Review

Psikiyatride Güncel Yaklaşımlar-Current Approaches in Psychiatry 2026; 18(2):466-477
doi: 10.18863/pgy.1693924

Neuroplastic Effects of Music Listening as Measured by Electroencephalography: A Systematic Review

Müzik Dinletisinin Elektroensefalografi ile Değerlendirilen Nöroplastisite Etkileri: Sistematik Bir Derleme

Onur Birol Kırış[1], Sena Güldehan Uçan[1], Evren Erik[1]

[1]Üsküdar University, İstanbul

ABSTRACT

This systematic review evaluates experimental studies published between 2020 and 2025 that were conducted with healthy individuals and investigated neuroplastic effects measured by electroencephalography (EEG) during passive music listening. The aim is to understand the effects of music listening on emotional and cognitive brain networks. The review includes eight studies with within-subject designs in which EEG data were collected. The findings indicate that music listening increases synchronization in theta and alpha bands, strengthens functional connectivity, and induces changes in network modularity specific to information processing in prefrontal, temporal, and motor regions. Studies focusing on emotional processes show that responses such as pleasure and enjoyment increase theta activity in the orbitofrontal cortex, insula, and temporal regions; studies targeting cognitive processes reveal network reorganizations associated with functions such as attention, memory, and familiarity. It is stated that music listening supports experience-dependent long-term neuroplastic changes and may enhance emotional regulation, attention, and learning processes. However, limitations such as small sample sizes, methodological diversity, and the inclusion of only healthy individuals restrict the generalizability of the findings. Limited EEG studies in Türkiye support that music listening creates effects in beta and sensory-motor rhythm bands and reduces anxiety. It is recommended that future EEG research include large samples and structured music protocols.

Keywords: Electroencephalography, functional connectivity, music, neuroplasticity, systematic review

ÖZ

Bu sistematik derleme, 2020–2025 yılları arasında yayımlanmış, sağlıklı bireylerle yapılan ve pasif müzik dinletisi sırasında elektroensefalografi (EEG) ile ölçülen nöroplastik etkileri inceleyen deneysel çalışmaları değerlendirmektedir. Amaç, müzik dinletisinin duygusal ve bilişsel beyin ağları üzerindeki etkilerini anlamaktır. Derleme, karşılaştırmasız (within-subject) tasarımlı, EEG verisi toplanmış sekiz çalışmayı kapsamaktadır. Bulgular, müzik dinletisinin prefrontal, temporal ve motor bölgelerde teta ve alfa bantlarında senkronizasyon artışı, fonksiyonel bağlantısallık güçlenmesi ve bilgi işlemeye özgü ağ modülerliğinde değişimler oluşturduğunu göstermektedir. Duygusal süreçlere odaklanan çalışmalar, hoşnutluk ve haz gibi tepkilerin orbitofrontal korteks, insula ve temporal bölgelerde teta aktivitesini artırdığını; bilişsel süreçlere yönelik çalışmalar ise dikkat, bellek ve tanıdıklık gibi işlevlerle bağlantılı ağ yeniden yapılanmalarını ortaya koymaktadır. Müzik dinletisinin, deneyime bağlı uzun vadeli nöroplastik değişimleri desteklediği ve duygusal regülasyon, dikkat ile öğrenme süreçlerini güçlendirebileceği belirtilmektedir. Ancak, küçük örneklem boyutları, yöntemsel çeşitlilik ve yalnızca sağlıklı bireylerin incelenmesi gibi sınırlılıklar, bulguların genellenebilirliğini kısıtlamaktadır. Türkiye'deki sınırlı EEG çalışmaları, müzik dinletisinin beta ve duyusal-motor ritim bantlarında etkiler yarattığını ve anksiyeteyi azalttığını desteklemektedir. Gelecekte, geniş örneklemli, yapılandırılmış müzik protokolleri içeren EEG araştırmaları yapılması önerilir.

Anahtar sözcükler: Elektroensefalografi, fonksiyonel bağlantısallık, müzik, nöroplastisite, sistematik derleme

Address for Correspondence: Onur Birol Kırış, Üsküdar University Institute of Health Sciences, Istanbul, Türkiye
e-mail: onurkiris@gmail.com
Received: 07.05.2025 | **Accepted:** 11.07.2025

Introduction

Music is a complex environmental stimulus that can simultaneously influence auditory, motor, cognitive, and emotional systems through its structural and affective components, such as melody, rhythm, and harmony. These features enable music to coordinate diverse functional brain networks and affect higher-order cognitive processes (Zatorre et al. 2007, Torun 2020).

