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Between Imagination and Action: A Descriptive Single-Case EEG Pilot Study of Oscillatory Dynamics during Artistic Activity

Rener Marcos J. Delagracia, Solange Muglia Wechsler

Pontifícia Universidade Católica de Campinas, São Paulo, Brazil
Email: edu.professor.psi@gmail.com

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Abstract

This descriptive single-case pilot study investigated electroencephalographic (EEG) patterns associated with three stages of artistic activity: resting state with eyes open, artistic imagination with eyes closed, and artistic execution with eyes open. EEG activity was recorded using a 19-channel system arranged according to the International 10 - 20 System. Spectral analysis focused on the relative distribution of Delta, Theta, Alpha, Beta, and Gamma oscillations across cortical regions. The results revealed distinct oscillatory profiles across conditions. Artistic imagination was associated with a greater relative predominance of Alpha and Theta activity, whereas artistic execution showed a greater relative predominance of Beta activity, particularly in frontal, central, and parietal regions. These findings are consistent with previous literature describing Alpha and Theta oscillations during internally oriented cognition and Beta oscillations during sensorimotor processing and interaction with the external environment. However, interpretations should remain cautious due to the single-case design, the exploratory nature of the analysis, and the potential influence of eye closure during the imagination condition. Overall, the study demonstrates the methodological feasibility of using EEG to investigate different stages of artistic activity and provides preliminary evidence to guide future research on the neurophysiology of imagination and artistic execution.

Keywords

EEG, Creativity, Artistic Activity, Mental Imagery, Oscillatory Activity, Visual Arts

1. Introduction

Creativity is one of the most complex phenomena investigated by contemporary cognitive sciences. Traditionally approached from philosophical, psychological, and educational perspectives, creativity has increasingly been examined through the lens of neuroscience, enabling the investigation of neural processes underlying the generation, transformation, and implementation of original ideas (Dietrich, 2004; Dietrich & Kanso, 2010; Beaty et al., 2016). This shift has contributed to the development of models that conceptualize creativity not as an isolated ability localized within a single brain region, but rather as a dynamic process emerging from interactions among multiple cognitive, emotional, and perceptual systems.

Under this perspective, creativity may be understood as the production of ideas or products that are simultaneously original and appropriate within a given context (Runco & Jaeger, 2012). This definition emphasizes that creativity extends beyond the spontaneous generation of ideas, encompassing processes of evaluation, selection, refinement, and implementation. Consequently, creative activity requires the coordinated involvement of memory, imagination, attention, executive control, perception, and motor action, which dynamically interact over time (Beaty et al., 2016; Jung & Vartanian, 2018).

In artistic contexts, this dynamic becomes particularly evident. Before being materialized into a tangible work, artistic production often emerges as an internal experience composed of mental imagery, symbolic associations, memories, emotions, and perceptual representations. Subsequently, these contents are transformed into coordinated motor actions that enable their expression through physical or digital media. Thus, imagination and execution do not represent independent processes but rather complementary stages of a broader creative cycle (Wallas, 1926; Kaufman & Beghetto, 2009).

Several theoretical models have sought to explain how the brain organizes the different stages of creative activity. Among them, contemporary frameworks emphasize the coordinated participation of large-scale neural systems involved in the generation, monitoring, and implementation of ideas. Functional neuroimaging studies have suggested that states associated with imagination, spontaneous thought, and mental simulation frequently involve regions belonging to the Default Mode Network (DMN), whereas cognitive control and evaluative processes tend to recruit regions associated with the Central Executive Network (CEN). Additionally, the Salience Network (SN) has been proposed as a system involved in switching between internally and externally oriented attentional states (Menon, 2011; Beaty et al., 2016). However, it is important to emphasize that these models derive primarily from functional connectivity and neuroimaging research and should therefore be regarded as theoretical frameworks when applied to investigations based exclusively on electroencephalographic recordings.

Electroencephalography (EEG) constitutes a particularly valuable tool for investigating these processes because of its high temporal resolution. Unlike neuroimaging techniques that offer greater spatial resolution, EEG enables the monitoring of rapid fluctuations in brain electrical activity on a millisecond timescale, providing insights into dynamic cognitive transitions (Niedermeyer & da Silva, 2004; Lopes da Silva, 2013). This characteristic makes EEG especially suitable for creativity research, given that creative activity involves continuous shifts between idea generation, imagination, evaluation, and execution.

At the electrophysiological level, different frequency bands have been associated with distinct modes of cognitive processing. Delta oscillations have been linked to homeostatic regulation and internally oriented processing; Theta activity has frequently been associated with working memory, information retrieval, and cognitive integration; Alpha oscillations have been related to internally directed attention, mental imagery, and sensory gating; whereas Beta oscillations have been observed in contexts involving motor planning, action monitoring, and interaction with external stimuli (Klimesch, 1999; Engel & Fries, 2010; Harmony, 2013; Knyazev, 2012). Although these associations are not exclusive, they provide a useful framework for interpreting oscillatory patterns observed during creative tasks.

Studies investigating creativity have frequently reported increased Alpha and Theta activity during idea generation, mental imagery, and creative incubation tasks (Fink et al., 2009; Fink & Benedek, 2014). In contrast, activities requiring response implementation, motor coordination, and continuous monitoring of actions often exhibit greater participation of Beta oscillations (Engel & Fries, 2010; Kilavik et al., 2013). Recent reviews have also highlighted the potential of EEG for investigating creativity in more ecologically valid contexts, including drawing, design, artistic improvisation, and other forms of creative expression. Nevertheless, important methodological challenges remain regarding protocol standardization and the interpretation of neurophysiological findings (Zangeneh Soroush & Zeng, 2024).

