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Karawitans' musician brain adaptation: standardized low-resolution electromagnetic tomography study

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ABSTRACT

The rapid advancement of music studies has resulted in a plethora of multidisciplinary participants. Rather than distinguishing between musicians and non-musicians' brain activity, the current study indicated differences in brain activity while musicians listened to music based on their musical experience. In Go/NoGo response task reaction times, it showed that effects between treatments and visits were different across periods of cognitive function tests. The cognitive function at post-listening assessment out-performed the pre-listening in terms of reaction times 531.94 (±24.70) msec for post-listening assessment; and 557.13 (±37.15) msec for pre-listening assessment. The results of using electroencephalography (EEG) recording in an experimental manner with Karawitan musicians (N=20) revealed that listening to unknown cultural music, Mozart's Piano Sonata in C Major, and western music resulted in increased brain activity. Furthermore, while Karawitan musicians were listening to Mozart's Piano Sonata in C Major, the major brain activity occurred in the frontal lobe. This outcome will elicit additional consideration of music's integration, such as neuroscience of music.

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1. INTRODUCTION

Music and its cognition have long been investigated by neuroscience, a cognition-focused field. It has attempted to explain not just the process of musical perception, but also the anatomical and functional impact of music on the brain. Lots of research has gone into how musical practice affects cognitive function. Passively listening to music while doing something increases cognitive performance [1]. Some music tempo and mode treatments boost spatial cognition by enhancing arousal and mood [2]. Outside of music, musical training enhances brain function and cognitive abilities [3]. Previous research on symphonic musicians and non-players used the visuospatial task to show how complexity of musical training influences activation of Broca's region during the test, which enhanced performance [3]. Gaser and Schlaug examined professional, amateur, and non-musicians to see how their brains differed [4].

Previous research suggested that long-term musical practice by amateur and professional musicians was the main reason. In a previous study [1], [5], music experience was used as a form of previous conditioning to find the people who took part [1], [5]. Involvement in long-term musical training and skill acquisition allows for a different psychological process. For example, musicians must memorize musical expressions, improvise music, and recognize a note without a referential note [5]. Each of these challenges in music practice was viewed as a brain stimulation to improve performance and perception. Musical experience was defined as "having received" or "having not received" musical instruction. It is easy to distinguish between the subject and the potential difference that occurred.

As a result, rather than looking at distinctions between musicians and non-musicians, the current study tried to explain the brain activity of Karawitan musicians listening to Mozart's Piano Sonata in C Major. A previous study on musical preference and cognitive style found that people with various cognitive styles have certain personality traits, and musical genre became a distinct variable. We investigated how Karawitan artists with diverse musical backgrounds perceive acoustic cues. An electroencephalogram (EEG) frequency range and standardized low-resolution electromagnetic tomography (sLORETA) were used to quantify cortical activation and locate the brain region contributing to the scalp recorded auditory inputs. The current study's goal was to investigate the lateralization of musical experiences and cognitive function using Mozart's Piano Sonata in C Major.

2. RESEARCH METHOD

2.1. Participants

This study included healthy right-handed people with normal hearing and no known neurological problems. This study involved 20 Karawitan musicians aged 23-29 (mean 28.25±1.41). All Karawitan musicians actively learned Gendhing Lancaran practical music lessons and did not learn piano music lessons for three years. The length of time spent learning music was considered. All participants spoke Bahasa Indonesia as their primary language. They had normal hearing and eyesight, and their health conditions were confirmed via physical examination. The procedure had been described and authorized by everybody. The Graduate School of the Indonesia Institute of the Arts, Yogyakarta, Indonesia, approved the experiment in accordance with the 1964 Helsinki Declaration and its following updates. The flowchart for study enrollment and completion as well as the timeline of the study are shown in Table 1 and Figure 1.