Neural synchronization and alterations in connectivity during music listening can be examined using various neuroimaging methods, with electroencephalography (EEG) being a non-invasive technique characterized by superior temporal resolution. EEG enables the assessment of functional connectivity dynamics by analyzing synchronization patterns and frequency band fluctuations, including theta, alpha, and beta (Michel and Koenig 2018). Improved synchronization in response to music may enhance neuronal connectivity and facilitate neuroplastic processes, including synaptogenesis, dendritic branching, and myelination (Herholz and Zatorre 2012, Harding et al. 2025). Neuroplasticity refers to the brain's intrinsic capacity to adapt to environmental stimuli, occurring not just during embryonic phases but also in maturity within the realms of learning, emotional regulation, and rehabilitation (Kolb and Gibb 2011).

Neuroimaging research demonstrates that music listening can induce both structural and functional neuroplasticity in regions such as the prefrontal cortex, anterior cingulate, insula, and hippocampus (Grahn and Brett 2007, Chanda and Levitin 2013, Särkämö et al. 2013). Recent EEG studies have shown that the rhythmic structure of music affects interregional brain connectivity and generates neural patterns associated with cognitive and affective functions (Reybrouck et al. 2018, Leeuwis et al. 2021).

Numerous literature studies have emphasized the beneficial impacts of music therapy on cognitive processes and neuroplasticity (Lök and Bademli 2016, Önsüz and Can 2025). Nonetheless, these evaluations mostly concentrate on clinical samples and investigations that incorporate ongoing treatment interventions. Research on passive music listening, in which individuals solely partake in structured auditory experiences without engaging in music composition, is relatively scarce. This review is characterized by a comprehensive analysis of experimental designs only utilizing passive listening paradigms. Furthermore, it provides a distinctive contribution by concentrating on research that use single-subject methods, highlighting individual neuroplastic responses instead of comparative group analyses. The expanding study on the brain impacts of music listening is impeded by the range of methodological approaches and variability in experimental designs, which obstruct the formation of a coherent and integrated understanding of the results.

The neurophysiological impact of passive music listening on brain connection patterns has ramifications for both fundamental neuroscience and diverse clinical disorders. Numerous research indicate that music listening can diminish anxiety, influence attention processes, and facilitate emotional regulation (Chanda and Levitin 2013, Särkämö et al. 2013). Real-time EEG measures of brain alterations indicate that music may serve as a supplementary intervention to mitigate symptoms linked to neurodevelopmental disorders, stress-related illnesses, and attentional deficiencies. These findings highlight the translational potential of music-induced brain responses and pave the way for new avenues of applied research in the discipline.

This systematic review aims to synthesize and evaluate recent experimental studies utilizing EEG to investigate the neurocognitive effects of passive music listening on the human brain. The review primarily focused on investigating changes in the connectivity between frontotemporal and parietal regions, oscillatory activity throughout theta, alpha, and beta frequency bands, and the neural correlates of emotional experiences, such as musical enjoyment. This approach aims to synthesize existing findings and highlight consistent EEG-based neuroplastic patterns.

Method

This research analyzes experimental EEG studies published from 2020 to 2025, involving healthy volunteers in within-subject designs that solely concentrated on passive music listening. This research investigates neurophysiological reactions to emotions provoked by music, the directional flow of information, inter-regional connectivity, and brain activity patterns.

The literature search in the PubMed, Web of Science, and ScienceDirect databases was performed from April 20 to April 23, 2025. A literature search was performed utilizing the Boolean expression: ("music therapy" OR "structured music" OR "music-based intervention" OR "music listening") AND ("neuroplasticity" OR "brain connectivity" OR "functional reorganization") AND (EEG). Three scholars conducted separate analyses of all information obtained at the title and abstract level. Thorough evaluations of research satisfying the first eligibility criteria were conducted for a more detailed analysis. Figure 1 depicts the flow diagram that summarizes the study selection procedure, executed in compliance with PRISMA criteria (Moher et al. 2009).