Within the specific context of visual arts, relatively few studies have directly examined the transition between imagination and execution using continuous electrophysiological recordings. Most available research has focused on divergent thinking, problem solving, or verbal creativity, leaving comparatively limited evidence regarding the neural dynamics underlying the artistic process itself (Dietrich & Kanso, 2010; Jung & Vartanian, 2018). This gap highlights the relevance of exploratory studies capable of describing neurophysiological patterns observed during different stages of artistic production.

Against this background, the present study aimed to investigate, through EEG spectral analysis, oscillatory patterns observed during three distinct conditions: resting state with eyes open, artistic imagination with eyes closed, and artistic execution with eyes open. By comparing these conditions, the study sought to describe possible differences in the relative distribution of frequency bands across cortical regions, thereby contributing to a preliminary understanding of the neurophysiological correlates associated with imagination and artistic execution.

Given the exploratory and descriptive nature of the study, no attempt was made to establish causal relationships or validate specific neurocognitive models. Rather, the findings are presented as preliminary observations intended to support hypothesis generation and methodological refinement for future investigations involving creativity, mental imagery, and artistic activity.

2. Method

2.1. Study Design

The present investigation was designed as a descriptive single-case pilot study with an exploratory approach aimed at examining electroencephalographic patterns associated with different stages of artistic activity. The experimental design was structured to compare three conditions: resting state with eyes open, artistic imagination with eyes closed, and artistic execution with eyes open. The study adopted an observational and descriptive framework, seeking to identify potential variations in oscillatory brain activity associated with the specific cognitive demands of each condition.

Given the exploratory nature of the investigation and the use of a single participant, the findings are not intended to support inferential conclusions or generalizations. Instead, they should be understood as preliminary observations intended to generate hypotheses and contribute to the methodological refinement of future studies involving creativity, mental imagery, and artistic execution (Flyvbjerg, 2006; Yin, 2018).

2.2. Participant

The study included one right-handed cisgender female participant, 34 years of age, holding undergraduate and master's degrees in Visual Arts and having more than ten years of professional experience in artistic production.

The participant was selected through convenience sampling. The primary inclusion criterion was extensive experience in visual artistic practice, a characteristic considered relevant for promoting consistent engagement in both imagination and artistic execution tasks.

Prior to data collection, a structured clinical and psychological interview was conducted to identify factors that could potentially interfere with EEG recording quality or compromise the interpretation of results. The participant reported no history of neurological disorders, psychiatric conditions, epilepsy, significant traumatic brain injury, or use of substances likely to substantially alter brain activity during the recording session.

2.3. Ethical Considerations

The present study was conducted as an exploratory descriptive single-case pilot investigation involving a healthy adult volunteer. The participant received detailed information regarding the objectives, procedures, potential risks, and expected benefits of the study before data collection began. Participation was entirely voluntary and occurred following the signing of a written informed consent form.

All procedures were conducted in accordance with internationally recognized ethical principles for research involving human participants, including the principles established by the Declaration of Helsinki. Measures were adopted to ensure confidentiality and privacy, and all data were anonymized prior to analysis and dissemination. The participant retained the right to withdraw from the study at any time without penalty or adverse consequences.

2.4. Instruments and EEG Acquisition

Brain electrical activity was recorded using a Neuron-Spectrum-3 electroencephalographic system (Neurosoft®, Russia) equipped with 19 channels arranged according to the International 10 - 20 System. Ambu WhiteSensor WSP-30-00-S/50 electrodes were mounted on a standard EEG cap.

The recording montage included prefrontal (Fp1, Fp2), frontal (F3, F4, F7, F8), central (C3, C4, Cz), temporal (T3, T4, T5, T6), parietal (P3, P4, Pz), and occipital (O1, O2) derivations, providing broad cortical coverage of regions commonly associated with cognitive, perceptual, attentional, and motor functions. The cortical regions analyzed, their corresponding electrode locations, and the functions most frequently associated with each region in the literature are summarized in **Table 1**.

Table 1. Electrode distribution and cortical regions analyzed.

Cortical Region	Electrodes	Frequently Associated Functions in the Literature
Prefrontal	Fp1, Fp2	Emotional regulation, behavioral monitoring, and decision-making processes.
Frontal	F3, F4, F7	Executive attention, planning and cognitive flexibility.
Central	C3, C4, Cz	Sensorimotor integration and motor control.
Temporal	T3, T4, T5, T6	Associative processing, memory, and information integration.
Parietal	P3, P4, Pz	Visuospatial processing and multimodal integration.
Occipital	O1, O2	Visual processing and representation of visual information.

The functions presented correspond to associations frequently reported in the neuroscience literature and are included solely as a theoretical framework for interpreting the electroencephalographic recordings. The present study did not directly assess these cognitive functions.

EEG signals were acquired at a sampling rate of 500 Hz using a linked-ears reference montage. During acquisition, a high-pass filter of 0.5 Hz, a low-pass filter of 35 Hz, and a 60 Hz notch filter were applied to minimize low-frequency drift, high-frequency noise, and electrical line interference, respectively.

For descriptive topographical visualization, EEG recordings were additionally inspected using average-reference representations (Average 19 montage) available in the NeuroSpectrum-3 software. This procedure was adopted exclusively to facilitate visualization of the spatial distribution of oscillatory activity across cortical regions and was not used as a separate analytical measure.

In addition to EEG recording, a structured clinical interview was administered to obtain information regarding health history, sleep habits, medication use, substance consumption, and other factors potentially relevant to the interpretation of electrophysiological data.