Table 1. The demographic data of participants

Characteristics	Participants (*n* = 20)
Age (years), mean (SD)	28.25±1.41
Male	6
Female	14
Education (level)	
1st year	8
2nd year	4
3rd year	6
4th year	2

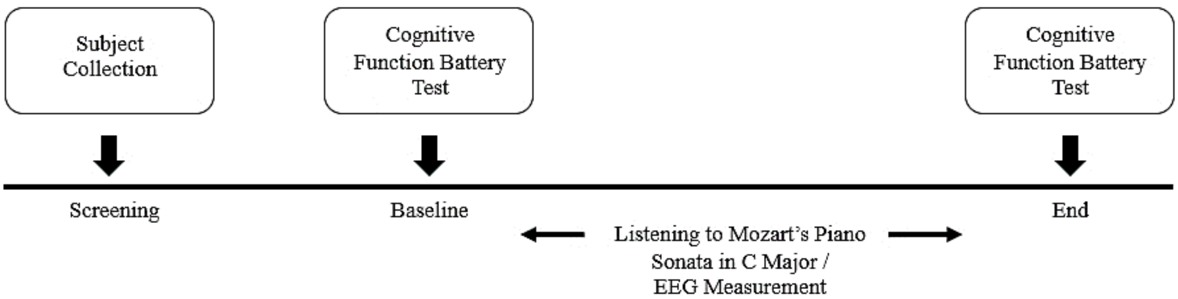

Figure 1. The timeline of both cognitive function battery test and and EEG measurement in the study

2.2. Study design, task and cognitive function assessment

Prior to beginning, the protocol was approved by the Graduate School of the Indonesia Institute of the Arts, Yogyakarta, Indonesia. This study was carried out in accordance with the Helsinki Declaration. Informed consent from all participants was provided before being enrolled in the investigation. Upon enrollment, participants were assigned identification numbers in ascending order and randomly assigned. A computerized psychological battery was used to evaluate each participant's cognitive abilities at baseline, prior to and after listening to stimuli. The participants' unfamiliar music was Mozart's Piano Sonata in C Major, which served as a stimulus. The sound lasted one minute. It was delivered binaurally through headphones at 85 dB sound pressure level (SPL). The beginning of stimuli was used to time-lock the EEG signal recording. Participants were instructed to focus on the stimuli delivered through earbuds. The cognitive battery of psychometric and psychological tests was administered via a computer interface. This study's cognitive battery included memory tasks, i.e., the Go/NoGo test. The exam was used to assess working memory updating, shifting, and inhibition. The participants were assessed by research assistants who were either graduate students or degree holders in music and/or psychology from the Indonesia Institute of the Arts of Yogyakarta, Indonesia. Each test session's accuracy and response times were recorded and expressed as a percent and milliseconds. Participants were instructed to memorize a set of X and O letters to test their cognitive performance. For this test, a list of X and O letters was presented to the participant one at a time, and the participant was asked to memorize the X and O letters. The participant was required to recall them when they were asked to select only X, but not O. During this task, X and O, which served as Go and No-Go signals, were presented on a monitor at a distance of around 150 cm from the participants' eyes. The X represented the 'Go' condition with 80 percent probability, and the O represented the 'NoGo' condition, with 20 percent probability. The task consisted of 200 stimuli (2 blocks; 20% NoGo signals). In the task, the alphabets X was used as Go and O as NoGo signals. Participants were required to hold their reactions to a single NoGo (O) letter and a series of Go (X) stimuli. At the end of each block, participants were given feedback. The reaction buttons were placed under the participants' palms in a soundproofed and electrically protected chamber. Participants had to press the response pad as quickly as they could (with their dominant hand) every time the more frequent X (Go) stimulus appeared on the computer screen, and to withhold their reactions to the less frequent O (NoGo) stimulus. The order of conditions was counterbalanced across participants as sown in Figure 2.

