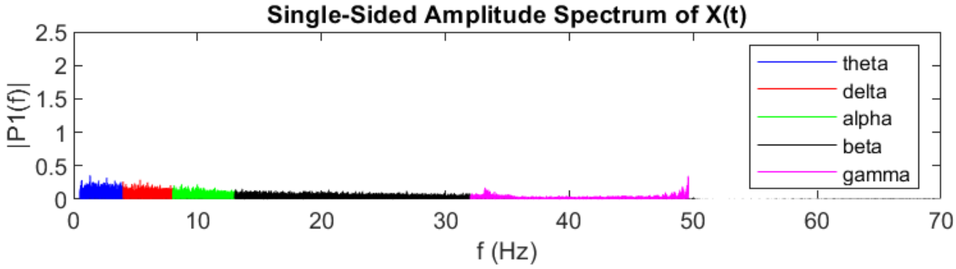
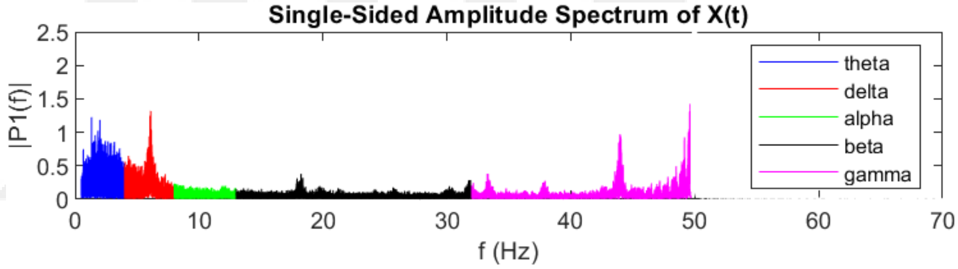


Incongruent – Temporal Region – Meditation

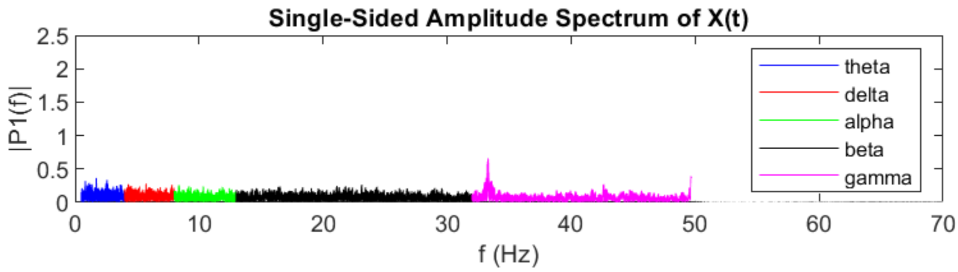


Incongruent – Temporal Region – Control

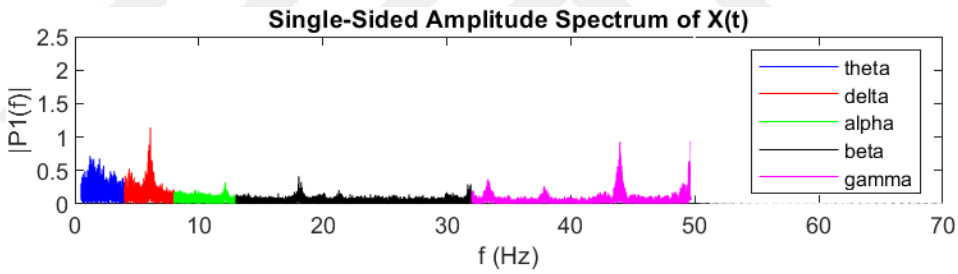


APPENDIX B: FFT GRAPHICS ACCORDING TO AROUSAL

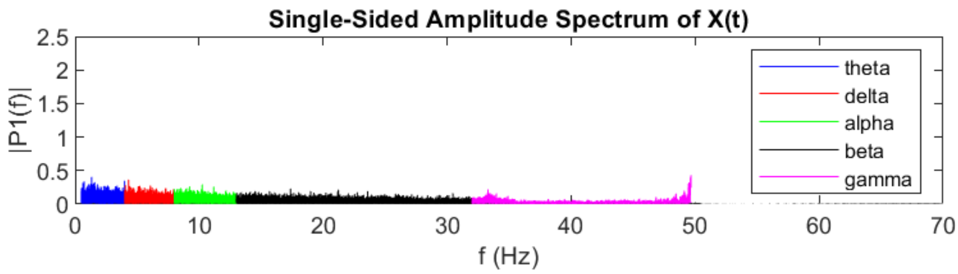
Arousal High – Frontal Region- Meditation