2.5. Experimental Procedures

Data collection was conducted in a quiet environment with controlled lighting and minimal external interference. Before the experimental session, the participant was instructed to avoid alcohol, caffeine, and other stimulant substances for at least 24 hours and to avoid sleep deprivation.

Initially, baseline recordings with eyes open and eyes closed were obtained to verify signal stability and recording quality. However, the present study focused analytically on three primary experimental conditions:

Condition 1: Resting State with Eyes Open

The participant remained seated comfortably in a relaxed waking state with eyes open and without engaging in any specific cognitive or motor task. This condition served as the experimental baseline for comparison with the subsequent conditions.

Recording duration: 10 minutes.

Condition 2: Artistic Imagination with Eyes Closed

The participant was instructed to close her eyes and mentally imagine a drawing of her own choice, freely developing visual forms, images, and artistic elements without producing any overt motor response.

Recording duration: 7 minutes.

Condition 3: Artistic Execution with Eyes Open

Following the imagination phase, the participant was instructed to reproduce graphically, on a sheet of paper, the content previously imagined. EEG recording remained active throughout the entire execution period.

Recording duration: 10 minutes.

The sequence was designed to represent a progression from a baseline state of wakeful rest to an internally oriented imaginative condition and finally to an externally oriented artistic execution condition. Table 2 summarizes the experimental conditions and their respective analytical objectives.

Table 2. Experimental conditions and analytical objectives.

Experimental Condition	Description	Analytical Objective
Eyes-Open Resting State	Relaxed wakefulness without engagement in an explicit cognitive, motor, or creative task.	Establish a neurophysiological baseline for comparison with the experimental conditions.
Artistic Imagination (Eyes Closed)	Mental generation and elaboration of visual content without overt motor execution.	Investigate processes associated with mental imagery and internal visual representation.
Artistic Execution (Eyes Open)	Graphic reproduction of previously imagined content through freehand drawing.	Investigate oscillatory patterns associated with visuomotor integration, graphic execution, and action monitoring.

Experimental conditions were conducted sequentially during a single recording session.

2.6. Signal Processing and Artifact Handling

Following acquisition, EEG recordings underwent detailed technical inspection for the identification and treatment of physiological and environmental artifacts. Signal preprocessing involved a combination of expert visual inspection, automated artifact detection procedures, and complementary manual review.

Potential artifacts included eye blinks, eye movements, excessive muscle activity, body movements, movement-related artifacts associated with drawing execution, and instabilities in electrode-scalp contact.

Additionally, Independent Component Analysis (ICA) was employed as an auxiliary procedure for identifying and attenuating components associated with ocular and muscular artifacts. Components identified as non-neural sources were inspected and removed when appropriate before subsequent analyses.

After preprocessing, continuous artifact-free segments ranging from approximately two to three minutes were selected for each experimental condition. Segment selection prioritized periods characterized by greater signal stability and minimal contamination from non-neural sources, thereby enhancing comparability across conditions.

Given the exploratory nature of the study, artifact handling procedures were designed primarily to maximize signal quality and facilitate descriptive comparisons among the experimental conditions rather than to support inferential statistical analyses.

2.7. Data Analysis

Data analysis was conducted using a descriptive approach based on visual inspection of electroencephalographic recordings, spectral decomposition of the EEG signal, and evaluation of the topographical distribution of frequency bands across experimental conditions.

Artifact-free segments selected for each condition were subjected to spectral analysis using the Fast Fourier Transform (FFT), allowing decomposition of the EEG signal into its constituent frequency bands (Cooley & Tukey, 1965; Niedermeyer & da Silva, 2004).

The following frequency bands were examined:

Delta (1 - 3 Hz);

Theta (4 - 7 Hz);

Alpha (8 - 12 Hz);

Beta (13 - 30 Hz);

Gamma (>30 Hz).

The analysis focused on the relative distribution of oscillatory activity across cortical regions and experimental conditions rather than on absolute power measurements. The term relative predominance was used to describe the greater representation of a given frequency band in relation to other bands within the same experimental condition, without implying quantitative or statistical significance.

Interpretations were based on the topographical distribution of oscillatory activity, descriptive differences observed among conditions, and previous literature concerning brain oscillations, mental imagery, creativity, and motor execution. Because of the exploratory nature of the study and the use of a single participant, all findings were interpreted descriptively and non-inferentially, with the primary goal of identifying preliminary patterns capable of informing future investigations.

3. Results

The descriptions presented below are based on the comparative inspection of topographical maps and frequency spectra obtained for each experimental condition. Given the exploratory and descriptive nature of the study, the findings are reported in terms of the relative distribution of frequency bands and their topographical organization, without the use of inferential statistical analyses.

3.1. Condition 1: Resting State with Eyes Open

The analysis of EEG recordings obtained during the eyes-open resting condition revealed a stable and organized pattern of brain activity consistent with a relaxed wakeful state. No epileptiform discharges, marked asymmetries, or electrophysiological abnormalities were observed that could compromise signal quality or comparability with subsequent conditions.

The topographical distribution of oscillatory activity showed relative homogeneity across hemispheres, without pronounced focal predominance in specific cortical regions. This pattern suggests adequate neurophysiological stability throughout the baseline condition and provides an appropriate reference for comparison with the imagination and artistic execution phases.

From a spectral perspective, a relative predominance of Beta activity was observed in frontal and central regions, a pattern commonly reported in wakeful states involving attention directed toward the external environment. Simultaneously, lower relative Alpha activity was observed in occipital regions, a finding frequently associated with eyes-open resting conditions.

Topographical maps indicated maintenance of this general profile throughout the recording period, suggesting consistency of the analyzed segments.