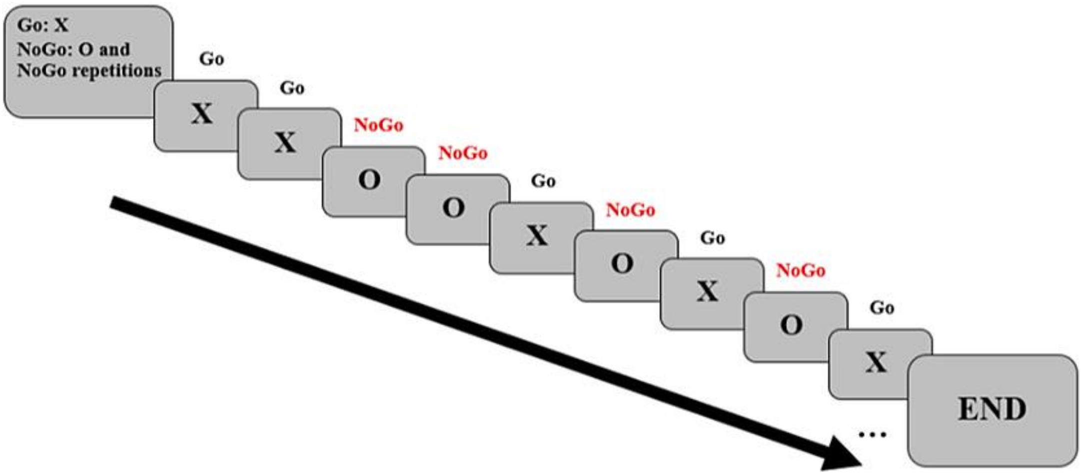

Figure 2. Parametric Go/NoGo task

2.3. Behavioral recording and analyses

The cognitive function challenge required subjects to press buttons accurately and quickly. So, button presses were classified as correct (button code matched stimulus type), incorrect (button code did not match stimulus type), or missed (no button press). The difference in timing between the button codes and the stimulus start was used to calculate reaction times. Participants' reaction accuracy and times were measured from their key presses for each cognitive function task. Reaction times for correct, incorrect, and missed responses were measured as the difference in timing between the stimulus onset and key press reaction. We only included trials with reaction times of 100–1500 ms. This was done to prevent accidental or excessively delayed button pushing due to attention or cognitive exhaustion. Each participant's reaction times were averaged. Reaction times were averaged and corrected for learning affects over time across trials for each participant. On significant analysis of variance (ANOVA) results, we applied Tukey's post hoc analysis. The cognitive function exam used student t-tests for accuracy and reaction speeds. The *p*-value of 0.05 was chosen as the statistical significance level [6].

2.4. Electroencephalographic recording procedure

EEG recordings were based on signals detected through the scalp with a wearable, multi-electrode array neuroheadset (EMOTIV Epoc Plus, San Francisco, USA). The electrical activity of 14 active electrodes (AF3, F3, F7, FC5, T7, P7, O1, O2, P8, T8, FC6, F8, F4, and AF4) as shown in Figure 3(a) - Figure 3(b) was recorded according to the International 10-20 Electrode Positioning System. The left and right mastoids were used as reference electrodes. Manual reference electrodes were placed on ipsilateral mastoids (M1 and M2), with Fp1 and Fp2 electrodes employed for ocular artifact detection. EEGs were 30,000 times amplified and filtered at 0.1-100 Hz. Eye movement and muscular artifacts were extensively analyzed after filtering. Epochs with voltage variations of over 100 μV in any EEG channel were excluded. All responses were recalculated offline against an average reference for additional examination as shown in Figure 3(c). The resistance of the electrodes was less than 10 kΩ. With a 0.05 to 100 Hz band pass, the EEG signals were amplified, captured at 500 Hz, and the live signal data was saved to a hard disk for off-line processing. A 0.1–30 Hz band pass was then used to digitally off-line filter the recorded EEGs. The epoch on which the average was calculated was 500 milliseconds for the commencement of the presenting stimuli. All neural and ocular artifacts were removed from the continuous EEG prior to the extraction of EEG waves. The baseline correction was also applied to each epoch, with any changes in voltage 0.1 μV or 70 μV rejected from further analysis. After registration, the data was re-referenced offline to the common average montage, followed by correction and rejection of artifacts. EEG epochs with absolute amplitudes greater than 100μV were automatically flagged and removed from further investigation. Before averaging, all channels were subjected to artifact rejection with a threshold of ± 100 μV. The total recording time was 5 minutes for each of the cognitive tests. All EEG analyses were performed using TestBench analysis software (EMOTIV Epoc Plus, San Francisco, USA), featuring source reconstruction, signal analysis, and MRI processing tools by sLORETA analysis software.

