Investigating Gamma Power as a Neural Marker of Mindfulness-Related Change

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Declaration

I, Erik Panzer, certify that this thesis is an original work undertaken solely by me and does not incorporate material from published sources or work previously submitted for the award of any other degree or qualification. I further confirm that all data collected for this research, together with the complete set of analyses referenced herein, have been provided to my Primary Supervisors and are available upon request.

Name: Erik Panzer

Signature:

Date: 15/01/2026

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Abstract

Background: Mindfulness training has been shown to influence both psychological well-being and brain function. Neurophysiological studies using electroencephalography (EEG) have found that mindfulness practice can alter brain oscillations, particularly within frequency bands linked to attention, awareness, and emotional regulation. Despite growing evidence that mindfulness affects brain dynamics, the specific impact of mindfulness training on resting-state gamma activity and how such changes relate to psychological outcomes and facets of mindfulness remains underexplored. This study aimed to investigate the neurophysiological effects of mindfulness training, with a focus on gamma-band EEG activity and its association with psychological functioning.

Method: This study used a longitudinal design with two groups (mindfulness training vs control). Resting-state EEG and self-report measures; Five Facet Mindfulness Questionnaire (FFMQ) was collected at baseline (T1) and after a 6-week training period (T2). The primary focus was on gamma-band activity across five brain regions, (frontal, frontocentral, temporal, centroparietal, and occipitoparietal) and their relationship with mindfulness outcomes.

Results: At T2, gamma power in frontal regions negatively correlated with the "Acting with Awareness" facet of mindfulness. Regression analyses showed that EEG activity, particularly Left Frontal Lower Gamma at T2 predicted mindfulness scores, explaining an additional 47.2% of the variance beyond baseline levels. Higher gamma power was associated with lower self-reported awareness, suggesting mindfulness training reduced neural activation in regions linked to automatic processing. These effects were not present in the control group.

Conclusion: These findings indicate that mindfulness practice is associated with changes in gamma-band neural oscillations, which may reflect enhanced attentional control and reduced cognitive interference, key mechanisms underlying mental health resilience. By identifying gamma-band EEG markers predictive of mindfulness improvements, this study provides a foundation for developing personalized, brain-informed interventions that can be integrated into clinical settings to support stress reduction, emotional regulation, and overall mental well-being.

Keywords: Electroencephalography, Gamma Power, Five Facet Mindfulness Questionnaire

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Introduction

Mindfulness

The concept of *mindfulness*, which emphasizes awareness and presence in everyday life, has its roots in Buddhist meditative traditions. In the late 1970s, Jon Kabat-Zinn and colleagues introduced this approach into Western clinical practice, adapting it to build a framework for stress reduction and psychological well-being (Lee et al., 2021). Langer (1989) describes mindfulness as a state characterized by openness to novelty, sensitivity to context, and freedom from rigid, habitual thinking patterns. In contrast, Kabat-Zinn (1994) defined mindfulness as "paying attention in a particular way: on purpose, in the present moment, and nonjudgmentally." This definition highlights intentionality, present-moment focus, and an attitude of openness and acceptance. Baer (2003) further elaborated on this conceptualization, suggesting that mindfulness encompasses awareness of both internal experiences, such as thoughts, emotions, and bodily sensations, and external stimuli as they occur.

Contemporary literature conceptualizes mindfulness as a body–mind self-regulatory practice involving the deliberate training of attention to enhance voluntary control over mental processes (Berkovich-Ohana et al., 2012). Through cultivating non-judgmental awareness of present-moment experiences, mindfulness forms the basis for its therapeutic and cognitive benefits (Szumska et al., 2021).

Mindfulness is now widely recognized as a valuable approach to enhancing psychological well-being and cognitive functioning. Building on its conceptual foundations, it is cultivated through structured practices that train attention and awareness. Among these, mindfulness meditation is the most common, emphasizing sustained present-moment focus with openness and acceptance (Duda et al., 2024).

Mindfulness Practice

Translating these foundations and principles into practice, Mindfulness-based interventions have been developed and become increasingly integrated into clinical and educational settings, reflecting their broad applicability in promoting mental health and self-regulation (Gouda et al., 2016; Lomas et al., 2017).

Structured programs such as Mindfulness-Based Stress Reduction (MBSR) and Mindfulness-Based Cognitive Therapy (MBCT) have been shown to reduce symptoms of depression, anxiety, and stress, while fostering long-term resilience (Kabat-Zinn, 2003; Segal, Williams, & Teasdale, 2018). Recent evidence further highlights the effectiveness of MBCT in enhancing cognitive functions and emotional regulation across diverse populations, reinforcing its value as a clinically grounded and neurologically impactful intervention (Gkintoni et al., 2025).

Beyond symptom reduction, mindfulness-based approaches also promote psychological flexibility. Vøllestad et al. (2012) found that Mindfulness-and Acceptance-Based Interventions (MABIs) led to substantial improvements in emotional well-being, supporting the view that mindfulness influences emotion-related neural systems and facilitates adaptive regulation of affective states. MABI’s introduce an additional emphasis on psychological flexibility through acceptance strategies.

These interventions place particular emphasis on acceptance strategies derived from contextual behavioral therapies such as Acceptance and Commitment Therapy (ACT), encourage individuals to engage with thoughts and emotions without avoidance and thereby enhancing resilience and adaptive coping (Vøllestad et al., 2012).

In educational contexts, the Pause Breathe Smile (PBS) program represents a tailored mindfulness-based intervention. Research has shown that PBS significantly improves students' emotional regulation, attention, and overall well-being, with effects sustained beyond the program's completion (Bernay et al., 2016; Devcich et al., 2017). Qualitative evaluations highlight increased calmness, enhanced focus, and the development of pro-social behaviors such as empathy and kindness (Mindfulness Education Group, 2019; Rix & Bernay, 2015).

While structured programs such as MBSR, MBCT, MABIs, and PBS provide formalized frameworks for cultivating mindfulness, the essence of these interventions lies in the practices they employ. Mindfulness practice refers to the specific techniques through which individuals develop sustained attention, present-moment awareness, and acceptance.

Mindfulness practices differ in their attentional strategies and can be broadly classified into two primary categories, each engaging unique cognitive and neural mechanisms, which both offer distinct benefits. Focused Attention (FA) involves sustaining attention on a chosen object (e.g., breath), redirecting focus when distracted, while Open Monitoring (OM) cultivates non-reactive awareness of present experiences without anchoring attention to a specific object (Lutz et al., 2009).

Additional practices, such as body scans and loving-kindness meditation, further support emotional regulation and prosocial attitudes, contributing to the broad therapeutic benefits associated with mindfulness.

Mindfulness Assessment

One of the most widely used and evaluated measures of mindfulness is the Five Facet of Mindfulness Questionnaire (FFMQ) (Baer et al. 2008). It is a self-report questionnaire which measures five facets of mindfulness: observing, describing, acting with awareness, non-judgment of inner experience, and non-reactivity.

Research looking at the construct validity of the FFMQ found that the five facet scales demonstrated adequate to good internal consistency, with alpha coefficients ranging from .75 to .91, and relationships between the facet scales and other variables were consistent with predictions in most cases (Baer et al. 2008).

While self-report and behavioral measures such as the FFMQ provide valuable insight into the subjective and psychological outcomes of mindfulness training, there is growing recognition of the importance of examining its underlying neural mechanisms.

Neuroimaging techniques, particularly electroencephalography (EEG), offer a valuable means of exploring how mindfulness may induce neuroplastic changes in brain activity, providing insight into the cognitive and emotional processes it engages that are central to mindfulness. Integrating EEG measures with self-reported mindfulness therefore enables a more comprehensive examination of how mindfulness influences both brain function and subjective experience (Kaunhoven & Dorjee, 2017; Schoenberg & Eisendrath, 2016).

Mindfulness and Brain Function

Building on these psychological benefits, research has increasingly examined how mindfulness training influences the brain at both structural and functional levels. One line of evidence suggests mindfulness induces structural changes in regions associated with emotion regulation, self-awareness, and memory. Hözel et al. (2011) conducted a longitudinal study examining grey matter concentration before and after an 8-week MBSR program. Their findings revealed significant increases in grey matter within the left hippocampus, a region critical for learning and memory consolidation. In addition to this hypothesized change, whole-brain analyses identified structural increases in the posterior cingulate cortex (PCC), a region involved in the default mode network (DMN), cognitive control, and self-referential processing; the left temporo-parietal junction (TPJ), linked to language processing and social cognition; and two regions within the cerebellum, implicated in emotional regulation and attentional processes.

Supporting these findings, Fox et al. (2014) conducted an anatomical likelihood estimation (ALE) meta-analysis of structural neuroimaging studies, identifying eight brain regions consistently altered in long-term meditation practitioners. These included areas associated with meta-awareness (frontopolar cortex), body awareness (insula and sensory cortices), memory consolidation (hippocampus), and self- and emotion regulation (anterior and mid cingulate cortex, orbitofrontal cortex). Their results suggest that sustained mindfulness practice can lead to widespread and functionally meaningful changes in brain structure.

Beyond structural plasticity, mindfulness also appears to strengthen attentional systems. Jha et al. (2007) demonstrated that MBSR improved conflict monitoring and orienting attention, reflecting greater efficiency in the dorsal attention system, which supports top-down, goal-directed control. Improvements in alerting performance, linked to the ventral attention system, further indicated increased attentional readiness, particularly in individuals with prior meditation experience. These results highlight the potential of mindfulness to strengthen voluntary and receptive forms of attention and contribute to more adaptive cognitive control.