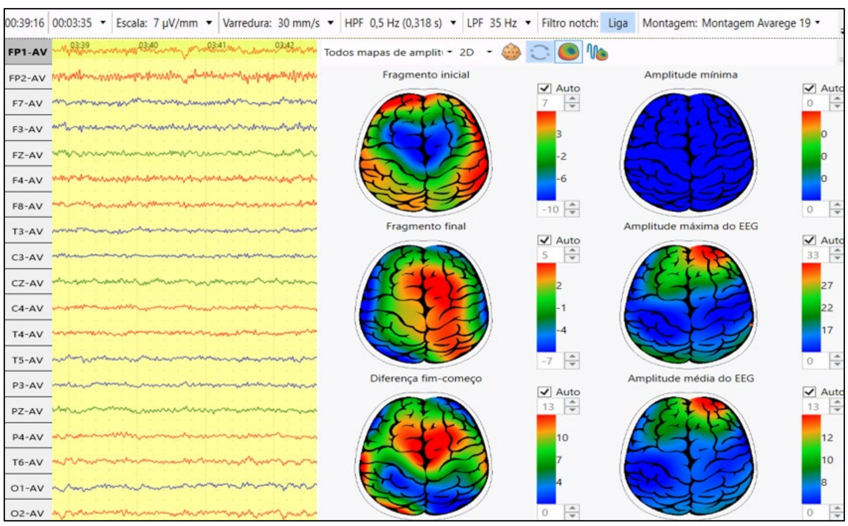

Figure 1. Representative electroencephalographic recordings and topographical maps obtained during the resting-state condition with eyes open.

In Figure 1, initial and final EEG segments are presented together with topographical representations derived from the selected epochs. The recordings revealed a relatively stable oscillatory profile characterized by moderate Beta activity in frontal and central regions and lower relative posterior Alpha activity.

Overall, the eyes-open resting condition provided a functionally stable baseline for the interpretation of subsequent experimental conditions.

3.2. Condition 2: Artistic Imagination with Eyes Closed

The artistic imagination condition exhibited an oscillatory profile distinct from that observed during the baseline condition. Analysis of the selected segments revealed a greater relative predominance of Alpha and Theta activity across several cortical regions, particularly within frontal, temporal, parietal, and occipital areas.

In frontal regions, a relative reduction in Beta predominance was observed compared with the artistic execution condition, accompanied by greater relative expression of Alpha and Theta oscillations. This pattern suggests differences in the cognitive demands associated with the experimental conditions and may reflect a greater allocation of attentional resources toward internally generated content.

In central regions, Alpha activity showed relative predominance alongside reduced participation of Beta oscillations, suggesting lower involvement of overt motor processes during this phase. This configuration is consistent with the non-motor nature of the imagination task.

Temporal regions exhibited relatively prominent Theta activity, whereas parietal and occipital regions demonstrated greater relative Alpha activity. Considering that this condition was performed with eyes closed, part of this pattern may be attributable to the well-established physiological effects of eye closure on posterior Alpha rhythms, in addition to the cognitive demands associated with imagination.

Topographical maps also suggested gradual variations in oscillatory distribution throughout the task. Early segments appeared to involve relatively greater participation of frontal and temporal regions, whereas later segments showed relatively greater parietal and occipital involvement.

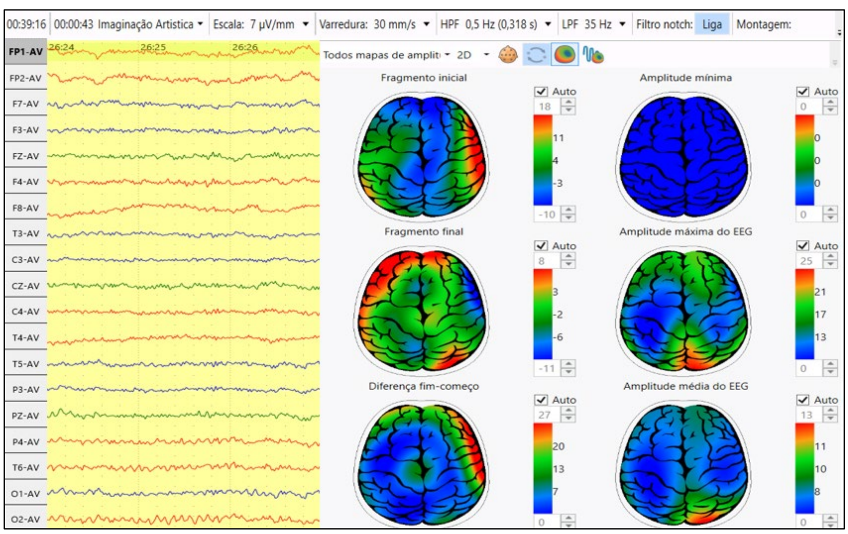

Figure 2. Representative electroencephalographic recordings and topographical maps obtained during the artistic imagination condition with eyes closed.

In **Figure 2**, initial and final EEG segments are presented together with topographical representations derived from the selected epochs. The recordings demonstrated greater relative predominance of Alpha and Theta activity across frontal, temporal, parietal, and occipital regions.

The comparison between early and late segments suggests a gradual reorganization of oscillatory activity during artistic imagination. However, these observations should be interpreted as exploratory due to the single-case design adopted in this study. **Table 3** provides an interpretive summary of the main oscillatory characteristics observed during the artistic imagination condition (eyes closed).

Table 3. Interpretive summary of the artistic imagination condition (eyes closed).