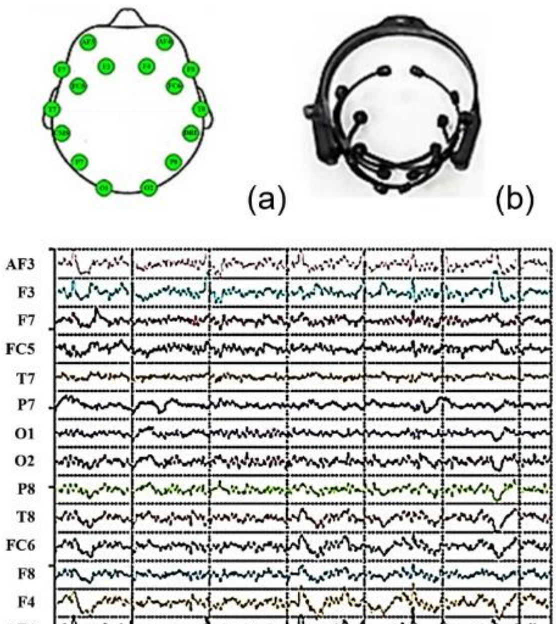

Figure 3. Electroencephalographic recordings were based on signals detected through the scalp with a wearable, multi-electrode array neuroheadset according to the International 10-20 Electrode Positioning System; (a) electroencephalographic device (EMOTIV Epoc Plus), (b) the 14-channels electrode montage, and (c) all electrical activity responses were recalculated offline against an average reference.

2.5. Data pre-processing

The EEG data was converted from.edf to.csv and then captured by the TestBench application. We deleted unnecessary tables and ensured that collected data was consistent with geographical analysis in this Excel-compatible file. The electrical activities of Karawitan musicians' brains while listening to Mozart's

Piano Sonata in C Major were characterized as a moment of global field power (GFP) and were segmentally separated for each of the frequency ranges, for example, delta, theta, alpha, and beta, separately, using stable scalp-potential topography [6]. An EEG map's spatial standard deviation of all voltage values equaled the GFP peak. Each participant's mean GFP peak amplitude was calculated, and each participant's mean spontaneous EEG map was checked for artifacts. These were then averaged across all subjects. The brain's current source density distribution was evaluated using sLORETA, which was added to the electrical scalp field [7]. The smoothest of all possible source configurations over the brain volume was identified using the entire squared Laplacian [7]. A brain electric field map's electric strength (hilliness) was assessed using the GFP peak measure an EEG map's spatial standard deviation of all voltage estimates. The GFP peak measure is higher on a mountainous map than on a flat map. This GFP was self-contained [8], [9]. As a result, the spatial standard deviation of global field power provides a reference-independent descriptor of the potential field. The latencies of evoked potential components are determined by global field power maxima. Global field power builds up with time [10]. Students learned about global field power computation, component latency, global dissimilarity of potential field distributions, and topographical temporal segmentation using multichannel data. We got GFP by averaging the EPs across all scalp channels except electrooculographic. Each person's mean GFP peak amplitudes were obtained. Their GFP peak amplitudes were also computed [7]–[10]. The GFP waveforms were examined using cognitive function tests. Brain responses to the tango piece measured with electroencephalography (EEG).

2.6. Statistical and data analysis

While listening to Mozart's Piano Sonata in C Major, Karawitan musicians' brainwaves were continuously monitored. The smoothest source configurations across the brain volume were produced by limiting the absolute squared Laplacian of source quality. Quantitative data is provided as means with standard deviations. The data were analyzed using SPSS Program (Mae Fah Luang University) version 21.0, renewal quote number: 26500879; Passport advantage site number: 3547818. To determine the effects of music on cognitive function over the time periods (before and after listening), mean response times (RTs) and correct responses, as well as cognitive function analyses, were performed using a two-way paired t-test. Response times to cognitive function battery tests were measured for correct responses. One-way ANOVAs were performed on accuracy and reaction times for the cognitive function tests. Statistical results were considered significant at $p < 0.05$ [6].

3. RESULTS AND DISCUSSION

3.1. Cognitive enhancing effects

In Go/NoGo response task reaction times, the two-way (treatment x assessment) interaction effect was statistically significant, with F (1,19) = 19.37, $p < 0.001$, indicating that the two-way interaction effects between treatments and visits were different across periods of cognitive function tests. Baseline and end-of-treatment reaction times scores are reported in Table 2. The cognitive function at post-listening assessment out-performed the pre-listening in terms of reaction times (531.94 (±24.70) msec for post-listening assessment; and 557.13 (±37.15) msec for pre-listening assessment.