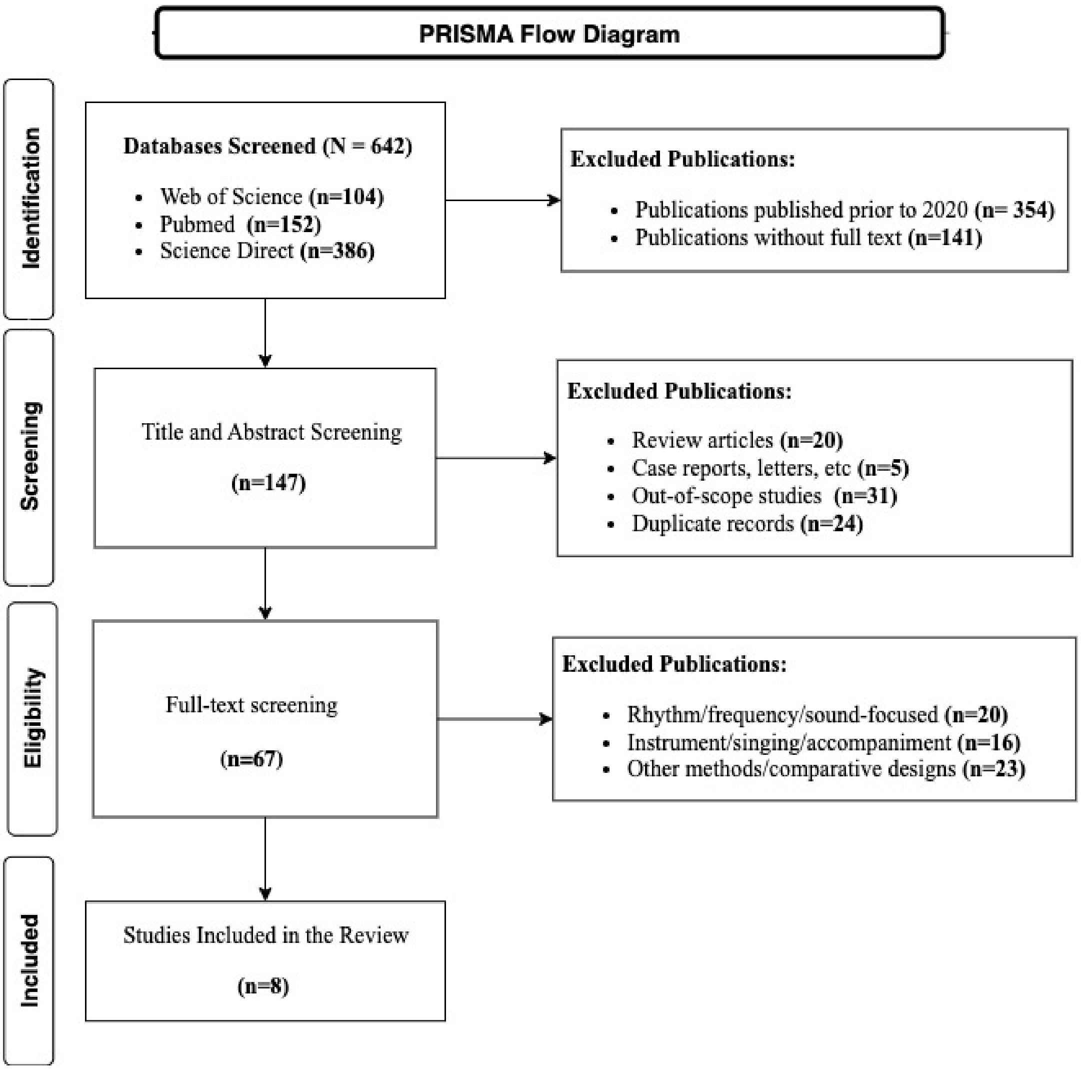

Figure 1. PRISMA flow diagram of studies included in the review

A total of 642 entries were identified using database searches: 104 from Web of Science, 152 from PubMed, and 386 from ScienceDirect. Researchers deliberated and achieved consensus on inclusion decisions according to established eligibility criteria. The inclusion criteria encompassed original experimental investigations published from 2020 to 2025, involving human participants, employing EEG methodologies, and only concentrating on passive music listening. The chosen studies investigated indications of music-related neuroplasticity, such as frequency band activity, functional connectivity, and synchronization, utilizing real-time EEG recordings during the intervention. The exclusion criteria were studies without experimental design or EEG recordings during music listening, therapies employing only basic rhythmic stimuli (such as metronomes or click sounds), and research involving active music engagement (such as singing or playing instruments). A total of eight studies met the inclusion criteria for this review.