Extending this work, EEG provides an opportunity to examine how mindfulness influences the brain's dynamic oscillatory activity across different frequency bands.

Mindfulness and EEG

EEG is a non-invasive technique that offers unique methodology for studying the neural correlates of mindfulness by capturing oscillatory brain activity across distinct frequency bands (Knyazev, 2007).

Over the past decade, a growing body of literature has demonstrated the influence of mindfulness practice on EEG outcomes, including alterations in brain wave patterns (Lomas et al., 2015; Luo et al., 2024; Szumska et al., 2021), and changes in effective connectivity (Ng et al., 2023). EEG research on mindfulness has also identified both *state effects* – the immediate neural changes observed during meditation, and *trait effects* – longer lasting alterations in cognition, affect, and behavior that extend beyond the meditation practice itself (Cahn & Polich, 2006; Duda, Clarke, & Barry, 2024).

Mindfulness-related EEG research has reported frequency-specific effects across multiple bands, with different meditation practices showing distinct oscillatory profiles (Lee et al., 2018). Beyond meditation, spectral power has also been used to characterize clinical states such as depression, where patient EEG profiles show reliable differences across sub-bands compared to healthy controls (Fitzgerald & Watson, 2018; Kalev & Bachmann, 2014; Wu, 2018). Together, these findings highlight the relevance of frequency-based EEG analysis for examining how mindfulness modulates brain function.

Mindfulness and EEG Band Frequencies

EEG activity is commonly divided into five primary frequency bands including delta (δ: 0.4–4 Hz), theta (θ: 4–8 Hz), alpha (α: 8–12 Hz), and beta (β: 12–28 Hz) and gamma (γ: >30 Hz), each associated with distinct cognitive and affective processes (Figure 1) (Knyazev, 2007; Lee et al., 2018). Theta and alpha bands are typically linked to attentional control and relaxed awareness, whereas beta activity is associated with cognitive engagement and executive functioning. Gamma oscillations are implicated in higher-order integrative processes, including sensory integration, memory, and attentional binding (Berkovich-Ohana et al., 2012; Lutz et al., 2004).

Mindfulness has been shown to influence neural oscillations across all major EEG frequency bands. Mindfulness practice consistently increases theta (4-8 Hz) power, especially in frontal midline regions, reflecting enhanced sustained attention and internal awareness (Duda, Clarke, Barry, et al., 2024; Kim et al., 2022). This increase is linked to reduced anxiety and improved emotional regulation (Aftanas & Golocheikine, 2001; Inanaga, 1998). Theta enhancement has been observed across various populations, including university students (Jung & Lee, 2021), and is often accompanied by alpha increases and overall EEG slowing (Cahn & Polich, 2006). Although anxiety states may also show elevated theta, mindfulness-related theta is more focused and typically paired with higher prefrontal alpha (Komarov et al., 2020). A systematic review confirmed that theta and alpha increases are reliable markers of mindfulness, especially in regular practitioners (Lomas et al., 2015).

Alpha (8-13 Hz) activity is frequently elevated during and after mindfulness practice, particularly in frontal and central regions, indicating relaxed alertness and internalized attention (Jung & Lee, 2021; Lomas et al., 2015). Frontal alpha asymmetry shifts positively following mindfulness training, suggesting improved emotional regulation (Hawley et al., 2021). Alpha increases often co-occur with theta enhancement, forming a characteristic EEG signature of meditative states (Cahn & Polich, 2006). While anxiety is associated with low prefrontal alpha, mindfulness appears to counteract this pattern, promoting emotional stability (Komarov et al., 2020).

Beta (13-30 Hz) modulation in mindfulness is variable. Some studies report reductions in beta power post-intervention, suggesting a calming effect on cortical arousal (Jung & Lee, 2021; Minguillon et al., 2016). Others observe increased beta coherence, indicating improved neural integration and cognitive control. Hawley et al. (2021) found increased beta over time, which they interpreted as reflecting reduced mind-wandering and improvements in obsessive-compulsive symptoms. These findings suggest that beta changes may reflect mindfulness-related shifts in attention and executive function.

Gamma (>30 Hz) activity during mindfulness shows complex modulation. Long-term practice is associated with reduced frontal gamma power, interpreted as decreased DMN activity and reduced mind-wandering (Berkovich-Ohana et al., 2012). Simultaneously, increased posterior gamma and enhanced coherence have been observed in experienced meditators, reflecting improved integrative and attentional processing (Berkovich-Ohana et al., 2012; Jung & Lee, 2021). Gamma power also negatively correlates with anxiety levels (Kim et al., 2022), and mindfulness scores have been linked to high-frequency gamma activity during meditation (Hauswald et al., 2015). Changes in low-gamma power have been observed even in early stages of practice (Cahn et al., 2010; Lutz et al., 2004; Ng et al., 2023).

The table below displays these four bands and their associations.

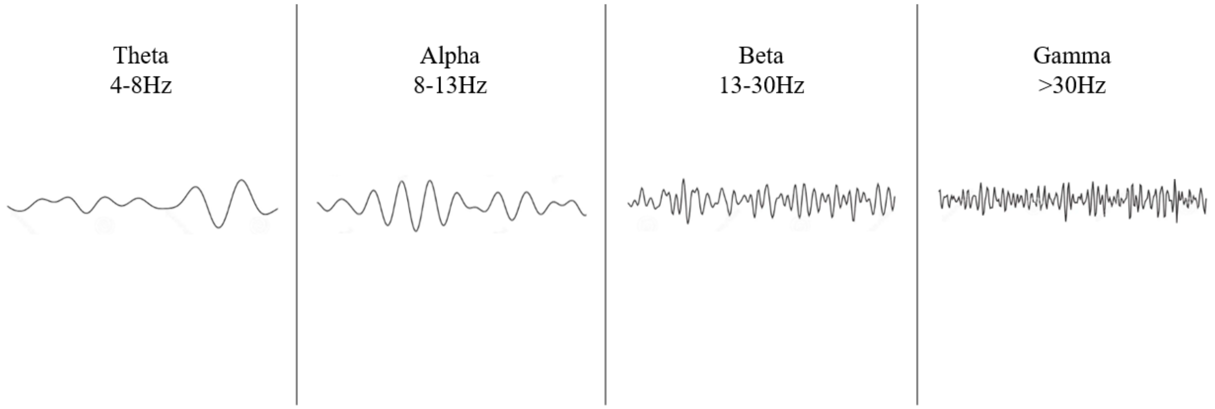


Figure 1 *Frequency bands, their corresponding frequency ranges in Hertz (Hz), and associated wave patterns.*

Mindfulness and Gamma Band

Gamma oscillations (>30 Hz) are associated with sensory integration, attention, memory, and higher-order cognitive functions (Lutz et al., 2004; Ng et al., 2023). They also play a critical role in neural synchrony, coordinating activity across distributed brain networks—an essential mechanism for unified cognitive processing. Given these functions, studying gamma-band activity offers a valuable window into the neurophysiological mechanisms underlying mindfulness practice. Existing studies have primarily focused on state-related gamma effects during meditation, but emerging evidence suggests that gamma may serve as a sensitive marker of both cognitive integration and emotional regulation in mindfulness practice.

Recent work by Ng et al. (2023) investigated EEG signals before and after mindfulness training and reported global increases in low-gamma effective connectivity following the intervention. They found that regardless of whether the participant was in the resting, breathing or body-scan mindfulness training, that low-gamma band effective connectivity increased globally after mindfulness training.

Complementing these findings, Berkovich-Ohana et al. (2012) reported that trait mindfulness is linked to lower frontal gamma activity, while both state and trait mindfulness are associated with increased posterior gamma, irrespective of meditation proficiency (Berkovich-Ohana et al., 2012).

Evidence from long-term meditation studies further supports the involvement of gamma oscillations in mindfulness-related neural processes (Jung & Lee, 2021). Specifically, Jung and Lee (2021) found that greater meditation experience predicted enhanced gamma coherence, reflecting improved integrative and attentional processing. Similarly, Vipassana meditation has been associated with increased gamma coherence in parieto-occipital regions (Lutz et al., 2004; Cahn et al., 2013), a finding also supported by (Braboszcz et al., 2017). Among Buddhist practitioners, increases have also been observed in the fronto-parietal region. Lee et al. (2018) further suggest that advanced practitioners of various meditation traditions show increased gamma activity more broadly. Collectively, these studies indicate that mindfulness practices, in their different forms, are linked to increases in gamma oscillations across specific brain regions, with the precise pattern depending on the type of meditation. More recent research by Cahn et al. (2010), Fell et al. (2010), and Lomas et al. (2015) has proposed that heightened gamma activity reflects the deepest states of meditation, characterized by unified and coherent mental activity. This reinforces the finding that higher gamma is most consistently observed in more experienced meditators.

Despite these observations, gamma-band effects have been less consistently reported than changes in theta and alpha activity, which remain the most robust EEG markers of mindfulness (Duda, Clarke, Barry, et al., 2024; Hawley et al., 2021; Kim et al., 2022). According to Duda, Clarke, & Barry (2024), research on gamma oscillations in mindfulness is still new. Gamma activity thus represents a compelling target for further exploration as it could add new dimensions to the neuroscience of mindfulness.