Region/ Electrodes	Predominant Frequency Bands	Exploratory Interpretation Consistent with the Literature
Fp1/Fp2	Relative predominance of Alpha and Theta	Pattern compatible with internally directed attention and the elaboration of mental content.
F3/F4	Alpha + Theta	Pattern compatible with mental imagery and the internal organization of visual representations.
F7/F8	Theta/Alpha	Pattern compatible with associative processing and imaginative elaboration.
C3/C4/Cz	Predominant Alpha with reduced Beta	Lower relative predominance of rhythms commonly associated with overt motor
T3/T4/T5/T6	Prominent Theta + Alpha	Pattern compatible with retrieval and integration of internally generated information.
P3/P4/Pz	Robust Alpha activity	Pattern compatible with the maintenance of mental imagery and internally oriented visuospatial processing.
O1/O2	Predominant Alpha activity	Activity compatible with visual imagery and, potentially, with the physiological effects of eye closure.

Interpretations are exploratory and were based on the relative distribution of frequency bands observed across cortical regions and on previous literature concerning mental imagery, brain oscillatory activity, and creative cognition. Because the condition was performed with eyes closed, part of the posterior Alpha predominance may reflect physiological effects associated with eye closure rather than imaginative processes alone.

3.3. Condition 3: Artistic Execution with Eyes Open

The artistic execution condition displayed an oscillatory profile distinct from both the resting and imagination conditions. Overall, a greater relative predominance of Beta activity was observed across frontal, central, parietal, and occipital regions.

In prefrontal and frontal areas, Beta oscillations showed a more pronounced relative predominance than during the imagination condition. This pattern was accompanied by a lower relative contribution of Alpha and Theta activity.

In central regions, Beta activity predominated while residual Alpha components remained present. This profile is consistent with the visuomotor demands of the task, which required continuous coordination between visual perception and motor activity during drawing execution.

Temporal regions exhibited the coexistence of Theta and Beta activity, whereas parietal regions displayed a combination of Alpha and Beta oscillations. In occipital areas, a relative reduction in Alpha predominance and a greater representation of Beta activity were observed compared with the imagination condition.

Topographical maps demonstrated a broader spatial distribution of Beta activity throughout task execution, suggesting greater involvement of processes related to continuous interaction between visual perception and motor action (Engel & Fries, 2010; Kilavik et al., 2013).

Compared with the artistic imagination condition, the execution task was characterized by a more diffuse distribution of Beta activity across cortical regions, particularly within frontal, central, and occipital areas. This shift was accompanied by a relative reduction in the predominance of Alpha activity, which had been more evident during imagination.

Despite regional variations, the predominance of Beta oscillations remained one of the most consistent features observed during artistic execution. This pattern was evident across regions involved in perceptual processing, visuomotor integration, and action monitoring. **Table 4** summarizes the main oscillatory characteristics observed during the artistic execution condition.

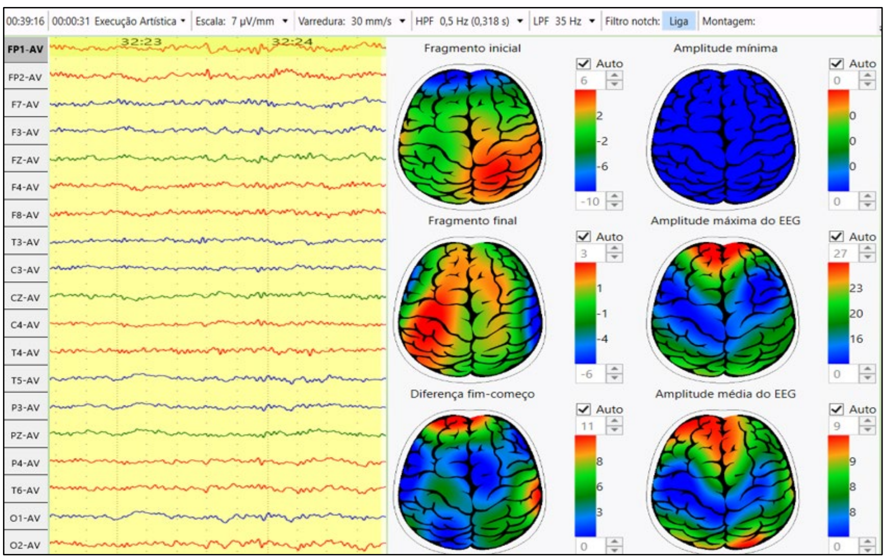

Figure 3. Representative electroencephalographic recordings and topographical maps obtained during the artistic execution condition with eyes open.

Figure 3 presents the initial and final EEG segments together with topographical representations derived from the selected epochs. The recordings demonstrated a greater relative predominance of Beta activity across frontal, central, parietal, and occipital regions. The principal oscillatory characteristics observed during the artistic execution condition are summarized in **Table 4**.

Table 4. Interpretive summary of the artistic execution condition (eyes open).

Region/ Electrodes	Predominant Frequency Bands	Exploratory Interpretation Consistent with the Literature
Fp1/Fp2	Predominant Beta with reduced Alpha	Pattern compatible with greater task-directed attention and continuous interaction with the external environment.
F3/F4	Predominant Beta	Pattern compatible with executive and visuomotor demands involved in graphic execution.
F7/F8	Beta with minor Theta participation	Pattern compatible with the integration of cognitive and behavioral processes required for task performance.
C3/C4/Cz	Predominant Beta with residual Alpha	Pattern compatible with sensorimotor demands associated with drawing execution.
T3/T4/T5/T6	Minor Theta + Beta	Pattern compatible with associative processing and information integration during task performance.
P3/P4/Pz	Alpha + Beta	Pattern compatible with visuospatial integration and coordination between perception and action.
O1/O2	Predominant Beta with reduced Alpha	Pattern compatible with continuous visual monitoring of the drawing during execution.