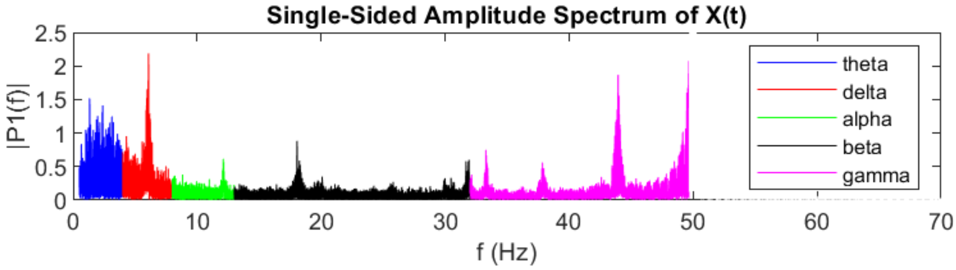
Arousal High – Frontal Region- Control



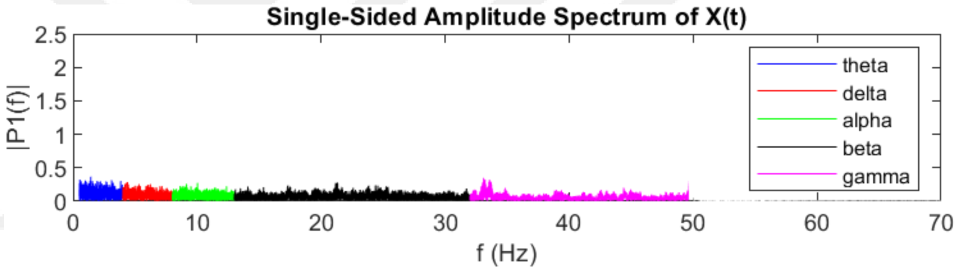
Arousal High – Temporal Region- Meditation



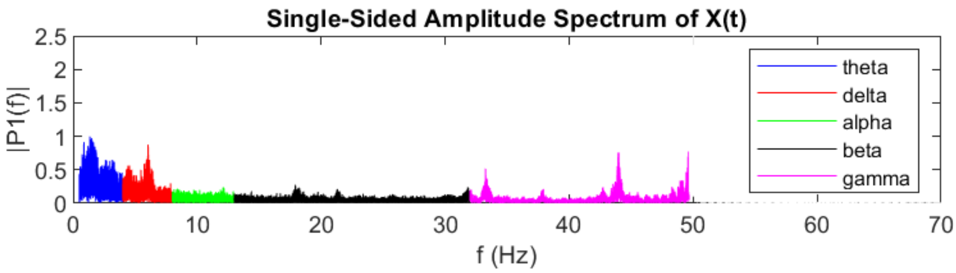
Arousal High – Temporal Region- Control



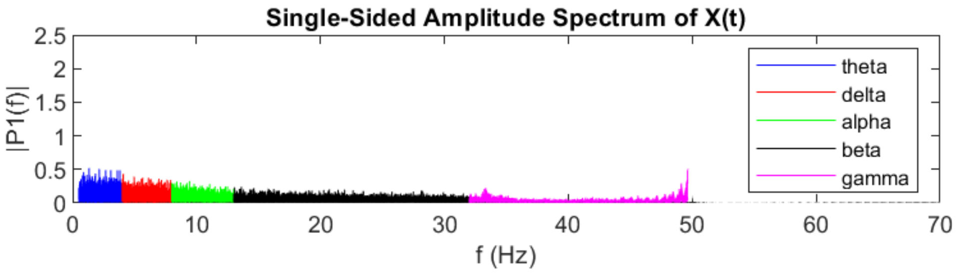
Arousal Low – Frontal Region- Meditation