The novelty of this study lies not only in its integration of EEG and behavioral measures but also in its focus on trait-level neural changes. Whereas much of the existing research examines gamma-band activity during meditation, this study uniquely investigates pre- to post-intervention changes, offering insight into the enduring neurophysiological effects of mindfulness practice. By extending prior work on theta and alpha bands to the less explored gamma frequency range, these findings contribute to a growing understanding of the neural mechanisms underlying mindfulness. Importantly, this study also provides the first evidence that a psychoeducational-based mindfulness program (PBS) can produce measurable changes in brain activity, complementing previous reports of psychological and behavioral benefits.

If mindfulness can reliably modulate gamma-band activity, it may offer a pathway to enhance cognitive flexibility, sensory processing, and emotional regulation, functions often disrupted in mental health conditions. This has significant implications for therapeutic applications, particularly for disorders characterized by dysregulated neural synchrony or attentional deficits. Understanding how mindfulness influences gamma oscillations could inform the refinement of mindfulness-based interventions and support the development of personalized mental health treatments.

Research Aim, Research Questions, and Hypotheses

The aim of this study is to investigate the neurophysiological impact of mindfulness training on gamma-band EEG activity and its relationship with psychological outcomes, specifically mindfulness. Unlike much of the existing research that examines gamma activity during meditation, this study focuses on resting-state EEG before and after a 6-week mindfulness intervention, allowing for the assessment of trait-level neural changes.

Research Questions

Overarching Research Question: Does mindfulness training induce measurable changes in resting-state gamma-band EEG activity, and can these neural changes predict improvements in mindfulness?

1. Does mindfulness training lead to measurable changes in resting-state gamma-band activity compared to a control group?
2. Are changes in gamma activity associated with improvements in self-reported mindfulness?
3. Can gamma activity predict mindfulness outcomes after training, beyond baseline measures?

Hypotheses:

- H1: Participants in the mindfulness group will show significant changes in gamma activity from pre- to post-intervention compared to controls.
- H2: Reduced frontal gamma activity will be associated with higher scores on mindfulness measures.
- H3: Gamma activity will significantly predict post-intervention mindfulness outcomes, after controlling for baseline levels.

Method

Participants

A total of 44 individuals initially consented to participate in the study. However, the final sample was reduced to 32 participants due to attrition, including withdrawal from the study, issues related to cognitive functioning, or lack of follow-up without explanation. The final sample comprised 22 females, with N=9 in the Experimental group (mean age 31.78 years, SD 13.85) and N=13 in the Control group (mean age 26.92 years, SD 10.20), and 10 males, with N=4 in the Experimental group (mean age 29.25 years, SD 7.59), and N=6 in the control group (mean age 29.83 years, SD 13.35).

The ethnic makeup was diverse, with participants identifying as New Zealand European (46.9%), Other (21.9%), Asian (18.8%), Indian (6.3%), Māori (3.1%), and Pacific (3.1%).

Table 1 *Participant demographics by gender and group, including sample size (N), mean age, and standard deviation (SD)*

Gender	**Group**	**N**	**Mean Age**	**SD**
Female	Experimental	9	31.78	13.85
Female	Control	13	26.92	10.20
Male	Experimental	4	29.25	7.59
Male	Control	6	29.83	13.35

Ethics

All experiments were performed in accordance with the relevant guidelines and regulations. Ethical approval was obtained by the Auckland University of Technology (AUT)

Ethics Committee (AUTEC) New Zealand, and informed consent obtained (Doborjeh et al., 2019).

Additionally, ethical approval was obtained from The University of Waikato to facilitate a data-sharing agreement, see Appendix B.

Procedure

Participants were recruited via advertisements to staff and students at Auckland University of Technology, New Zealand, through posters, emails through various university communication channels, Facebook pages, and presentations at the beginning of classes.

Protocol of Study

Figure 2 *Protocol of the study, including EEG recording during a 120-second resting state with eyes closed, and administration of the FFMQ questionnaire before (Time 1) and after (Time 2) mindfulness training.*

Mindfulness Training

The mindfulness training was a modified version (Krägeloh, 2019) of an educational mindfulness program called Pause, Breathe Smile (Devcich et al., 2017). Mindfulness training sessions were delivered weekly for at least 1-hour. Across the adjusted 6-week program, there were body-based and breath-based practices, breathing meditation practices, mindful movements, and mindful eating practices. Additionally, participants were encouraged to practice for at least 15 minutes per day.

Materials/Measures

Self-Report/Behavioral Measures

Participants completed self-report questionnaires online via Qualtrics at both pre- and post-intervention time points. Mindfulness was assessed using the Five Facet Mindfulness Questionnaire (FFMQ; Baer et al., 2006), a 39-item measure evaluating five dimensions: Acting with Awareness, Describing, Nonjudging, Nonreactivity, and Observing. Items are rated on a 5-point Likert scale (1 = never or very rarely true, 5 = very often or always true), with higher scores indicating greater mindfulness. The full FFMQ is provided in Appendix A.

EEG Measures

EEG recordings were obtained in two sessions: (1) before participants began mindfulness training (MT) and (2) after 6 weeks of MT. In each session, 2 minutes of eyes-closed resting-state data were recorded using a SynAmps amplifier and a 62-channel QuikCap based on the international 10–20 system (FP1, FPZ, FP2, AF3, AF4, F7, F5, F3, F1, FZ, F2, F4, F6, F8, FT7, FC5, FC3, FC1, FCZ, FC2, FC4, FC6, FT8, T7, C5, C3, C1, CZ, C2, C4, C6, T8, TP7, CP5, CP3, CP1, CPZ, CP2, CP4, CP6, TP8, P7, P5, P3, P1, PZ, P2, P4, P6, P8, PO7, PO5, PO3, POZ, PO4, PO6, PO8, CB1, O1, OZ, O2, CB2). Data were collected at sampling rate of 1000 Hz and artefacts from eye movements and muscle activity were removed offline using Independent Component Analysis (ICA).

Data Analysis

EEG Data Processing

EEG data were pre-processed using the MATLAB toolbox EEGLAB (version) (Delorme & Makeig, 2004). Preprocessing steps included re-referencing the data to the mastoid electrodes (M1 and M2), selecting 62 scalp channels for analysis, and decomposing the data using ICA to identify and remove artifacts. Cleaned EEG data were then segmented for spectral analysis.

EEG power values were extracted for lower and upper gamma frequency bands and log-transformed using base-10 logarithms ($\log_{10}$) in SPSS to reduce skewness and improve adherence to assumptions of parametric statistical testing. Raw EEG power values typically span several orders of magnitude, and log transformation compresses this range while preserving proportional differences. All subsequent statistical analyses were conducted using log-transformed power values.

Spatial Organization of EEG Measures

EEG power was organized according to predefined scalp regions and hemispheres. For the main repeated-measures analyses, electrodes were grouped into five regions: frontal, frontocentral, temporal, centroparietal, and occipitoparietal, with left and right hemisphere values retained separately.

For correlational and regression analyses, regional averages were computed from selected electrodes representing all regions to examine associations between gamma-band activity and mindfulness measures. These regional summaries were used exclusively for correlational and predictive analyses and were not used in the repeated-measures ANOVA.