Interpretations are exploratory and were based on the relative distribution of frequency bands observed across cortical regions and on previous literature concerning Beta activity, sensorimotor control, visuospatial integration, and action monitoring. Given the descriptive nature of the study and the use of a single participant, the observed patterns should not be interpreted as specific markers of particular cognitive or creative processes.

3.4. Global Comparison of Experimental Conditions

Comparison across the three experimental conditions revealed consistent differences in the relative distribution of frequency bands.

The eyes-open resting condition displayed a relatively stable pattern characterized by moderate Beta activity and lower posterior Alpha predominance. The artistic imagination condition showed greater relative predominance of Alpha and Theta oscillations, particularly in temporal, parietal, and occipital regions. In contrast, the artistic execution condition was characterized by greater relative predominance of Beta activity across frontal, central, and parietal regions.

Overall, the findings suggest that the experimental conditions were associated with distinct oscillatory profiles. However, given the single-case design and the descriptive nature of the analysis, these differences should be interpreted as preliminary and exploratory observations.

The results suggest that artistic imagination and artistic execution were associated with distinct oscillatory distributions within the context of this study, supporting the need for future investigations involving larger samples, comparative designs, and complementary analytical approaches. A comparative summary of the oscillatory patterns observed across the experimental conditions is presented in Table 5.

Table 5. Comparative summary of oscillatory patterns observed across experimental conditions.

Experimental Condition	Predominant Oscillatory Profile	Exploratory Interpretation Consistent with the Literature
Eyes-Open Resting State	Moderate relative predominance of Beta activity in frontal and central regions, accompanied by lower relative posterior Alpha activity.	Pattern compatible with a baseline state of relaxed wakefulness and attention directed toward the external environment.
Artistic Imagination (Eyes Closed)	Greater relative predominance of Alpha and Theta rhythms across frontal, temporal, parietal, and occipital regions.	Pattern compatible with mental imagery, internally generated content, and visual imagination. Part of the posterior Alpha activity may reflect physiological effects associated with eye closure.
Artistic Execution (Eyes Open)	Greater relative predominance of Beta activity across frontal, central, parietal, and occipital regions.	Pattern compatible with visuomotor demands, perception-action integration, and continuous monitoring of graphic activity.

The comparison presented is descriptive and exploratory and was based on the relative distribution of frequency bands observed in a single participant. Interpretations were informed by the literature on brain oscillations, mental imagery, and motor execution and should not be regarded as direct evidence of specific cognitive or neural mechanisms.

4. Discussion

4.1. Oscillatory Differences across Experimental Conditions

The present study aimed to describe electroencephalographic patterns observed during three distinct stages of artistic activity: resting state with eyes open, artistic imagination with eyes closed, and artistic execution with eyes open. Overall, the findings revealed distinct oscillatory distributions across the analyzed conditions, suggesting that different cognitive and behavioral demands may be associated with different configurations of brain electrical activity. Although the adopted design does not permit causal inferences, the observed patterns are broadly consistent with previous findings reported in the literature on mental imagery, creative cognition, and artistic performance (Fink & Benedek, 2014; Beaty et al., 2016; Zangeneh Soroush & Zeng, 2024).

The eyes-open resting condition displayed a relatively stable pattern characterized by moderate Beta activity in frontal and central regions and lower relative Alpha expression in occipital areas. This profile is consistent with classical electroencephalographic descriptions of wakeful resting states involving attention moderately directed toward the external environment (Klimesch, 1999; Niedermeyer & da Silva, 2004). The stability observed in this condition suggests that the baseline recording provided an adequate reference for exploratory comparisons with the imagination and artistic execution phases.

In contrast, the artistic imagination condition exhibited greater relative predominance of Alpha and Theta oscillations across several cortical regions, whereas the artistic execution condition was characterized by greater relative predominance of Beta activity. Although these observations do not permit causal interpretations, they suggest that the proposed tasks involved distinct cognitive demands and potentially different modes of information processing. This pattern is broadly consistent with studies reporting increased Alpha and Theta activity during imagination, idea generation, and creative cognition, as well as increased Beta activity during action monitoring, motor coordination, and continuous interaction with external stimuli (Fink et al., 2009; Fink & Benedek, 2014; Engel & Fries, 2010; Zangeneh Soroush & Zeng, 2024).

The differences observed across experimental conditions reinforce the notion that internally oriented mental elaboration and the materialization of imagined content may be associated with distinct oscillatory configurations. Although the findings should be interpreted cautiously due to the single-case design, they converge with contemporary perspectives describing creativity as a dynamic process involving multiple cognitive operations unfolding over time (Beaty et al., 2016; Zangeneh Soroush & Zeng, 2024).

4.2. Artistic Imagination and Alpha-Theta Activity

The relative predominance of Alpha and Theta activity observed during the artistic imagination condition is consistent with previous studies investigating mental imagery, creative incubation, memory retrieval, divergent thinking, and idea generation (Fink et al., 2009; Jauk et al., 2012; Fink & Benedek, 2014). More recent reviews have also emphasized the recurrent association between Alpha and Theta oscillations and tasks involving internally generated mental content, creativity, and visual imagination, although the underlying mechanisms remain under investigation (Zangeneh Soroush & Zeng, 2024).

The literature suggests that Alpha oscillations may be associated with internally directed attention, mental imagery, and modulation of external sensory input, whereas Theta activity has been linked to working memory, information retrieval, and cognitive integration (Klimesch, 1999; Harmony, 2013; Pearson, 2019). From this perspective, the predominance of these bands during artistic imagination appears compatible with the internal construction and maintenance of mental images required by the task.