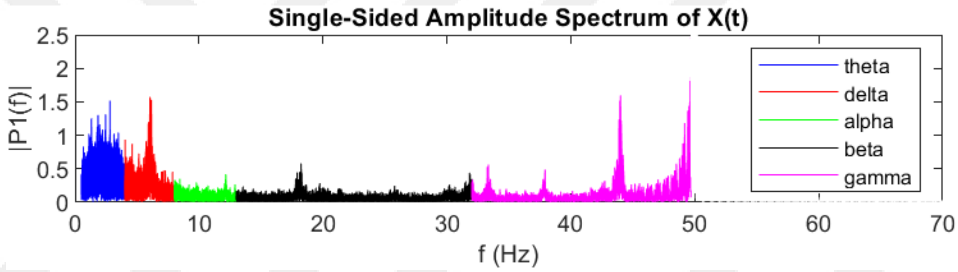
Arousal Low – Frontal Region- Control



Arousal Low – Temporal Region- Meditation

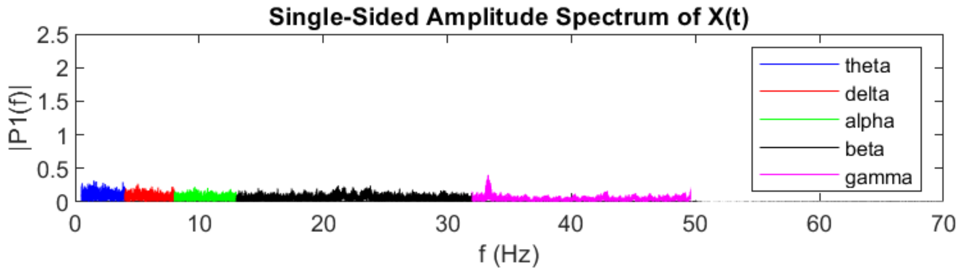


Arousal Low – Temporal Region- Control

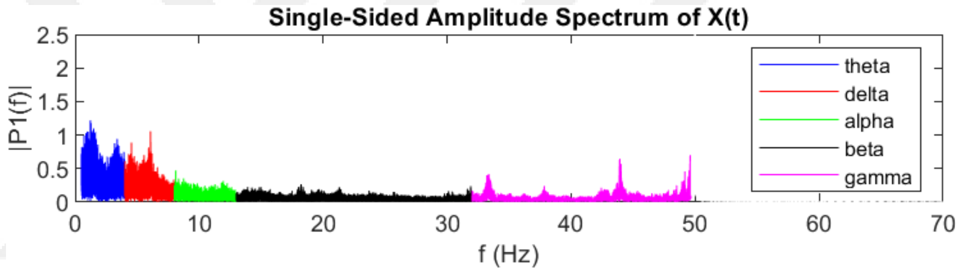


APPENDIX C: FFT GRAPHICS ACCORDING TO PLEASURE

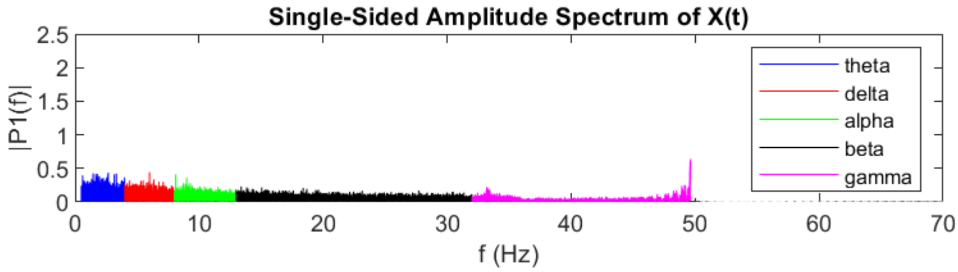
Pleasure High – Frontal Region- Meditation



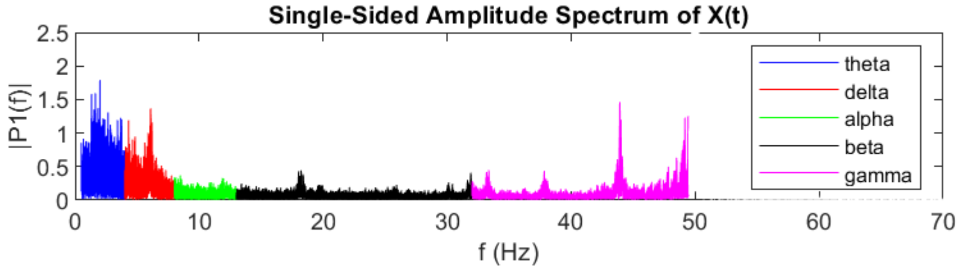
Pleasure High – Frontal Region- Control



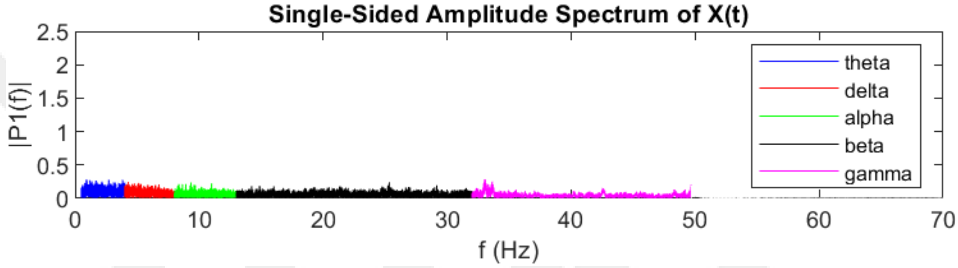
Pleasure High – Temporal Region- Meditation