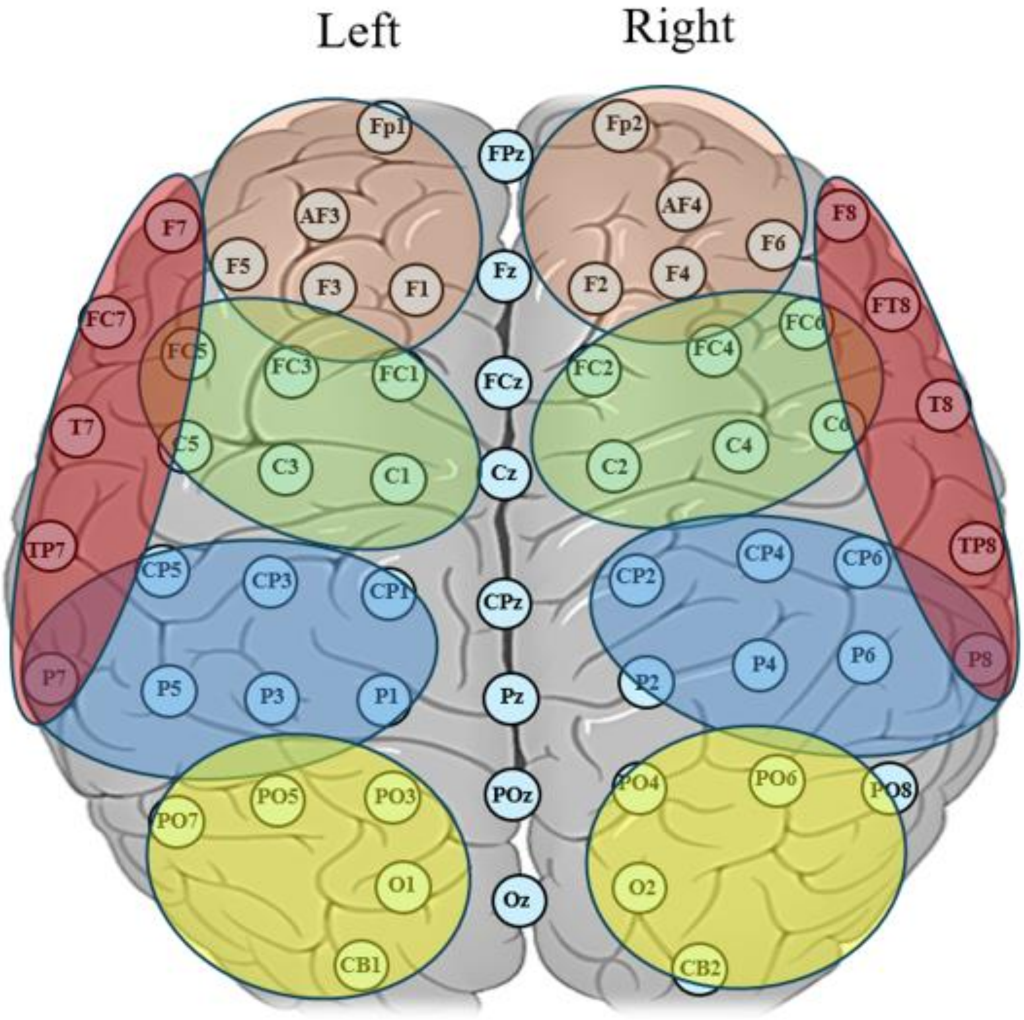


Figure 3 *Dividing EEG channels into five sites for both hemisphere (left and right) with respect to their topological information including: orange colour: left and right frontal (Fp1, AF3, F5,F3, F1 and Fp2, AF4, F6, F4, F2); green colour: left and right frontocentral (FC5, FC3, FC1, C5, C3, C1 and FC6, FC4, FC2, C6, C4, C2); red colour: left and right temporal (F7, FT7, T7, TP7 and F8, FT8, T8, TP8); blue colour: left and right centroparietal (CP5, CP3, CP1, P7, P5, P3, P1 and CP6, CP4, CP2, P8, P6, P4, P2); yellow colour: left and right occipitoparietal (PO7, PO5, PO3,O1, CB1 and PO8, PO6, PO4, O2, CB2).*

Correlation Analysis

Pearson correlation analyses were conducted to examine associations between mindfulness facets and EEG gamma-band activity at both Time 1 and Time 2. Psychological measures included the FFMQ facets (Acting with Awareness, Describing, Non-reactivity, Non-judging, and Observing), while EEG measures comprised lower and upper gamma power across frontal, parietal, temporal, and occipital regions. These analyses aimed to determine whether higher mindfulness scores corresponded with increased gamma activity. These analyses were conducted separately for the mindfulness and control groups

Regression Analysis

Hierarchical multiple regression analyses were conducted to examine whether EEG gamma-band activity predicted post-intervention mindfulness, specifically the Acting with Awareness facet of the FFMQ. The primary objective was to determine whether gamma power at Time 2 (T2) predicted Acting with Awareness scores at T2 after controlling for baseline mindfulness at Time 1 (T1).

In each model, Acting with Awareness at T1 was entered in the first block to control for baseline levels and assess trait stability. EEG gamma power at T2 was added in the second block as the predictor of interest. Five models were tested, each incorporating a different EEG variable to evaluate the unique contribution of gamma activity from distinct regions and frequency ranges: Left Frontal Lower Gamma, Left Frontal Upper Gamma, Right Frontal Upper Gamma, Right Fronto-Central Lower Gamma, and Right Fronto-Central Upper Gamma.

Separate analyses were conducted for the experimental and control groups. Scatter plots were generated to visually assess the direction and strength of these relationships.

Repeated-Measures ANOVA

To examine changes in resting-state gamma power across time, hemispheres, and scalp regions, repeated-measures analyses of variance (ANOVAs) were conducted separately for lower and upper gamma bands. Each ANOVA included Time (T1, T2), Hemisphere (left, right), and Site (frontal, frontocentral, temporal, centroparietal, occipitoparietal) as within-subjects factors, with Group (mindfulness, control) as a between-subjects factor.

Greenhouse–Geisser corrections were applied where violations of sphericity were detected, and corrected degrees of freedom are reported where appropriate. Significant higher-order interactions were followed up with region-specific analyses to clarify the source of effects.

Results

The current study was organized in a three-phase analysis as follows:

1. Explored associations between gamma activity (upper and lower bands) and mindfulness scores (FFMQ) through the method of correlational analysis.
2. Assessed whether EEG gamma activity at T2 predicted mindfulness outcomes at T2, while controlling for baseline mindfulness (T1), through hierarchical regression analysis.
3. Examined differences in gamma power between the experimental and control groups to evaluate the impact of mindfulness training, through group comparison methods (ANOVA).

These steps are explained in the following sections.

Correlational Analysis Between Gamma Power and Mindfulness

At post-intervention (Time 2), the experimental group showed a more focused pattern of significant correlations, primarily between Acting with Awareness subscale of the FFMQ and gamma activity.

Significant negative correlations were observed between Acting with Awareness and gamma power in frontal and frontocentral regions. Specifically, higher Acting with Awareness scores were associated with lower and upper-gamma activity across left frontal, right frontal, and right frontocentral sites as shown in Table 2.

The results showed that at baseline (Time 1), the control group had a broader pattern of significant correlations between gamma activity and multiple mindfulness facets (see Table 3). Negative associations were observed between gamma power and the Describing and Non-reactivity subscales across temporal, frontal, and centroparietal regions, as shown in Table 3.

Table 2 *Pearson Correlation Table, Time 2, Experimental. LF - Left Frontal, RF - Right Frontal, RFC - Right Fronto-Central*

Time 2 Gamma x FFMQ – Experimental	**r-(Pearson)**	**p-value**	**N**
LF Lower Gamma x Acting with Awareness	-.703*	0.016	11
LF Upper Gamma x Acting with Awareness	-.719*	0.013	11
RF Upper Gamma x Acting with Awareness	-.655*	0.029	11
RFC Lower Gamma x Acting with Awareness	-.646*	0.032	11
RFC Upper Gamma x Acting with Awareness	-.669*	0.024	11

Table 3 *Pearson Correlation Table, Time 1, Control. LT - Left Temporal, RT - Right Temporal, RCP - Right Centro-Parietal*

Time 1 Gamma x FFMQ – Control	**r-(Pearson)**	**p-value**	**N**
LT Lower Gamma x Describing	-.620	0.014	15
RT Lower Gamma x Describing	-.624	0.013	15
RT Upper Gamma x Non-Reacting	-.515	0.050	15
RCP Lower Gamma x Non-Reacting	-.541	0.037	15

Predictive Role of Gamma Activity on Post-Training Mindfulness

Hierarchical regression analyses were conducted to examine whether gamma-band activity at Time 2 predicted Acting with Awareness scores at Time 2 after controlling for baseline levels (see Figure 4 for scatter plots of all regression models).

In the experimental group, reduced gamma activity in frontal and frontocentral regions was associated with higher Acting with Awareness scores across several models. Left frontal lower gamma significantly predicted Acting with Awareness at Time 2 ($\beta = -.695$, $p = .025$), with the overall model explaining 50% of the variance ($R^2 = .50$). A similar pattern was observed for left frontal upper gamma ($\beta = -.730$, $p = .015$; $R^2 = .56$). Right frontal upper gamma also showed as a significant predictor ($\beta = -.653$, $p = .045$), although the overall model did not reach conventional significance. Models including right frontocentral gamma activity showed significant EEG coefficients; however, the overall model fit did not reach significance, and these findings should therefore be interpreted cautiously.

In contrast, across all regression models in the control group, baseline Acting with Awareness was the dominant predictor of post-intervention mindfulness ($\beta s > .91$, $ps < .001$). Gamma activity did not contribute significantly to any model, indicating stability of mindfulness scores over time in the absence of intervention.