However, an important methodological consideration must be emphasized. The imagination condition was performed with eyes closed, a circumstance that by itself tends to increase posterior Alpha activity and influence other frequency bands. Consequently, the observed results should not be attributed exclusively to imaginative processes. Part of the recorded pattern may reflect the well-established physiological effects of eye closure on EEG activity (Klimesch, 1999; Niedermeyer & da Silva, 2004; Beaty et al., 2016).

Furthermore, the descriptive nature of the study and the absence of complementary measures of cognitive performance or functional connectivity prevent precise identification of the mental processes underlying the observed oscillations. Therefore, the interpretations presented here should be understood as compatible with the available literature rather than as direct demonstrations of the cognitive mechanisms involved in artistic imagination.

Accordingly, the findings suggest an association between artistic imagination and the relative predominance of Alpha and Theta rhythms. Nevertheless, they do not allow a definitive distinction between the contribution of imaginative processes and the physiological effects associated with eye closure, highlighting the need for future studies employing visually equivalent control conditions and more comprehensive neurophysiological analyses.

4.3. Artistic Execution and Relative Predominance of Beta Activity

The artistic execution condition exhibited greater relative predominance of Beta activity compared with the imagination condition. This pattern was observed primarily in frontal, central, and parietal regions, areas frequently associated with motor coordination, action monitoring, visuospatial integration, and behavioral control (Engel & Fries, 2010; Lopes da Silva, 2013).

Beta oscillations have frequently been described as reflecting motor maintenance, action monitoring, sensorimotor integration, and continuous interaction with environmental stimuli (Engel & Fries, 2010; Kilavik et al., 2013). In this sense, the predominance of Beta activity during artistic execution appears compatible with the task demands, which involved continuous visual monitoring, visuomotor coordination, motor planning, and fine graphic control required for artistic production.

Moreover, artistic execution required the simultaneous integration of perceptual, motor, and attentional processes, as the participant continuously monitored the evolving drawing and adjusted movements in real time. Although these processes were not directly measured, the predominance of Beta activity observed during this condition is consistent with previous reports involving active interaction with the environment and continuous motor control (Kilavik et al., 2013; Engel & Fries, 2010).

Nevertheless, the functional interpretation of these oscillations should remain cautious. EEG provides information regarding cortical electrical activity recorded at the scalp surface and does not permit direct identification of specific cognitive operations being performed at each moment of the task. Consequently, the interpretations presented here should be regarded as compatible with both the characteristics of the task and the available literature rather than as direct evidence of underlying cognitive mechanisms.

Accordingly, the results suggest that artistic execution was associated with greater relative predominance of Beta activity compared with artistic imagination. Although exploratory, these observations converge with evidence linking Beta oscillations to sensorimotor and behavioral demands involved in continuous perception-action interactions.

4.4. Imagination and Execution as Complementary Components of the Creative Process

One of the most relevant contributions of the present study lies in the observation that artistic imagination and artistic execution exhibited distinct, yet potentially complementary, oscillatory profiles. Although the findings should be interpreted cautiously due to the single-case design, the observed differences suggest that imaginative elaboration and graphic materialization may be associated with different electrophysiological configurations throughout artistic activity.

Historically, several models of creativity have described the creative process as a dynamic sequence involving preparation, incubation, elaboration, and implementation (Wallas, 1926; Kaufman & Beghetto, 2009). More recent perspectives emphasize that creativity emerges from the continuous interaction among processes related to idea generation, evaluation, transformation, and implementation, involving multiple cognitive systems that dynamically interact over time (Beaty et al., 2016; Zangeneh Soroush & Zeng, 2024). Within this framework, imagination may be understood as a phase dedicated to the internal construction of possibilities, whereas execution represents the transformation of those possibilities into observable actions.

The findings appear broadly compatible with this process-oriented perspective of creativity. The relative predominance of Alpha and Theta oscillations during imagination and the greater predominance of Beta activity during execution suggest that the two tasks involved distinct oscillatory configurations. However, the data do not support the conclusion that such patterns are exclusive markers of creativity or that they represent specific signatures of creative processing. Rather, these oscillatory profiles may reflect the interaction of multiple cognitive operations involved in creative activity, including internally directed cognition, attention, memory processes, and sensorimotor demands, a perspective that has been increasingly emphasized in recent neurophysiological models of creativity (Beaty et al., 2016; Zangeneh Soroush & Zeng, 2024).

Likewise, it is not possible to determine whether the observed differences reflect exclusively creative operations, as perceptual, attentional, and motor demands inherent to the tasks may also have contributed to the recorded patterns. Accordingly, the findings are more appropriately interpreted as preliminary oscillatory profiles associated with the distinct demands of artistic imagination and artistic execution.

From this perspective, the study contributes to an exploratory understanding of the neurophysiological dynamics observed during different stages of artistic activity and provides a basis for future investigations capable of examining these relationships using larger samples and more rigorous experimental designs, an approach that has been increasingly recommended in contemporary EEG-based creativity research (Zangeneh Soroush & Zeng, 2024).

4.5. Considerations on DMN, CEN, and SN

Contemporary models of creativity frequently describe the coordinated participation of large-scale neural systems, including the Default Mode Network (DMN), the Central Executive Network (CEN), and the Salience Network (SN), as important components of creative cognition (Menon, 2011; Beaty et al., 2016). In general, these models propose that processes related to idea generation, mental imagery, cognitive monitoring, and response evaluation emerge from dynamic interactions among distributed neural systems.