Results

The studies in the review were classified into two primary categories according to the brain processes they investigated. The initial group concentrated on the impact of music listening on emotional experiences and hedonic reactions, including pleasure and affective arousal. The second group examined the impact of music listening on cognitive functions and the overall structure of the brain. Although both research examined EEG-based alterations in the theta, alpha, and beta frequency regions, their principal brain targets varied. The initial group focused on the brain correlates of subjective emotional states—such as pleasure or emotional intensity—provoked by music (Table 1). Conversely, the second group examined cognitive areas such as familiarity, attention, memory, and functional connections (Table 2). This classification facilitated a more systematic assessment of how passive music listening can concurrently influence emotional experiences and cognitive-neural mechanisms.

Table 1. Summary of studies investigating the effects of music listening on emotional and hedonic responses

Study	Participants	Aim and Experimental Design	EEG Measures (Regions & Bands)	Principal Findings
Chabin et al.2020	Eighteen healthy right-handed participants (11 female, 7 male; mean age = 39.7 ± 18.3 years, range = 18–73), all scoring >65 on the Barcelona Music Reward Questionnaire (BMRQ), indicating high sensitivity to musical reward and frequent chill experiences during pleasurable music listening; 10 were amateur musicians with an average of 20.2 years of musical practice.	This study investigated cortical patterns associated with musical chills using high-density EEG, focusing on the relationship between hedonic intensity and theta activity (4–8 Hz) in the fronto-central and centro-parietal regions. Participants listened to five pleasurable and three neutral self-selected music excerpts (each 90 seconds) and reported their momentary pleasure levels using a four-level response box. Each excerpt was separated by a 30-second silent interval.	High-density EEG (HD-EEG) data were continuously recorded throughout each listening session, and 1-second epochs were extracted for analysis. Power spectral density (PSD) was calculated in the theta (4–8 Hz), alpha (8–12 Hz), and beta (12–20 Hz) bands for left/right central (LC, RC), frontal (LF, RF), prefrontal (LPF, RPF), and temporal (LT, RT) regions. Alpha asymmetry and beta/alpha ratio were analyzed in the frontal areas. For source localization, the LAURA model was applied to assess activation in the orbitofrontal cortex (OFC), supplementary motor area (SMA), bilateral insula, and right/left superior temporal gyrus (RSTG, LSTG).	Theta band activity (4–8 Hz) showed modulation in the right prefrontal, temporal, and central regions. As emotional ratings increased, prefrontal theta power and orbitofrontal cortex (OFC) activation also increased. During chill responses, theta power decreased in the right central and temporal areas but increased in the prefrontal region ($p < .05$). The beta/alpha ratio significantly increased in association with emotional pleasure ($p < .05$). Source analysis revealed heightened activation in the OFC, insula, supplementary motor area (SMA), and bilateral superior temporal gyri (STG) ($p < .01$).
Ara and Marco-Pallarès 2020	Twenty-five healthy right-handed participants (mean age: 22.32 ± 2.66 years; 19	This study aimed to investigate oscillatory neural connectivity associated with perceived plea-	Each 45-second EEG recording was analyzed after removing the first and last 2 seconds. Theta band (4–8 Hz) phase	High levels of pleasure were associated with increased theta band (4–8 Hz) synchronization between right frontal and

	female) with similar music preferences and comparable levels of music-induced pleasure; none had more than three years of formal music training. Three participants were excluded from the analysis due to poor data quality.	sure during music listening. Participants randomly listened to 30 music excerpts (45 seconds each) selected from indie, pop, electronic, folk, and experimental genres. During each excerpt, they continuously rated their level of pleasure on a 1–5 scale while fixating on a static visual point.	synchronization between frontal, temporal, and parietal regions was assessed using ISPC-time. Surface Laplacian was applied to minimize volume conduction, and peripheral or closely spaced electrodes (<6 cm) were excluded from analysis.	temporal regions, particularly at AF4–T8 and F4–T8 electrode pairs. Time-weighted pleasure ratings strongly predicted overall music appreciation. Bayesian beta regression revealed that theta synchronization increased with rising pleasure levels in both AF4–T8 and F4–T8 connections.
Ara and Marco-Pallarès 2021	Twenty-two healthy right-handed participants (mean age = 21.86, SD = 2.36; 17 female).	This study examined the effect of musical familiarity on theta phase synchronization associated with pleasure. Participants listened to 60 music excerpts across two sessions—familiarity was rated in the first, and pleasure in the second. EEG analyses focused on theta connectivity patterns in right fronto-temporal and temporo-parietal regions.	Each 45-second EEG recording was analyzed after removing the first and last 2 seconds. Theta band (4–8 Hz) phase synchronization between frontal, temporal, and parietal regions was assessed using ISPC-time. Surface Laplacian was applied to minimize volume conduction, and peripheral or closely spaced electrodes (<6 cm) were excluded from analysis.	During unfamiliar music listening, theta band synchronization increased between right fronto-temporal regions (AF4–FT8, AF4–T8), significantly correlating with higher pleasure ratings. For familiar music, a similar increase was observed between right temporal and left parietal regions (T8–CP5, CP5–TP8). Analyses were conducted using a Bayesian multilevel beta regression model with a logit link function and a ±0.01 ROPE threshold.