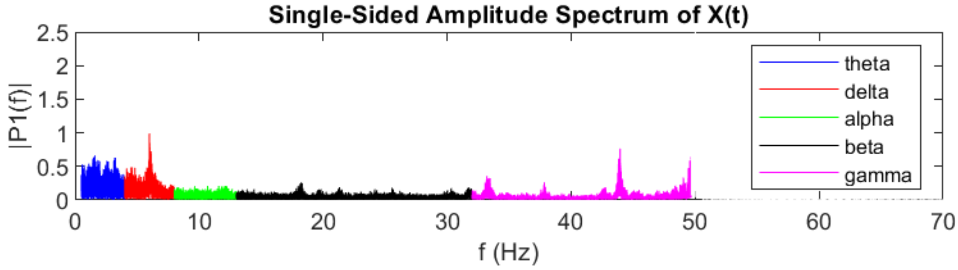
Pleasure High – Temporal Region- Control



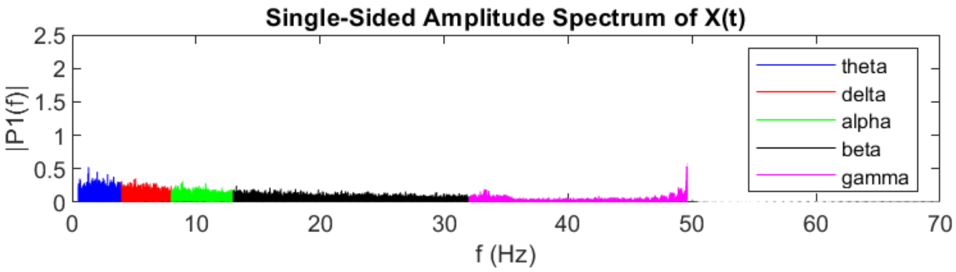
Pleasure Low – Frontal Region- Meditation



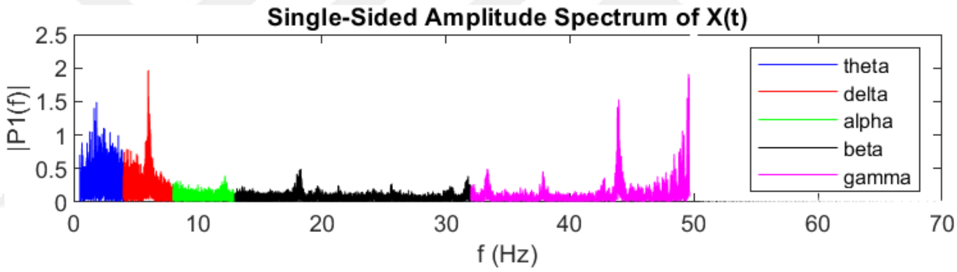
Pleasure Low – Frontal Region- Control



Pleasure Low – Temporal Region- Meditation



Pleasure Low – Temporal Region- Control



APPENDIX D: ETHICAL APPROVAL FORM

T.C.
YEDİTEPE ÜNİVERSİTESİ REKTÖRLÜĞÜ

07.07.2021

Sayı : E.50532705-302.14.01-925
Konu : Simay Selek Kurul Onayı

İLGİLİ MAKAMA

Üniversitemiz Sosyal Bilimler Enstitüsü Bilişsel Bilimler Yüksek Lisans Öğrencisi Simay Selek'in "Meditasyonun Bir Duygu Düzenleme Stratejisi Olan Kopma(Detachment) Üzerindeki Etkisi" başlıklı araştırmasının Beşeri Bilimler etik standartlarına uygunluğu Yeditepe Üniversitesi Beşeri ve Sosyal Araştırmalar Etik Kurulu Onayı ekte sunulmuştur.

Gerekli iznin verilmesi hususunu bilgilerinize arz ve rica ederim.