From this theoretical perspective, the relative predominance of Alpha and Theta oscillations observed during artistic imagination could be considered compatible with states commonly associated with internally oriented cognition and the elaboration of mental content. Similarly, the greater predominance of Beta activity observed during artistic execution could be considered compatible with demands related to behavioral control, action monitoring, and interaction with the external environment (Klimesch, 1999; Engel & Fries, 2010).

Nevertheless, these interpretations remain necessarily indirect. The present study did not evaluate functional connectivity, interregional synchronization, network dynamics, or any other measure capable of directly identifying the participation of specific large-scale brain networks. Consequently, any reference to the DMN, CEN, or SN should be understood exclusively as a theoretical interpretation grounded in the existing literature rather than as an empirical finding derived from the data reported here (Menon, 2011).

Furthermore, the direct identification of such networks generally requires methodologies specifically designed for that purpose, including functional connectivity analyses, network modeling approaches, or neuroimaging techniques with greater spatial resolution. Future studies may therefore investigate more directly the relationship between oscillatory patterns observed during artistic activity and contemporary models of large-scale brain organization (Beaty et al., 2016; Zangeneh Soroush & Zeng, 2024).

4.6. Limitations and Future Directions

The findings of the present study should be interpreted in light of several important methodological limitations. First, this investigation was designed as a descriptive single-case pilot study, which precludes generalization to other populations, artistic contexts, or levels of creative expertise. Although single-case designs can provide valuable exploratory insights into complex phenomena, the patterns observed here require examination in larger samples before broader interpretations can be supported (Flyvbjerg, 2006; Yin, 2018).

Second, the analysis adopted a predominantly descriptive approach based on oscillatory patterns and their topographical distribution, without inferential statistical procedures, network modeling techniques, or advanced functional connectivity analyses. Consequently, the interpretations presented are restricted to the observed electrophysiological patterns and do not permit direct inferences regarding specific neural mechanisms (Lopes da Silva, 2013; Dietrich & Kanso, 2010).

An additional limitation concerns the fact that the artistic imagination condition was performed with eyes closed. This factor may have contributed to part of the oscillatory activity observed, particularly the greater relative predominance of posterior Alpha rhythms. Although eye closure facilitated the imagination task, it also introduced a potential confounding factor that limits attribution of the observed patterns exclusively to imaginative processes. Future studies may benefit from incorporating visually equivalent control conditions that allow more precise differentiation between imagination-related activity and physiological effects associated with eye closure (Klimesch, 1999; Niedermeyer & da Silva, 2004).

Another limitation involves the absence of behavioral or creativity-performance measures capable of directly relating electrophysiological patterns to characteristics of artistic production. The integration of neurophysiological, behavioral, and qualitative measures may represent a promising direction for future research.

Future investigations may also employ larger samples, quantitative analyses of absolute and relative power, functional connectivity measures, source localization techniques, multimodal approaches, and comparative designs involving artists and non-artists. Such strategies may contribute to a deeper understanding of the neurophysiological correlates associated with different stages of artistic activity and creative cognition. Recent reviews have emphasized the importance of improving experimental design, analytical procedures, and methodological standardization in EEG-based creativity research, particularly regarding ecological validity, signal interpretation, and reproducibility of findings (Zangeneh Soroush & Zeng, 2024). Furthermore, the development of more ecologically valid experimental paradigms and openly available EEG datasets has been identified as an important step toward advancing the investigation of higher-order cognitive processes involved in creativity and real-world creative performance (Zangeneh Soroush, Zhao, Jia, & Zeng, 2024).

5. Conclusion

The present descriptive single-case pilot study investigated electroencephalographic patterns observed during three conditions related to artistic activity: resting state with eyes open, artistic imagination with eyes closed, and artistic execution with eyes open. Overall, the findings revealed distinct oscillatory distributions across the analyzed conditions, suggesting that different stages of artistic activity may be associated with different configurations of brain electrical activity.

The artistic imagination condition exhibited greater relative predominance of Alpha and Theta oscillations, whereas artistic execution was characterized by greater relative predominance of Beta activity. Although these observations should be interpreted cautiously and do not support causal inferences, the identified patterns are broadly consistent with previous literature concerning mental imagery, creative cognition, and sensorimotor processing.

A significant contribution of this study lies in demonstrating the methodological feasibility of using EEG to investigate different stages of artistic activity within a relatively ecological context. In addition to providing preliminary evidence regarding oscillatory dynamics associated with the investigated conditions, the findings contribute to the refinement of experimental protocols for future neurophysiological research on imagination and artistic execution.

Given the limitations inherent to the single-case design and the exploratory nature of the investigation, the results should be regarded as preliminary observations intended to support hypothesis generation. Future studies employing larger samples, more controlled experimental conditions, and complementary analytical approaches may further clarify the neurophysiological correlates involved in different stages of artistic activity.

In summary, the findings suggest that artistic imagination and artistic execution were associated with distinct oscillatory profiles within the context of this study. Although they do not permit identification of specific neural mechanisms or validation of particular neurocognitive models, the results reinforce the potential of EEG as a valuable tool for investigating the temporal dynamics of cognitive processes involved in artistic activity and provide an initial foundation for future research in this field.

Authors' Contributions

Rener Marcos J. Delagracia contributed to the conception and design of the study, data collection, data analysis, interpretation of results, manuscript drafting, and preparation of the final version of the manuscript. Solange Muglia Wechsler contributed to the study design, scientific supervision, interpretation of findings, critical revision of the manuscript, and final approval of the version submitted for publication.

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Data Availability Statement

The data supporting the findings of this study are available from the author upon reasonable request.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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