This table encapsulates experimental investigations that examined the impact of music listening on emotional processes, including pleasure, enjoyment, and emotional arousal, utilizing EEG data.

Neural Synchronization Associated with Emotional Arousal and Hedonic Responses

Experimental EEG research has shown that passive music listening can evoke significant emotional responses—such as pleasure, joy, and chills—linked to certain patterns of neural synchronization and frequency-specific brain activity. Chabin et al. (2020) shown using high-density EEG that during instances of chills induced by self-selected music, source activations were significant in the orbitofrontal cortex, bilateral insula, and superior temporal gyrus—areas linked to emotional awareness and reward processing. The experience was associated with an elevation in theta power in the prefrontal cortex, whereas simultaneous reductions in theta activity were noted in the right central and right temporal areas. Ara and Marco-Pallarès (2020) observed a notable enhancement in phase synchronization within the theta band between the right frontal and right temporal areas during the enjoyment of music. The subsequent study by Ara and Marco-Pallarès (2021) investigated the impact of musical familiarity on these connection patterns. Bayesian multilevel modeling demonstrated that unknown music heightened theta synchronization in the right fronto-temporal connections linked to pleasure, while familiar music produced analogous effects in interhemispheric temporo-parietal connections.

Table 2. Summary of studies investigating the effects of music listening on cognitive processes and neural organization				
Study	**Participants**	**Aim and Experimental Design**	**EEG Measures (Regions & Bands)**	**Principal Findings**
Zheng et al. 2021	Twenty-six healthy postgraduate students (14 male, 12 female; mean age = 21.5 ± 3.7 years) participated in the study. All had normal vision and hearing, no history of psychiatric disorders or medication use, and no formal musical training.	The aim of the study was to examine the topological and dynamic properties of brain networks during music listening and mental arithmetic conditions. To this end, static and dynamic Minimum Spanning Tree (MST) analyses were conducted to compare network structures across conditions. Participants completed tasks including eyes-closed and eyes-open resting states (1 min), music listening (~140–213 seconds), and mental arithmetic (16 problems). Although additional resting periods were interspersed between these tasks within the protocol, the study primarily focused on comparing three main conditions: rest, music, and arithmetic.	For each condition, 40 seconds of artifact-free EEG data (64 channels, 1000 Hz) were analyzed. Functional connectivity was assessed using the Phase Lag Index (PLI), and network topology was examined via the Minimum Spanning Tree (MST) method. Graph metrics—clustering coefficient (C), path length (L), tree hierarchy (TH), leaf fraction (LF), and diameter (D)—were computed across delta, theta, alpha, and beta frequency bands. Dynamic changes were evaluated using non-overlapping 2-second windows.	Music listening enhanced connectivity in the left posterior regions and yielded more integrated network configurations in the alpha and beta bands (↑C, ↓L). MST analysis revealed posterior-centered star-like patterns and greater structural dissimilarity compared to task conditions. ANOVA results showed that the music condition was associated with increased connectivity, elevated C, and reduced L. In the alpha band, significant differences emerged for TH, LF, and D ($P < .01$).
Ross et al. 2022	Seventeen healthy right-handed adults (15 females, 2 males); age range 18–26 years (mean age = 21.77 ± 2.73 years).	The study investigated the relationship between covert motor activity during music listening and overt motor tasks, as well as its effect on auditory temporal prediction. Participants underwent EEG recording under four conditions: silence, right-hand tapping, right-foot tapping, and music listening. The musical stimuli consisted of 12 normalized instrumental	EEG data from each condition were analyzed in 10-second epochs. Recordings were obtained using a 32-channel system, with a 1–50 Hz band-pass filter and line noise removal applied. ICA, equivalent dipole modeling and component clustering identified three regions associated with mu rhythmic (sensorimotor) activity: left BA4, right BA6, and midline BA6.	Music listening was associated with significant mu rhythm enhancement (event-related synchronization, ERS) in the left and midline motor regions (left alpha: $p < .00003$; midline alpha: $p = 8.6e-06$). In contrast, in the right hemisphere, alpha power suppression (event-related desynchronization, ERD) was observed only during right-hand