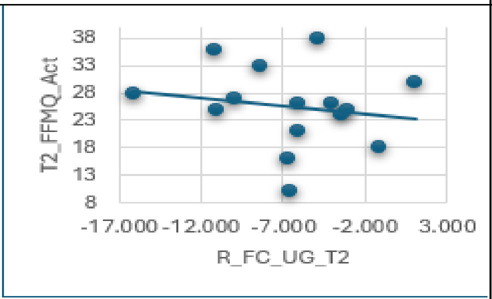
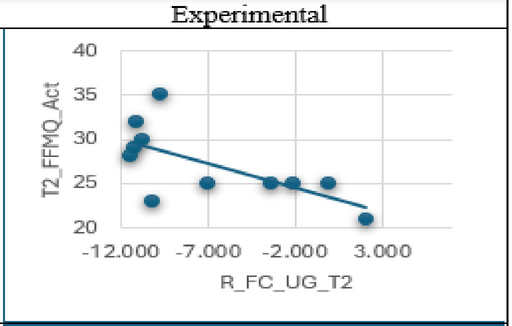
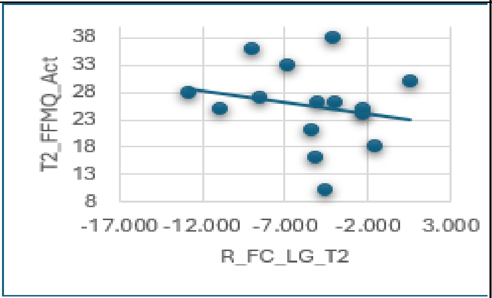
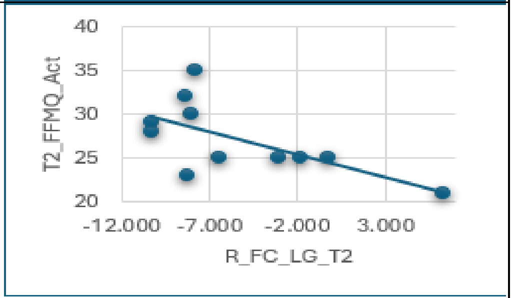
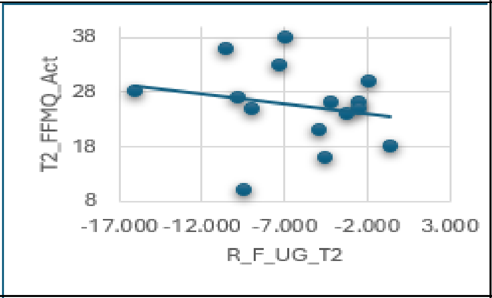
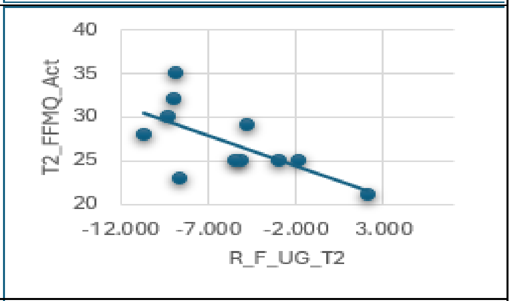
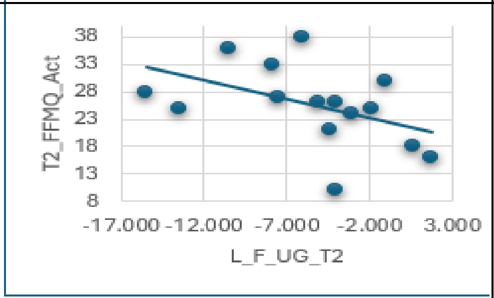
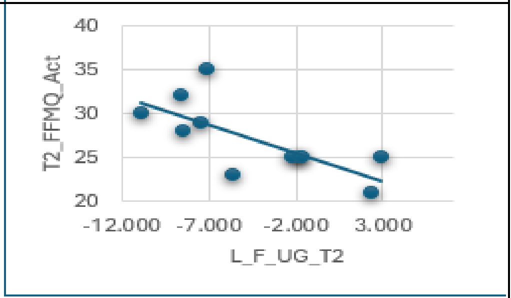
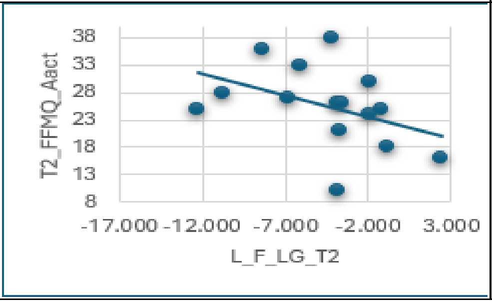
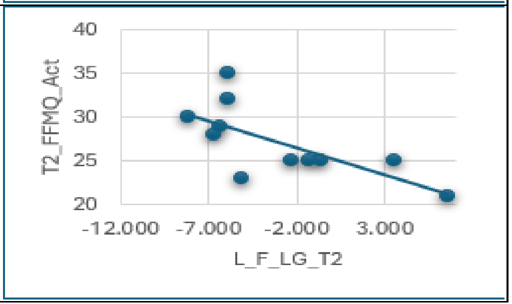
Regression	Control	Experimental
5		
4		
3		
2		
1		

Figure 4 *Scatter plots of regression analyses for Control and Experimental groups across five models. Each plot shows the relationship between EEG gamma-band activity and Acting with Awareness (FFMQ subscale) at Time 2 (T2).*
Note. Abbreviations: T2 = Time point two; FFMQ = Five Facet Mindfulness Questionnaire; Act = Acting with Awareness; R = Right; L = Left; LG = Lower Gamma; UG = Upper Gamma; F = Frontal; FC = Fronto-Central.

Group Differences in Gamma Power Following Mindfulness Training

A significant main effect of Site for both lower and upper gamma activity, indicating clear spatial variability in gamma power across brain regions, F(1.654, 47.962) = 9.317, < .001, $\eta p^2 = .243$ for lower gamma, and F(1.605, 45.554) = 8.750, $p < .001$, $\eta p^2 = .232$ for upper gamma. Figure 5 illustrates gamma power distributions across sites at Time 1 and Time 2 for both groups.

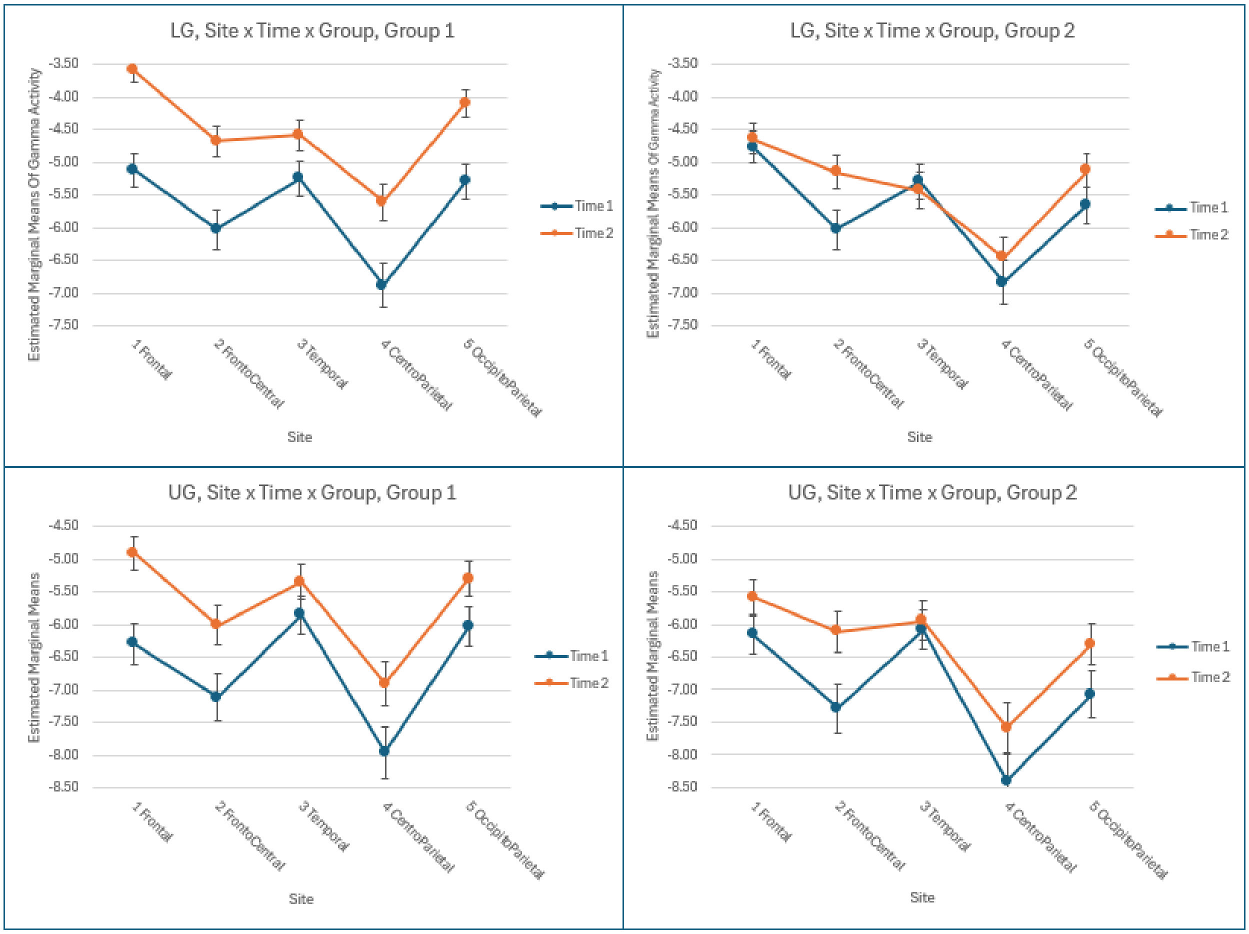


Figure 5 *Estimated marginal means of gamma activity from the Site × Time × Group ANOVA. Line graphs display lower gamma (LG; top row) and upper gamma (UG; bottom row) activity across five electrode sites (Frontal, FrontoCentral, Temporal, CentroParietal, OccipitoParietal) for Group 1 (left column) and Group 2 (right column) at time 1 - and Time 2. Error bars represent standard errors.*
Note. *LG = Lower Gamma; UG = Upper Gamma; Time 1 = pre-intervention; Time 2 = post-intervention.*

A significant Hemisphere × Site interaction was also observed, $F(3.038, 88.10) = 5.245$, $p = 0.002$, $\eta p^2 = .153$ for lower gamma, $F(2.939, 85.23) = 4.307$, $p = 0.007$, $\eta p^2 = .129$ suggesting that the distribution of gamma activity varied across hemispheres (see Figure 6).