Table 2. The effect of Piano Sonata in C Major on the cognitive function battery test

Cognitive Function Test$^{\alpha}$	Score at Pre-listening	Score at Post-listening	*p*-value
Go/NoGo Test			
(%) Accuracy (Go)	98.75	99.31	
(%) Error (Go)	1.25	0.69	
Response time (ms) (Go) (mean±SD)	557.13 (±37.15)	531.94 (±24.70)	< 0.05*
(%) Accuracy (NoGo)	87.64	89.37	
(%) Error (NoGo	12.36	10.63	

$^{\alpha}$ Test parameters: Go/NoGo Accuracy: Go/NoGo response task accuracy scores; Go/NoGo Error: Go/NoGo response task incorrect and omission scores; Go/NoGo response time: Go/NoGo response task mean reaction time in milliseconds (ms). * p value < 0.05.

3.2. Electroencephalographic data

Table 3 shows the effect of Mozart's Piano Sonata in C Major listening assessed by the electroencephalography. GFP was plotted as a function of time, and the occurrence times of GFP maxima were used to determine each frequency band sensitivity. The grand mean GFP peak amplitude of each frequency band over subjects is shown according to the experimental setting. The electrical activities of

Karawitan musicians' brains computed by sLORETA showed that alpha wave had the highest electrical activity (9.705±0.12μV, $t(19) = 3.06$; $p < 0.05$) compared to other waves (e.g., delta wave: 2.529±0.25μV, $t(19) = 2.18$; $p < 0.05$, theta wave: 2.58±0.61μV, $t(19) = 3.66$; $p < 0.05$, and beta wave: 2.621±0.45μV, $t(19) = 2.19$; $p < 0.05$), respectively, while tuning in to Mozart's Piano Sonata in C Major, as shown in Table 3 and Figure 4.

Table 3. Electrical activities (μV) of Karawitan Musicians' brains while tuning in to Mozart's Piano Sonata in C Major as computerized by sLORETA

Frequency Bands	Mozart's Piano Sonata in C Major Mean (±SD)
delta	2.529 (±0.25)
theta	2.580 (±0.61)
alpha	9.705 (±0.12)
beta	2.621 (±0.45)

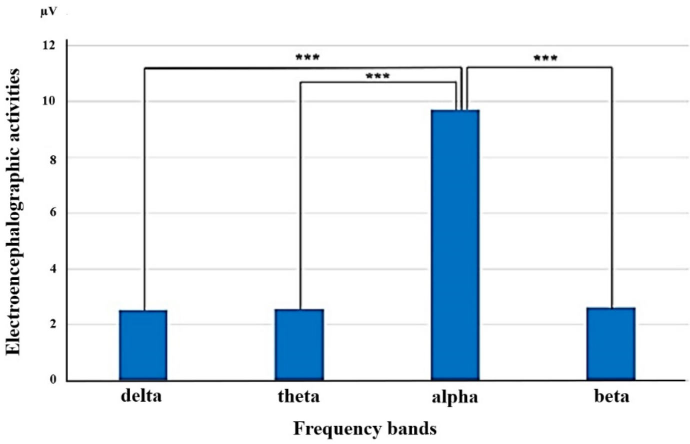

Figure 4. Electrical activities (μV) (Mean±SD) of Karawitan musicians' brains while tuning in to Mozart's Piano Sonata in C Major as computerized by sLORETA

3.3. Source localization data

Source localization analyses were performed utilizing sLORETA [8]. Figure 2 shows the *xyz*-values in Talairach space as determined with the sLORETA. The graphical representation of sLORETA *t*-statistic while Karawitan musicians listening to Mozart's Piano Sonata in C Major at superior frontal gyrus (STG)-frontal lobe (Brodmann area 10; X = -10, Y = 60, Z = 30; MNI coords; Best match at 0 mm; 9.71 μV) in the right-hemisphere (RH). The yellow color indicates local maxima of increased electrical activity in the right hemisphere (middle-to-back region) through the reference brain. A blue dot marks the center of significantly increased electric activity of an alpha wave as shown in Figure 5.