		excerpts selected from the Beat Alignment Test Version 2 (BAT v2), a protocol designed to assess rhythm perception and temporal sensitivity.	Alpha and beta band power were analyzed within these regions.	movement ($p < .00006$). These findings suggest that music listening may support implicit motor inhibition.
Zhu et al. 2023	Fourteen right-handed adults (age range: 20–46 years); individuals with no history of hearing loss, neurological disorders, or musical expertise.	The primary aim of the study was to introduce a network modeling framework based on Block Term Decomposition (BTD) to identify the dynamic evolution of brain functional communities during free music listening. Participants listened to a 512-second modern tango piece through headphones, during which the temporal and topological changes in brain networks were analyzed.	EEG data were recorded while participants listened to a 512-second modern tango piece. Signals were band-pass filtered between 2–35 Hz, and source localization was followed by parcellation into 68 cortical regions using the Desikan–Killiany Atlas. Functional connectivity was computed via Pearson correlations between these regions, and modular structures were identified through community detection analysis.	Functional networks were shown to dynamically reorganize during music listening, with community structures modulated in accordance with musical features. Modules identified through BTD were found to align with auditory, sensorimotor, and higher-order cognitive subsystems. Correlation analyses were assessed using a phase-randomization approach against the 95th percentile threshold, with significance corrected via Bonferroni adjustment ($p_{correct} = 0.05/R$).
Hashim et al. 2024	Forty-two participants; 27 female, 15 male; mean age 28.85 ± 4.85 years (age data missing for one participant); approximately 95% (n = 40) reported no hearing problems; one participant used a hearing aid or implant; one participant did not report hearing status but was noted to listen attentively; group allocation was not specified.	The aim of the study was to investigate the neural correlates of static and dynamic visual imagery performed during music listening in the absence of external visual stimuli, and to examine how these patterns evolve across different phases of the imagery experience. Participants listened to 24 emotionally evocative music excerpts (joyful, fearful, and neutral) with their eyes closed and subsequently rated the intensity of both static and dynamic imagery on	EEG data were recorded during 30-second music listening periods. For each piece, 32-second epochs were created (2 seconds baseline + 30 seconds listening). A total of 24 trials per participant were analyzed, yielding 1008 trials overall. EEG signals were segmented into 1-second windows and analyzed using Fast Fourier Transform (FFT). Power in the alpha, beta, and gamma frequency bands was examined across frontal, central-parietal, and parieto-occipital regions.	Static and dynamic visual imagery during music listening were associated with distinct neural patterns. Both conditions showed initial alpha suppression in the parieto-occipital region (static: $p = 0.027$; dynamic: $p < 0.001$). In the second half of the trial, static imagery was linked to alpha enhancement ($p < 0.001$), while dynamic imagery was associated with beta suppression ($p = 0.002$) and increased gamma power in the central-parietal region ($p = 0.017$). Musical

		a 0–100 scale following each piece.	Baseline correction was applied to all segments.	training modulated alpha and beta band responses.
Malekmo-hammadi and Cheng 2025	Twenty right-handed healthy males; aged between 21 and 39 years (mean = 29.10 ± 4.40); normal vision and hearing; no formal music training and no musical instrument practice in the past 7 years.	The study aimed to investigate phase-based functional connectivity changes in the theta and alpha frequency bands across parietal–frontal and parietal–temporal regions as unfamiliar classical music excerpts became familiar through repeated passive listening. Participants randomly listened to 85 ten-second instrumental music excerpts; 30 unfamiliar pieces were repeated three times, and mental repetition was rated on a 1–7 Likert scale.	Continuous EEG was recorded using 51 electrodes throughout each listening session; for analysis, 0–10 s epochs time-locked to stimulus onset were used. The pre-stimulus period was defined as −200 to −2 ms, and data were resampled. Functional connectivity was assessed in the theta and alpha bands using the weighted phase lag index (WPLI), focusing on regions of interest (ROIs) in the frontal, parietal, and temporal areas.	Short-term music familiarity enhanced phase synchronization in the theta and alpha bands within the right hemisphere, strengthening right fronto-parietal and temporo-parietal connections. Linear modeling analyses revealed a positive association between increasing familiarity and connectivity between right frontal and posterior regions ($P < 0.005$).