İmza
Prof. Dr. Fatma Yeşim EKİNCİ
Rektör a.
Rektör Yardımcısı

Ek: Etik Kurul Onayı.pdf

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YEDİTEPE ÜNİVERSİTESİ BEŞERİ VE SOSYAL BİLİMLER ETİK KURULU KOMİSYONU

28.06.2021 TARİHLİ
19/2021 No'lu TOPLANTI KARARLARI

6) Yeditepe Üniversitesi Sosyal Bilimler Enstitüsü Bilişsel Bilimler Yüksek Lisans Öğrencilerinden Nazlı Konukoğlu'nun "İki Boyutlu Şekillerin Parametrik Fiziksel Özelliklerinin Hatırlanmaya Ve Doğal Bulunmaya Etkileri" başlıklı araştırmasının Beşeri Bilimler etik standartlarına uygunluğu Yeditepe Üniversitesi Beşeri ve Sosyal Araştırmalar Etik Kurulu tarafından değerlendirilmiş ve onaylanmıştır.

7) Yeditepe Üniversitesi İktisadi ve İdari Bilimler Fakültesi Siyaset Bilimi ve Uluslararası İlişkiler (İng.) Bölümü Lisans Öğrencisi Onur Çezik'in Proje Yürütücüsü olarak TÜBİTAK "2209-A Üniversite Öğrencileri Araştırma Projeleri Destekleme Programı" çerçevesinde yürütecekleri "Karşılaştırmalı Siyasal Sistemler Dersi Kapsamında Ders Sonrası Öğrenci Algısı ve Dersin Öğrenim Kazanımlarının İncelenmesi" başlıklı araştırmanın Beşeri Bilimler etik standartlarına uygunluğu Yeditepe Üniversitesi Beşeri ve Sosyal Araştırmalar Etik Kurulu tarafından değerlendirilmiş ve onaylanmıştır.

8) Yeditepe Üniversitesi Sosyal Bilimler Enstitüsü Bilişsel Bilimler Yüksek Lisans Öğrencilerinden Simay Selek'in "Meditasyonun Bir Duygu Düzenleme Stratejisi Olan Kopma(Detachment) Üzerindeki Etkisi" başlıklı araştırmasının Beşeri Bilimler etik standartlarına uygunluğu Yeditepe Üniversitesi Beşeri ve Sosyal Araştırmalar Etik Kurulu tarafından değerlendirilmiş ve onaylanmıştır.

9) Yeditepe Üniversitesi Eğitim Bilimleri Enstitüsü Eğitim Yönetimi ve Denetimi Yüksek Lisans Öğrencilerinden Şule Yekeler'in "İlkokullarda Yönetici ve Öğretmenler Arasında Yaşanan İletişim Engelleri" başlıklı araştırmasının Beşeri Bilimler etik standartlarına uygunluğu Yeditepe Üniversitesi Beşeri ve Sosyal Araştırmalar Etik Kurulu tarafından değerlendirilmiş ve onaylanmıştır.

10) Yeditepe Üniversitesi Sosyal Bilimler Enstitüsü İşletme Doktora Öğrencilerinden Veysel Karani Nurdağ'ın "The Mediating Role of Psychological Capital in the Effector Agile Leadership on Corporate Entrepreneurship" başlıklı araştırmasının Beşeri Bilimler etik standartlarına uygunluğu Yeditepe Üniversitesi Beşeri ve Sosyal Araştırmalar Etik Kurulu tarafından değerlendirilmiş ve onaylanmıştır.

YEDİTEPE ÜNİVERSİTESİ BEŞERİ VE SOSYAL BİLİMLER ETİK KURULU KOMİSYONU

28.06.2021 TARİHLİ
19/2021 No'lu TOPLANTI KARARLARI

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Prof. Dr. Sultan ÜZELTÜRK
Hukuk Fakültesi, Hukuk Bölümü

Prof. Dr. Ayla ERSOY
Güzel Sanatlar Fakültesi, Sanat Yönetimi Bölümü

Prof. Dr. Zeynep Aslı ALICI
Ticari Bilimler Fakültesi, Uluslararası Finans Bölümü

Prof. Dr. Cengiz ERİŞEN
İktisadi ve İdari Bilimler Fakültesi, Siyaset Bilimi ve Uluslararası İlişkiler Bölümü

Prof. Dr. Demet LÜKÜSLÜ
Fen-Edebiyat Fakültesi, Sosyoloji Bölümü

Prof. Dr. Saffet BABÜR
Fen-Edebiyat Fakültesi, Felsefe Bölümü