When participants listened to Mozart's Piano Sonata in C Major, which was not related to their own culture, western music, the frontal lobe was the place where dominant brainwave (i.e. alpha wave) occurred. Karawitan musicians listened to Mozart's Piano Sonata in C Major for this study. When listening to Mozart's Piano Sonata in C Major, Karawitan musicians had the highest Alpha (α) brainwave activity. This could indicate that when the individuals were unfamiliar with the cultural music they were listening to, their brain activity increased. Individuals' brain activity is increased by familiarity rather than liking, according to a prior study [11]. The previous study indicated that various emotion-related areas such as the amygdala, putamen, anterior cingulate cortex, and thalamus were activated during familiar music listening using functional magnetic resonance imaging (fMRI). In our study, participants' brains were stimulated especially in the superior frontal gyrus by unrelated cultural yet familiar music (STG). In a meta-analysis of brain areas activated by familiar music, the left superior frontal gyrus was the most stimulated, followed by the ventral lateral [12]. The frontal gyrus is assumed to be stimulated by semantic memory of familiar music, while the ventral lateral, related to the motor cortex, is supposed to be stimulated by motoric anticipation of familiar music's rhythms [9]. Unable to locate it in our study because movement was not allowed while listening to music, a recent study found the ventral lateral activated by familiar music [12].

Our understanding about music to relax the brain might still be controversy. Take an example from Patston and Tippett's study where expert musicians even struggle harder to do the linguistic task when listening to familiar piano excerpts because of its overlapping processing showed that relaxing and cooling down effects also depend on the musical experience of individuals [1]. However, previous study demonstrated that the more participants familiar into the music, the higher his brain activity which means it is more relaxed. According to our findings, the claim of music relaxation shouldn't be made by putting music randomly as a background without examining an individual's musical background. The brain activity of our participants while listening to unfamiliar music, the Karawitan musicians showed higher brain activity (i.e. alpha wave) while listening to Mozart's Piano Sonata in C Major. Despite the fact that the Piano Sonata was unknown music to Karawitan musicians, their brain activity was greater in the alpha wave while listening to these portions. This circumstance could be explained by two assumptions. The initial assumption goes through the typical process of this type of music. This excerpt was musically distinct from our participants' cultural backgrounds, particularly in terms of speed and melody succession. Mozart's Piano Sonata in C Major, written in allegro, featured quick music with rapid melodic succession. It was considerably different from the traditional music of our participants. For example, Gendhing Lancaran's tempo was relatively slow and quiet, and the melody was a cyclical motif that was not as fast as Mozart's Piano Sonata in C Major. The second hypothesis could be linked to musical perception and experience. Furthermore, a prior study found that musical experience and perception can be influenced by cultural differences [13]. The significance of early musical experience in promoting auditory sequence memory in musicians has also been clarified [14]. The memory tasks of auditory, visual, and audio-visual stimuli were used in this previous study on a wide range of participants, including musicians, gymnasts, video game players, and psychology students. The results revealed that while there was no significant difference in the visual or audio-visual tasks, there was a significant difference in the audio task, where musicians scored higher [14]. Music training and performance have been demonstrated to boost cognitive function in older people. A previous study examined the effects of music on the brain structure of older people. Music training was found to be favorably and significantly connected to the volume of the inferior frontal cortex and parahippocampus. Music training increased volume in the posterior cingulate, insula, and medial orbitofrontal cortex. The study found a relationship between musical actions and executive function, memory, language, and emotion. Because gray matter diminishes with age, this earlier research suggests that musical training may help older people overcome age-related brain volume declines [15].