This table encapsulates experimental research assessing the impact of music listening on cognitive and neurological functions, including familiarity, attention, memory, and functional connectivity among brain.

Neural Impacts on Functional Network Dynamics and Cognitive Functions

EEG-based research examining the impact of passive music listening on cognitive processes and brain network organization demonstrates, using diverse analytical methods, that music affects not just affective aspects but also functional connection patterns. Zheng et al. (2021) discovered a star-like functional network topology with non-directional, integrated connections, particularly in the posterior brain areas during music listening. Ross et al. (2022) revealed that passive music listening, devoid of any motor action, can enhance mu rhythm activity, indicating the onset of covert motor activation within the sensorimotor system. Zhu et al. (2023) indicated that the brain experiences dynamic reconfiguration in response to the temporally evolving acoustic characteristics of music, involving the integrated functioning of auditory, motor, and cognitive systems. Hashim et al. (2024) reported alpha suppression succeeded by heightened beta and gamma activity in the parieto-occipital areas during visual imaging activities conducted concurrently with music. Malekmohammadi and Cheng (2025) found that frequent exposure to novel musical compositions correlated with enhanced phase synchronization in the theta and alpha bands among the right frontal, temporal, and parietal areas. The authors propose that this rise may indicate quantifiable alterations in brain connection patterns influenced by familiarity acquired through brief passive listening.

Discussion

This systematic review analyzes contemporary experimental studies employing within-subject designs and EEG data collection to evaluate the effects of passive music listening on emotional and cognitive functioning in the brain. Research undertaken between 2020 and 2025 reveals neurophysiological effects, including changes in regional brain activity—particularly within the theta, alpha, and beta frequency bands—and improved or reorganized connectivity patterns due to phase synchronization. These modifications have been observed concerning both emotional responses and the enjoyment of music (Ara and Marco-Pallarès 2020, Chabin et al. 2020, Ara and Marco-Pallarès 2021), as well as cognitive mechanisms (e.g., familiarity, imagery) and overall neural architecture, encompassing network structure and connectivity (Zheng et al. 2021, Ross et al. 2022, Zhu et al. 2023, Hashim et al. 2024, Malekmohammadi and Cheng 2025).

The findings indicate that music is not only a surface sensory stimulation; it activates a sophisticated brain process that concurrently engages emotional, reward-related, and cognitive control systems. The research conducted by Chabin et al. (2020) indicates that activations in the orbitofrontal cortex and insula substantiate the idea that music engages networks associated with reward processing and emotional awareness. Likewise, the right fronto-temporal theta synchronization identified by Ara and Marco-Pallarès (2020) suggests that pleasurable reactions to music are conveyed through distinct connection pathways, which fluctuate based on contextual variables. The researchers assert that music-induced positive feelings extend beyond individual choice, establishing context-dependent neurophysiological patterns through dynamic interactions between emotional and cognitive brain networks. Ross et al. (2022) indicated that mu rhythms, often observed in the sensorimotor cortex within the 8–12 Hz frequency range and linked to movement inhibition, were amplified in the motor cortex during passive music listening. This rise was understood as the activation of covert motor inhibition mechanisms in reaction to the stimulating attributes of music. The findings imply that music influences both emotional reactions and brain circuitry associated with motor control, indicating that even during passive listening, motor networks undergo regulatory adaptations to the inherent impulse for movement.

Previous studies by Blood and Zatorre (2001) and Koelsch et al. (2006) demonstrated that music listening significantly activates brain regions associated with reward and emotional processing, such as the ventral tegmental area, nucleus accumbens, orbitofrontal cortex, and anterior cingulate cortex. Furthermore, pleasurable music has been demonstrated to alter limbic regions such as the amygdala and hippocampus, potentially regulating stress responses (Koelsch et al. 2006). Consistent with these findings, the EEG analyses presented in this research demonstrated increases in theta and alpha phase synchronization in the prefrontal and temporal cortices, indicating a reorganization of emotion-related neural networks. By concurrently activating sensory, reward, and cognitive systems, music elicits immediate emotional reactions and appears to induce enduring changes in brain structure. In accordance with this, previous research has demonstrated that music listening enhances neural connectivity in the prefrontal cortex, temporal lobes, motor regions, and limbic system, thereby modifying network architecture via specific frequency bands (Trost et al. 2012, Thaut and McIntosh 2014, Reybrouck et al. 2018, Torun 2022). The findings of this review corroborate this approach and are in agreement with the assertions of Särkämö et al. (2013) and Reybrouck et al. (2018), who highlight the enduring impacts of music on neuroplasticity.