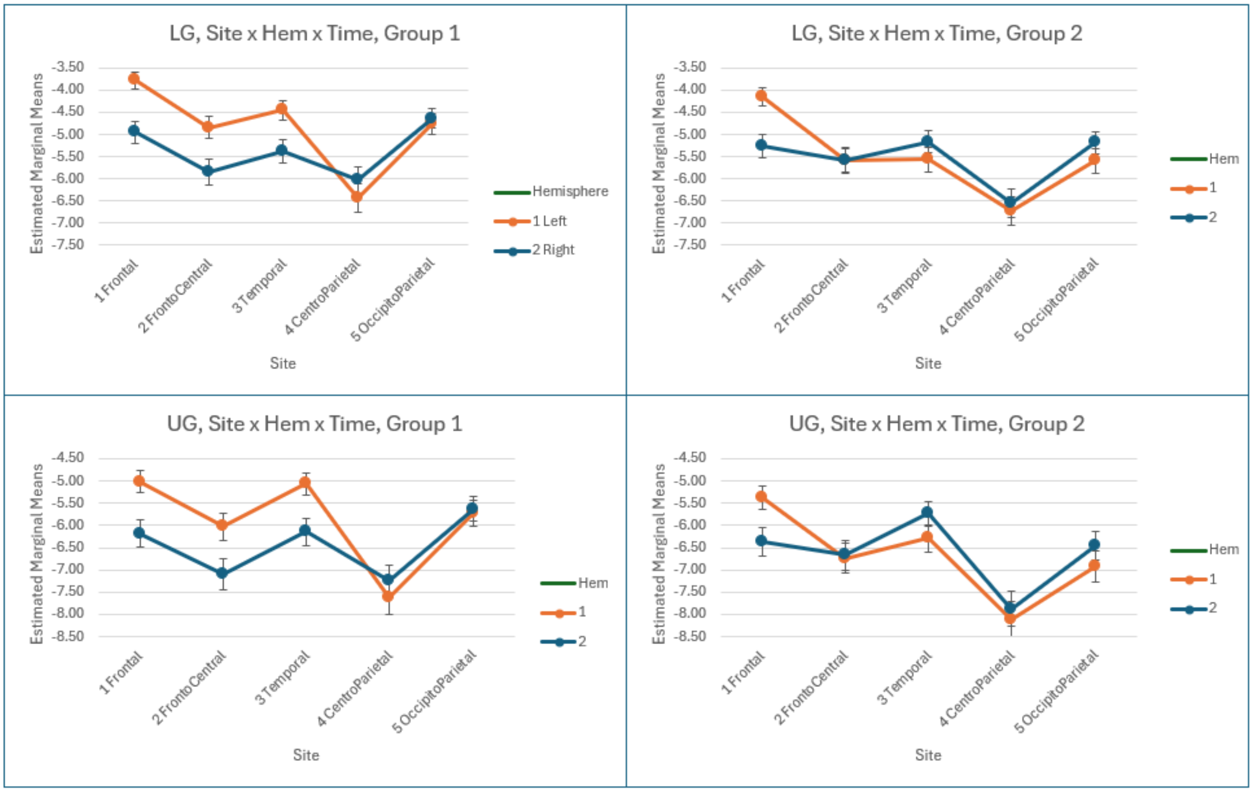


Figure 6 *Estimated marginal means of gamma activity from the Site × Hemisphere × Time ANOVA. Line graphs display lower gamma (LG; top row) and upper gamma (UG; bottom row) activity across five electrode sites (Frontal, FrontoCentral, Temporal, CentroParietal, OccipitoParietal) for Group 1 (left column) and Group 2 (right column), separated by hemisphere (Left - Orange vs. Right - Navy). Error bars represent standard errors.*
Note. *LG = Lower Gamma; UG = Upper Gamma; Hem = Hemisphere; 1 = Left; 2 = Right.*

To further examine these spatial patterns, follow-up analyses were conducted for each brain region to assess time effects and potential group differences at the regional level.

At frontal site, a significant main effect of Hemisphere was found for both lower gamma ($F(1,12) = 10.18$, $p = .008$, $\eta p^2 = .459$) and upper gamma ($F(1,12) = 9.60$, $p = .009$, $\eta p^2 = .444$) in the mindfulness group, as well as in the control group (lower gamma: $F(1,17) = 12.49$, p

= .003, ηp² = .424; upper gamma: *F*(1,17) = 6.87, *p* = .018, ηp² = .288). For the frontocentral site, no significant main effects or interactions were observed for either lower or upper gamma activity. The main effect of Hemisphere was not significant in either the mindfulness (*p* = .100) or control group (*p* = .853).

For the temporal site, no significant main effects or interactions were observed for either lower or upper gamma activity. The main effect of Hemisphere was non-significant in both the mindfulness (*p* = .151 for lower; *p* = .153 for upper) and control groups (*p* = .287 for lower; *p* = .202 for upper).

At occipitoparietal sites, a significant Hemisphere × Time interaction was observed for lower gamma in the control group (F(1,17) = 7.805, p = .012, ηp² = .315), with no significant effects in the mindfulness group, as shown in Figure 7.

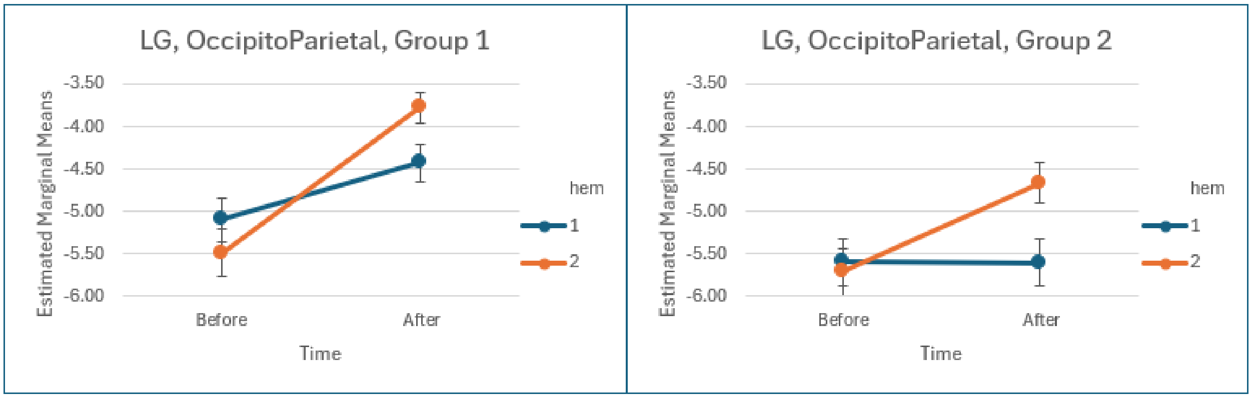


***Figure** 7 Estimated marginal means of lower gamma activity at the OccipitoParietal site. Line graphs display changes from Time 1 (Before) to Time 2 (After) for left and right hemispheres in Group 1 (left panel) and Group 2 (right panel). Error bars represent standard errors.*

***Note.** Hem = Hemisphere; 1 = Left; 2 = Right; LG = Lower Gamma.*

Discussion

This study examined whether mindfulness training produces measurable changes in resting-state gamma-band EEG activity and whether such neural changes predict improvements in mindfulness. Using a longitudinal design, we compared an experimental group undergoing mindfulness training with a control group to explore the neurophysiological and psychological effects of the intervention.

Results were derived using Pearson correlation, regression analysis, and repeated-measures ANOVA to examine the relationships between gamma-band activity and mindfulness outcomes across time and groups.

At Time 2 (post-intervention), the experimental group showed significant negative correlations between gamma activity and the Acting with Awareness facet, while the control group showed no significant correlations. At Time 1 (baseline), the control group showed significant negative correlations between gamma activity and the Describing and Non-Reacting facets of mindfulness.

These findings suggest that prior to any intervention, individuals with lower mindfulness exhibited elevated gamma activity, particularly in temporal, and centro-parietal regions, as observed in the correlation analysis. This pattern may reflect increased cognitive load, given that gamma-band activity in temporal and parietal regions has been linked to heightened working-memory and attentional demands (Kaiser et al., 2017; Roux et al., 2012; Thompson et al., 2021). After mindfulness practice, participants with higher scores in Acting with Awareness showed reduced gamma activity in frontal and fronto-central regions, a pattern consistent with findings that mindfulness practice is associated with decreased frontal gamma power and more efficient cognitive processing (Berkovich-Ohana et al., 2012).

The presence of significant gamma–mindfulness correlations in the control group at baseline likely reflects trait-level associations between cognitive–emotional load and self-reported mindfulness rather than intervention-related change. This interpretation is consistent with evidence that baseline gamma activity, particularly in frontal and temporal regions, reflects individual differences in cognitive effort and affective processing (Yang et al., 2020; Roux et al., 2012). The absence of these associations at Time 2, alongside the stability of mindfulness scores and regression patterns, suggests that without training, gamma activity remains functionally coupled to baseline cognitive processes. This contrasts with the experimental group, where mindfulness training appeared to alter the relationship between gamma activity and mindful awareness, consistent with findings showing that mindfulness practice reduces frontal gamma power and modifies gamma-based functional connectivity linked to self-referential processing (Berkovich-Ohana et al., 2012; Berkovich-Ohana et al., 2014).

This shift from broader baseline correlations to more specific post-intervention associations suggest a change in the relationship between gamma activity and mindfulness following training, and the absence of correlations in the control group at Time 2 further underscores the role of the intervention.