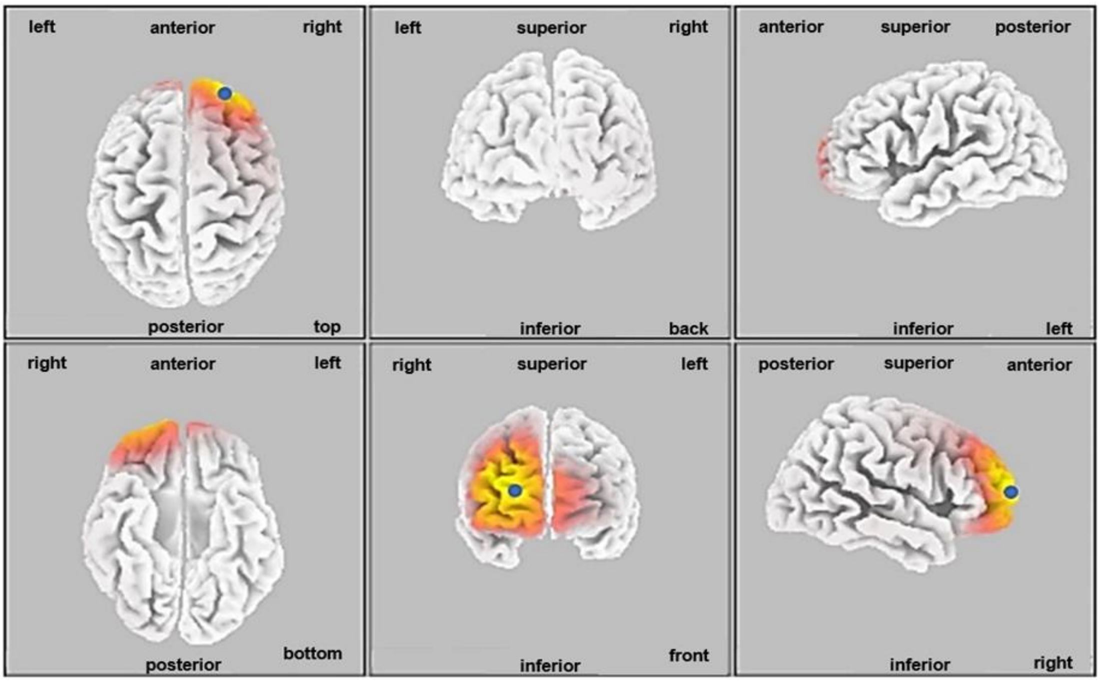

Figure 5. Graphical representation of the sLORETA while Karawitan musicians tune in to Mozart's Piano Sonata in C Major. The yellow color indicates local maxima of increased electrical activity. A blue dot marks the center of significantly increased electric activity of an alpha wave

Listening to music is first and foremost a human experience that becomes aesthetic when the listener totally immerses himself or herself in it. In a recent neuroimaging investigation, a relationship was established between the auditory cortex, the reward brain system, and mind wandering [16]. Music and language use harmonic complex perception. Numerous studies have connected musical training to greater harmonic complex processing. However, the benefit may not be universal across pitch models. Musicality can be reliably linked to objective measures of perception, according to a previous study. Musicianship also influences monotic/diotic and dichotic integration pitch assessments. Collectively, the findings update artists' neurobehavioral profiles and enhance creative capacity assessments [17]. In certain clinical studies, neutral and happy music reduce anxiety. An earlier study found that different emotional music types may have different mechanisms in state anxiety therapy. Neutral music reduces state anxiety. Neutral music was associated with decreased occipital lobe power spectral density and increased occipital-frontal functional connectivity. Happy music reduced state anxiety and enhanced occipital-right temporal functional connections. This earlier investigation may enable future nonpharmaceutical clinical therapy to better grasp state anxiety through music therapy [18].

The most prevalent complication of an acquired brain injury (ABI) is cognitive impairment, which can have a significant influence on a person's life and rehabilitation prospects. When compared to non-musicians, musicians have better cognitive control, attention, and executive functioning as a result of their music training. Music therapy is a technique that employs learning to play an instrument, specifically the piano, to stimulate and rebuild cognitive networks after a brain injury [19]. Music interventions are also viable remedies for Alzheimer's disease symptoms (AD). Music interventions can be active or receptive depending on the subjects' participation. It is possible that separate brain areas are involved in active and receptive music tasks. The clinical benefits of two types of music therapy and a control activity were compared in a recent study. Active music intervention can help with Alzheimer's symptoms and should be given as a supplement to standard care. The data demonstrate that combining AMI with standard treatment can help mild-to-moderate AD patients improve their cognition, behavior, and reliance [20].