Additional studies examined in this article, which concentrate on cognitive and brain organization, further substantiate the importance of music listening in fostering neuroplasticity. The star-like posterior network topology identified by Zheng et al. (2021) indicates that music listening promotes cognitive integration via non-directional but densely coupled pathways. Zhu et al. (2023) illustrate that the brain experiences dynamic reconfiguration in reaction to the auditory characteristics of music, resulting in the establishment of particular connection patterns among various cognitive and motor regions. Hashim et al. (2024) demonstrate that music-supported imaging engages auditory, multisensory, and motor systems, thereby enhancing cognitive representations at the network level. Moreover, the connection improvements noted by Malekmohammadi and Cheng (2025) indicate that musical familiarity gained via repeated exposure may facilitate learning and synaptic reinforcement at the network level.

Enhancements in theta and alpha synchronization facilitate neuronal remodeling associated with cognitive tasks such as learning, memory, and emotional processing through established mechanisms (Reybrouck et al. 2021). The EEG research presented indicate that music listening enhances phase synchronization and connection in the prefrontal, temporal, and motor regions, hence promoting enduring alterations in brain function. The findings suggest that music can provoke temporary emotional reactions and also facilitate enduring structural and functional alterations in brain networks. Music-based auditory approaches created globally seek to enhance functional improvements, particularly in neurodevelopmental disorders (Lai et al. 2012, Eskine et al. 2020). Kırış and Erik (2024) recently used a systematic, sensory-based music listening protocol called Sensory Activation Solutions (SAS) for a kid diagnosed with Cornelia de Lange

Syndrome (CdLS). The findings demonstrated a 10–15% enhancement in attention, memory, and cognitive abilities, underscoring music's potential to facilitate early brain development.

Although there is a limited number of EEG-based studies investigating the effects of music listening in Turkey, the results predominantly align with both the international literature and the findings presented in this review. Aker and Akar (2014) demonstrated that different Turkish music modes affect beta band activity, especially in the prefrontal and temporal areas, while Kayalar and Sazak (2018) revealed that classical and Turkish art music increased power in the theta, alpha, and sensorimotor rhythm (SMR) bands—particularly within the 12–15 Hz range associated with motor control and attentional processes. Uğraş et al. (2018) found that music listening reduced preoperative anxiety and its related physiological stress responses. Although these studies do not present recognized therapeutic procedures, they support the current study's findings by illustrating that music can induce transient effects on brainwave activity and facilitate emotional regulation. Research conducted in Turkey highlights the ability of music listening to improve brain connectivity, as well as emotional and cognitive performance.

The study exclusively includes publications with experimental designs utilizing EEG, published from 2020 to 2025, hence omitting research that employs alternative neuroimaging techniques such as fMRI, PET, and DTI. The prevalence of healthy participants in the study limits the generalizability of the results to sick populations. Furthermore, variations in sample size, session length, musical genres, and intervention frequency diminish the comparability of results. Some qualifying studies may have been omitted from the Boolean expressions and MeSH phrases utilized in the literature search. Focusing exclusively on full-text studies in Turkish and English may have resulted in a risk of publication bias.

Conclusion

Recent EEG-based experimental research has evidenced the impact of music listening on emotional and cognitive processes. The results demonstrate that music listening improves connection, especially in the prefrontal, temporal, and motor areas, via augmenting synchronization in the theta and alpha frequency bands. These alterations indicate the possibility of functional rearrangement within brain networks associated with learning, attention, memory, and emotional processing. From this viewpoint, music may serve as a transient sensory experience and a cognitive stimulus that fosters neuroplasticity.

This systematic review analyzes the impact of music on brain function via EEG findings, indicating that, despite a limited number of studies, passive music listening can elicit substantial alterations in brain networks linked to neurocognitive processes and provides a basis for future research in this domain. Assessing passive music listening as an adjunctive intervention for attention deficit disorders, emotional dysregulation, and stress could pave the way for novel avenues in scientific research and therapeutic application.

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Authors Contributions: The author(s) have declared that they have made a significant scientific contribution to the study and have assisted in the preparation or revision of the manuscript
Peer-review: Externally peer-reviewed.
Ethical Approval: This review study does not require ethical clearance.
Conflict of Interest: No conflict of interest was declared.
Financial Disclosure: No financial support was declared for this study..