Regression analyses revealed that in the experimental group, decreased gamma activity in frontal and frontocentral regions significantly predicted higher mindfulness scores across five models, though some models were marginally non-significant overall. In the control group, baseline mindfulness consistently predicted outcomes, with minimal EEG contribution. Scatter plots showed negative slopes in all models, often steeper in the experimental group.

Research questions fulfilment

1. Does mindfulness training lead to measurable changes in resting-state gamma-band activity compared to a control group?

Repeated measures ANOVA found group differences in gamma power after intervention. The mindfulness group showed significant increases in gamma power from T1 to T2, particularly in centroparietal and occipital-parietal regions, while the control group exhibited minimal change. There was a significant main effect of Site (lower gamma: $F = 9.317$, $p < .001$; upper gamma: $F = 8.750$, $p < .001$) and notable Hemisphere × Site interactions. These findings indicate that mindfulness training alters resting-state gamma activity, supporting the idea of neurophysiological change.

Our results align with broader evidence of oscillatory modulation following mindfulness practice. For example, McQueen et al. (2024) reported group differences in theta, alpha, and gamma oscillatory power between meditators and non-meditators, even after controlling for non-oscillatory 1/f activity. Their observation of altered gamma distributions supports the notion that mindfulness experience reshapes oscillatory dynamics across multiple frequency bands.

Similarly, Galindo-Aldana et al. (2025), in a systematic review of mindfulness-based interventions, highlighted consistent EEG changes in frontal regions linked to executive function and attentional control, and identified gamma as a candidate biomarker for intervention-related improvements. Song (2025) adds further support, noting robust and temporally stable enhancement of gamma-band power (30–45 Hz) across multiple segments in nearly all subgroups. This widespread increase, particularly in centroparietal and occipital-parietal regions, reinforces the view that gamma oscillations may serve as a neurophysiological marker of sustained internal attention and sensory integration during meditative and resting states.

Taken together, these results confirm Hypothesis 1: participants in the mindfulness group showed significant changes in gamma activity from pre- to post-intervention compared to controls.

2. Are changes in gamma activity associated with improvements in self-reported mindfulness?

Correlation analyses revealed that, at Time 2 (post-intervention), the experimental group showed significant negative correlations between gamma activity and the *Acting with Awareness* facet of mindfulness, particularly in frontal and frontocentral regions, e.g., LF Upper Gamma (r = –.719, p = .013), RFC Upper Gamma (r = –.669, p = .024).

These findings suggest that increased mindfulness, whether cultivated through training or as a dispositional trait, may be associated with reduced frontal gamma activity at rest. This pattern aligns with a growing body of literature linking gamma oscillations to self-referential processing and attentional control.

Our results are consistent with Berkovich-Ohana et al. (2012), who reported that mindfulness meditation practitioners exhibited lower frontal gamma activity, a pattern associated with reduced narrative self-reference and diminished DMN engagement. Similarly, Galindo-Aldana et al. (2025) demonstrated that lower frontal gamma power at rest correlates with higher dispositional mindfulness scores, reinforcing the notion that gamma suppression may reflect decreased mind-wandering and enhanced present-moment awareness. Auguerre et al. (2023) further support this interpretation, finding that dispositional mindfulness was linked to reduced frontal gamma power during rest. Although our study examined trained mindfulness rather than dispositional traits, the convergence of evidence suggests that both forms of mindfulness share a common neural signature: lower frontal gamma activity indicative of attenuated self-referential processing and improved attentional control.

These findings fulfil Hypothesis 2, which predicted that reduced frontal gamma activity would be associated with higher scores on mindfulness measures.

3. Can gamma activity predict psychological outcomes after training, beyond baseline measures?

Gamma activity showed evidence of predictive associations with mindfulness outcomes following training, beyond baseline measures, specifically in the experimental group. Several regression models showed that decreased gamma activity in frontal and frontocentral regions at Time 2 significantly predicted higher mindfulness scores, particularly the facet Acting with Awareness. This pattern persisted even after controlling for baseline scores, suggesting that reduced neural activation may reflect changes in neural efficiency associated with mindful awareness. Specifically, left frontal lower and upper gamma, and right frontal upper gamma emerged as significant EEG predictors, with R^2 values ranging from 43% to 56%. Although some models were marginally non-significant overall, EEG coefficients were consistently meaningful. In contrast, control group models explained over 90% of variance, but this was driven almost entirely by baseline mindfulness, with EEG activity contributing minimally, indicating that without intervention, mindfulness levels remained trait-like.

Scatter plots shown in Figure 4 supported these findings: all models showed negative slopes, meaning that as gamma power decreased, mindfulness increased. Slopes were generally steeper in the experimental group, reinforcing the stronger influence of EEG changes following intervention. For example, Regression 1 showed that reductions in left frontal lower gamma were associated with higher Acting with Awareness scores, while Regressions 3–5 revealed similar trends, with experimental group slopes more pronounced.

Statistical analyses confirmed these patterns, with Regression 2 showing a strong negative beta ($\beta = -0.730$, $p = .015$, $R^2 = 0.56$) and Regression 5 indicating a significant effect ($\beta = -0.660$, $p = .038$, $R^2 = 0.45$). These findings suggest that gamma activity may serve as a neurophysiological marker of mindfulness-related change, rather than simply reflecting trait-like characteristics, fulfilling Hypothesis 3.

Our results align with prior evidence: Galindo-Aldana et al. (2025) identified gamma as a candidate biomarker for intervention-related improvements, while Hsu et al. (2024) demonstrated high predictive accuracy using gamma-band connectivity features. Similarly, Berkovich-Ohana et al. (2012) linked lower frontal gamma to reduced DMN activity and diminished self-referential processing, supporting the interpretation that gamma modulation reflects neuroplastic changes in attentional networks following mindfulness training.

Contribution and Novelty of the Present Study

This study contributes to the literature in three ways.

First, whereas most mindfulness–EEG research has focused on neural activity during meditation, this study used pre–post resting-state EEG and demonstrated trait-level neural change following mindfulness training, showing that shifts in gamma activity are evident at rest and are not limited to transient state effects.

Second, while many studies evaluate well-established clinical programs (e.g., MBSR/MBCT), this study examined a psychoeducational, school-based program (PBS) and provides evidence that PBS can produce measurable gamma-band changes, extending EEG work on school-based interventions beyond clinical formats and the more commonly examined theta/alpha ranges.

Third, the findings reveal region-specific patterns across frontal and posterior sites, rather than a uniform shift in gamma power, suggesting neural reorganization, that is, mindfulness training may reshape how different brain regions contribute to attention, awareness, and cognitive–emotional processing.

Implications

The current study provides important insights into a few key areas:

1. Understanding mindfulness as a trainable neurophysiological state that influences brain function, reinforcing the idea that targeted mindfulness practices can induce measurable changes in neural activity. This understanding opens opportunities for designing interventions that leverage these mechanisms to improve psychological well-being.
2. Gamma-band activity as a potential biomarker for mindfulness training, offering a pathway to move mindfulness research beyond self-reported measures toward objective neurophysiological evidence. This shift could strengthen the scientific validity of mindfulness interventions and support their integration into clinical practice.
3. This study provides initial evidence that a psychoeducational-based mindfulness program (PBS) can produce measurable changes in brain activity. These findings suggest that even less intensive, concept-driven programs may influence neural processes, broadening the accessibility of mindfulness interventions for populations unable to commit to traditional formats like MBSR or MBCT.

Limitations:

While this study provides valuable insights, several limitations should be acknowledged. First, the sample size was relatively small, which limits statistical power and may lead to overestimation of effect sizes. Second, reliance on self-report measures introduces potential biases, such as social desirability and subjective interpretation of mindfulness constructs. Third, the duration of the intervention may have been insufficient to capture long-term neural changes associated with sustained mindfulness practice. Fourth, the control group did not engage in an active behavioral task during the six-week period, raising the possibility that some participants may have practiced mindfulness independently, potentially confounding group comparisons. Fifth, baseline levels of mindfulness experience and engagement were not systematically assessed, which limits our ability to fully interpret individual differences in responsiveness to the intervention. Finally, this study employed PBS rather than widely validated mindfulness-based interventions such as MBSR, MBCT, or MABIs. While PBS introduces mindfulness concepts and promotes awareness, it lacks the intensive experiential practice characteristic of these established programs, which may have reduced the potential impact on both psychological and neural outcomes.

Future work:

Building on the evidence that gamma-band activity is associated with mindfulness and attentional processes, future research could pursue several directions. While our findings provide initial support for EEG-based measures in mindfulness research, current studies on the PBS program have focused almost exclusively on psychological and behavioral outcomes (Bernay et al., 2016; Devcich et al., 2017; Rix & Bernay, 2015). No published work has examined its neural correlates using methods such as EEG, fMRI, or neuroplasticity markers. Addressing this gap is critical for understanding whether PBS produces measurable changes in brain activity or structure. Future studies should therefore investigate PBS and similar school-based mindfulness interventions using neurophysiological approaches like EEG to capture dynamic changes in attentional and emotional processes.

Exploring the use of more established interventions, such as MBSR, MBCT, or MABIs, may produce stronger psychological and neural effects than psychoeducational approaches. Additionally, implementing a longer intervention could allow for more sustained engagement and provide a better opportunity to observe long-term changes in neuroplasticity and gamma-band activity associated with mindfulness practice.

Using a larger sample size to increase statistical power would reduce variability and allow for more robust detection of relationships between gamma-band activity, mindfulness facets, and psychological outcomes. This would strengthen the evidence for gamma as a biomarker of mindfulness training.