Several studies have recently used another brain imaging technique called "Microstate Segmentation" to investigate human brain mechanisms during music listening. Furthermore, EEG is an excellent tool for investigating global states, as well as the briefer states (microstates) imbedded therein, due to its high time resolution [21]. Dimensional complexity proportions can indicate global states. These indicators count dynamic different brain processes to represent gross states like sleep stages [22], [23]. The global states of healthy, depressed, and schizophrenic people differ [24]. Previous studies used EEG frequency spectra and source localization. Less alpha activity and more delta and theta activity were found. The scalp maps of the EEG depict electric potential distributions. Skin maps with long-term quasi-stable potential patterns [21], [25] are microstates. A 60–120 millisecond microstate length is reported by EEG [21], [25]. Distinct spatial distributions of neuronal activity in the brain result in different scalp potentials. As a result, different microstates process data in different ways. "Potential atoms of thinking and emotion" [26], [27]. Microstates come in several forms [28], [29]. The four microstates usually detected in spontaneous resting-state EEG [30] are A, B, C, and D. The number of occurrences, time span, and mean term can be utilized to describe the microstates of the different classes. These characteristics vary greatly between states and tasks. The concept of microstates described in [31] is closely tied to the concept of symbolization in brain recordings. It was discovered by Lehmann that the scalp potential maps have quasi-stable activity lasting tens to hundreds of milliseconds [21], [31], with quick transition between them in event-related potentials (ERPs) and spontaneous EEG time organization. Lehmann provided symbols to the time periods. As indicated in [29], EEG microstate class representation is a valuable data reduction strategy. It's reasonable to believe that each of these microstates is involved in various activities or cognitive tasks [21], [32]. Scientists frequently assess cognitive activities using the microstates framework by mapping scalp potentials and analyzing spatial aspects. In time-domain, the microstates framework successfully measures the human brain electric field [30]. According to a prior study on musical preference and cognitive style, people with specific cognitive styles have a tendency to have certain personality features, and musical genres have become a unique variable.

Almudena Bartolomé-Tomás and colleagues investigated the relationship between traditional musical genre exposure and the memories of Spanish seniors from Murcia. The idea was to see if memories created by listening to rhythms heard as youngsters changed brain activity. The activation of brain areas was discovered using EEG signals. Using spectral power, the researchers discovered significant differences between "memory-evoked" and "non-memory-evoked" classes in the prefrontal cortex's alpha, beta, theta, and gamma frequency bands. The findings shed light on the listener's emotional state during the experiment [33], [34]. The brain's activity in response to memories acquired through music has also been shown. Other studies [33] have discovered comparable memory-forming zones. The experiment used a low-cost brain–computer interface, the Emotiv EPOC+ headset's 14 channels. Using 32 or 64 channels, several investigations have found significant differences between the prefrontal and frontal-temporal brain areas. Previous research [35] demonstrated that memory recall alters the alpha and theta bands. No one agrees that major changes occur in the beta and gamma bands. Experiments with different groups of subjects revealed variations that cannot be generalized at this time [36], [37]. The shown ability to distinguish between distinct regions helps us to discover and recognize the zones that are activated during the production of recovered memories, as indicated by others [38].

Tseng set out to identify prefrontal cortex brain activity connected with musical choice. Tseng's research focuses on interpreting EEG bands connected with musical liking. Popular songs induced more frontal theta than music with low and moderate preference ratings. The frontal theta is linked to both emotional and cognitive processes, according to frontal theta-cognitive connections. A study published in Psychological Science found that theta and lower alpha in the frontal lobe are effective indicators of both cognitive and mood [39]. Researchers can no longer study how musicians' emotions are processed in the brain. Their research involved having musicians perform a simple piano piece while adjusting their manner of play to transmit opposing feelings, and self-rating the emotion portrayed on arousal and valence scales. In both distressed and comfortable playing, EEG activity differed [40]. Electroencephalograms (EEGs) are widely used to record brain responses to brief, repeating stimuli. In real life, acoustic impulses are continually blended and cannot be isolated as in music. Because music's acoustic qualities are constantly fluctuating in this aural context, substantial values of various features might occur almost simultaneously. The results of a statistical analysis of the N100 and P200 times and delays corroborate this idea. The responses are more pronounced when these features appear combined, such as brightness and root mean square (RMS) or brightness and spectral flux. Together, RMS and spectral flux give greater reactions than when used alone [41]. Last but not least, music information retrieval algorithms can detect time points in music recordings that correspond to brain reactions. But it's unknown how the music's structure and aural qualities affect the brain's reaction. Haumann and colleagues tested a new method for automatically identifying brain reaction times. They used an existing library of EEG and Magnetoencephalography (MEG) recordings from 48 healthy listeners. Preliminary findings demonstrate that studying music novelty can help understand brain reactions to realistic music [42].

4. CONCLUSION

When Karawitan musicians listened to Mozart's Piano Sonata in C Major, western music, their brains displayed faster frequency bands, i.e. alpha wave activity. The main brain activity occurred in the frontal lobe of right hemisphere. Rather than distinguishing between musicians and non-musicians' brain activity, the current study indicated differences in brain activity while musicians listened to music based on their musical experience. This finding will lead to more research into the integration of music, such as music neuroscience.

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