Future studies should account for prior mindfulness experience and baseline mindfulness practice and engagement of participants. Our findings suggest that attentional control is a key mechanism underlying mindfulness; therefore, distinguishing experienced practitioners from novices could clarify how prior training influences gamma-band changes and attentional control.

Our observed link between gamma-band activity and attentional process suggests that an even greater attention-focused intervention could be designed to specifically enhance attentional control. A targeted approach may improve outcomes for populations with attentional deficits.

Comparing PBS with established programs such as MBSR and MBCT to determine whether neural changes differ in magnitude or durability, and examining underlying mechanisms, could clarify whether psychoeducational approaches offer a cost-effective, scalable alternative for populations unable to commit to intensive experiential programs.

Finally, exploring EEG-based neurofeedback to develop enhanced personalized mindfulness programs could be a promising avenue. Using EEG-based neurofeedback to reinforce desirable neural patterns associated with mindfulness may enable personalized interventions tailored to individual neural profiles, enhancing efficacy and engagement.

Conclusion:

This thesis suggests that lower gamma activity was associated with greater mindful awareness. Additionally, decreased gamma activity in frontal and frontocentral regions significantly predicted higher overall mindfulness scores.

This study reinforces the view of mindfulness as a trainable neurophysiological state capable of influencing brain function, with gamma-band activity emerging as a promising biomarker for such change. By demonstrating that a psychoeducational-based mindfulness program can produce measurable neural effects, these findings highlight the potential for accessible, concept-driven interventions to advance both the scientific validity and clinical integration of mindfulness practices.

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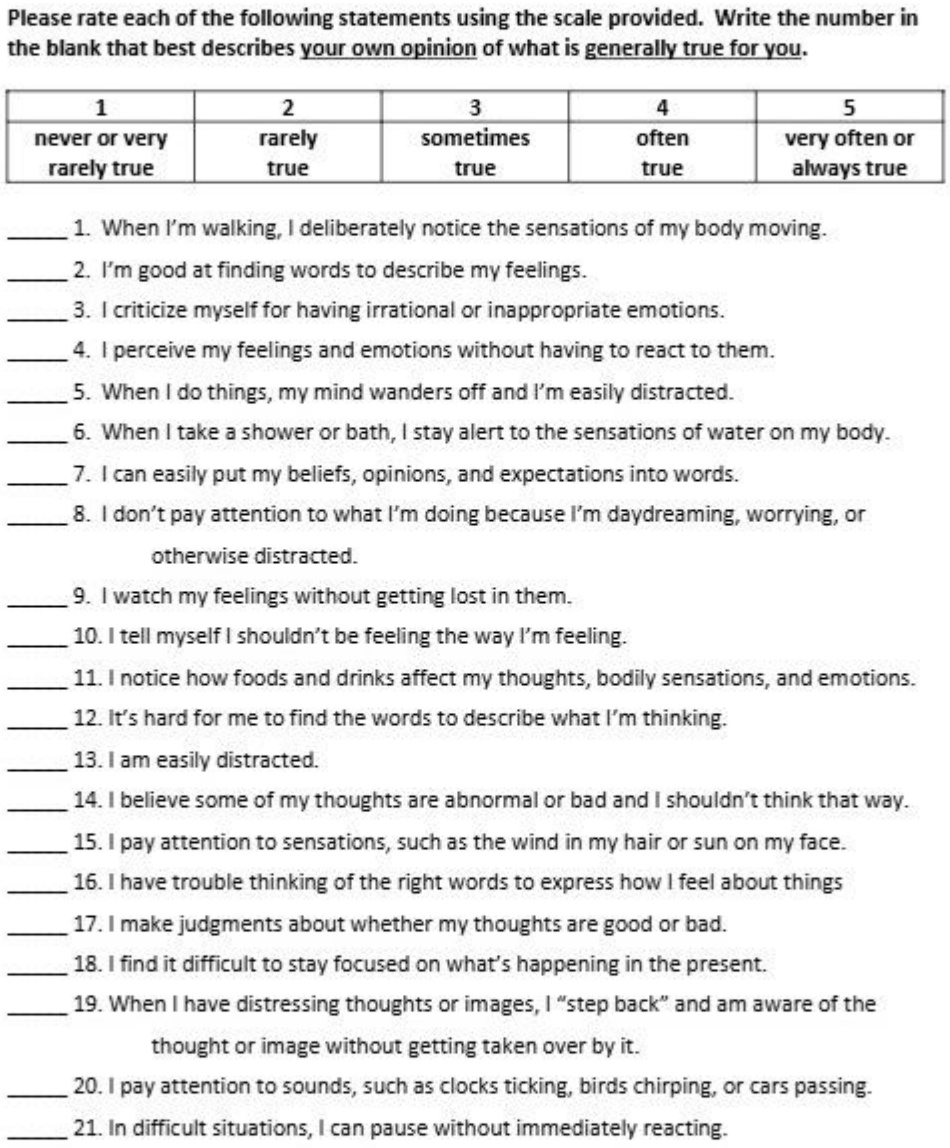
Appendix

Appendix A: The Five Facet Mindfulness Questionnaire (FFMQ)



Please rate each of the following statements using the scale provided. Write the number in the blank that best describes <u>your own opinion</u> of what is <u>generally true for you</u>.

1	2	3	4	5
never or very rarely true	**rarely true**	**sometimes true**	**often true**	**very often or always true**

_____ 1. When I'm walking, I deliberately notice the sensations of my body moving.
_____ 2. I'm good at finding words to describe my feelings.
_____ 3. I criticize myself for having irrational or inappropriate emotions.
_____ 4. I perceive my feelings and emotions without having to react to them.
_____ 5. When I do things, my mind wanders off and I'm easily distracted.
_____ 6. When I take a shower or bath, I stay alert to the sensations of water on my body.
_____ 7. I can easily put my beliefs, opinions, and expectations into words.
_____ 8. I don't pay attention to what I'm doing because I'm daydreaming, worrying, or otherwise distracted.
_____ 9. I watch my feelings without getting lost in them.
_____ 10. I tell myself I shouldn't be feeling the way I'm feeling.
_____ 11. I notice how foods and drinks affect my thoughts, bodily sensations, and emotions.
_____ 12. It's hard for me to find the words to describe what I'm thinking.
_____ 13. I am easily distracted.
_____ 14. I believe some of my thoughts are abnormal or bad and I shouldn't think that way.
_____ 15. I pay attention to sensations, such as the wind in my hair or sun on my face.
_____ 16. I have trouble thinking of the right words to express how I feel about things
_____ 17. I make judgments about whether my thoughts are good or bad.
_____ 18. I find it difficult to stay focused on what's happening in the present.
_____ 19. When I have distressing thoughts or images, I "step back" and am aware of the thought or image without getting taken over by it.
_____ 20. I pay attention to sounds, such as clocks ticking, birds chirping, or cars passing.
_____ 21. In difficult situations, I can pause without immediately reacting.

1	2	3	4	5
never or very rarely true	rarely true	sometimes true	often true	very often or always true

_____ 22. When I have a sensation in my body, it's difficult for me to describe it because I can't find the right words.

_____ 23. It seems I am "running on automatic" without much awareness of what I'm doing.

_____24. When I have distressing thoughts or images, I feel calm soon after.

_____ 25. I tell myself that I shouldn't be thinking the way I'm thinking.

_____ 26. I notice the smells and aromas of things.

_____ 27. Even when I'm feeling terribly upset, I can find a way to put it into words.

_____ 28. I rush through activities without being really attentive to them.

_____ 29. When I have distressing thoughts or images I am able just to notice them without reacting.

_____ 30. I think some of my emotions are bad or inappropriate and I shouldn't feel them.

_____ 31. I notice visual elements in art or nature, such as colors, shapes, textures, or patterns of light and shadow.

_____ 32. My natural tendency is to put my experiences into words.

_____ 33. When I have distressing thoughts or images, I just notice them and let them go.

_____ 34. I do jobs or tasks automatically without being aware of what I'm doing.

_____ 35. When I have distressing thoughts or images, I judge myself as good or bad, depending what the thought/image is about.

_____ 36. I pay attention to how my emotions affect my thoughts and behavior.

_____ 37. I can usually describe how I feel at the moment in considerable detail.

_____ 38. I find myself doing things without paying attention.

_____ 39. I disapprove of myself when I have irrational ideas.

Appendix B: Ethics Data Sharing Form

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THE UNIVERSITY OF
WAIKATO
Te Whare Wānanga o Waikato

Dr Zohreh Doborjeh

School of Psychological and Social Sciences

11 April 2025

Dear Zohreh

Re: **FS2025 (Data Sharing): The Impact of Mindfulness Training on Event-Related Potential (ERP) Responses During Emotional Face Processing**

Thank you for submitting your statement of intent (for Masters student Erik Panzer) and signed data sharing agreement from AUT (where you were involved in collecting this data). The data sharing agreement has now been signed by the University of Waikato and the Committee is pleased to offer formal approval for you to use the anonymised data for the purposes of this Masters project.

We encourage you to contact the committee should issues arise during your data collection, or should you wish to add further research activities or make changes to your project as it unfolds. We wish you all the best with your research. Thank-you for engaging with the process of Ethical Review.

Kind regards

Dr Amy Bird, Convenor
Division of Arts, Law, Psychology & Social Sciences Human Research Ethics