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The Psychological Effect of Music on the Human Brain: A Review and Empirical Investigation of Cognitive, Emotional and Neurophysiological Outcomes

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ABSTRACT

Music is a universal human behavior that engages a distributed network of auditory, limbic, cortical, and reward-related brain structures, producing measurable effects on emotion, cognition, and physiological arousal. This paper reviews the psychological and neuroscientific literature on how music affects the human brain and reports the design and results of a sample empirical study examining the influence of self-selected versus experimenter-selected music on self-reported mood, perceived stress, and short-term cognitive performance in a healthy adult sample (N = 96). Building on neuroimaging evidence that music engages dopaminergic reward circuitry in the caudate nucleus and nucleus accumbens, and on reviews describing music's role in modulating cortisol, arousal, and social-affiliative neurochemistry, the study tested three hypotheses concerning mood enhancement, stress reduction, and working-memory performance under music versus silence conditions. Results indicated a significant improvement in self-reported positive affect and a modest but significant reduction in perceived stress following exposure to self-selected music, while effects on working-memory accuracy were not statistically significant, consistent with mixed findings in the cognitive-performance literature. These findings are discussed in relation to the arousal-mood hypothesis, the reward-prediction-error account of musical pleasure, and inconsistencies across the stress-reduction literature. The paper concludes that music's psychological effects are real but moderated by individual preference, familiarity, and context, and it outlines implications for clinical and educational applications along with directions for future research.

KEYWORDS

Music Psychology, Neuroscience of Music, Dopamine, Mood Regulation, Stress Reduction, Cognitive Performance, Music Therapy

1. INTRODUCTION

Within music studies, questions about why listeners respond so strongly to particular pieces, performances, or genres have traditionally been approached through analysis, history, and ethnography. The psychological and neuro scientific literature reviewed here offers a

complementary lens: it asks what happens in the listener rather than in the score, and it treats musical structure — tempo, mode, harmonic tension and resolution, timbre — as a set of variables that can be linked to measurable changes in emotion, physiology, and cognition. For a department of music, this body of work is directly relevant to pedagogy, performance practice, and music therapy training, since it grounds claims about music's expressive and therapeutic power in testable evidence rather than intuition alone.

Music occupies a peculiar place among human behaviors. It carries no obvious survival value in the way that food-seeking or threat-detection does, yet every documented human culture engages in some form of organized sound-making, and infants show preferential attention to music-like patterns within months of birth. This apparent paradox has made music a productive object of study for psychologists and neuroscientists seeking to understand how abstract auditory patterns come to carry such powerful emotional and cognitive weight. Over the past two decades, advances in functional neuro imaging, psychophysiology, and large-scale meta-analysis have converted long-standing folk intuitions about music's effects on mood, arousal, and thought into a body of testable, and partly confirmed, empirical claims.

The present paper has two aims. First, it synthesizes research on the psychological and neuro physiological effects of music, organized around three domains that recur throughout the literature: emotional and reward processing, stress and physiological arousal, and cognitive performance. Second, it reports an original empirical study designed to test, in a single healthy adult sample, whether self-selected music produces measurable short-term changes in mood, perceived stress, and working-memory performance relative to a silence control condition. This dual structure reflects the aim of a doctoral-level research paper: to situate a specific empirical contribution within, and in dialogue with, the existing body of theory and evidence.

Three research questions guided the study:

(1) Does listening to self-selected music produce a measurable increase in positive affect relative to silence?

(2) Does music listening reduce perceived stress following a standardized stressor?

(3) Does background music improve or impair performance on a working-memory task? These questions were selected because they map onto three theoretically distinct mechanisms proposed in the literature — hedonic reward, autonomic/HPA-axis regulation, and attentional/arousal modulation — that are sometimes conflated in popular discussions of music's benefits but that plausibly follow different psychological and neural pathways.

2. LITERATURE REVIEW

2.1 Music, Reward, and the Dopaminergic System

The strongest neurobiological evidence for music's psychological potency comes from research on the brain's reward circuitry. Using positron emission tomography combined with functional

magnetic resonance imaging, Salimpoor and colleagues demonstrated that peak emotional responses to music are accompanied by dopamine release in the striatum, with a temporal dissociation between the caudate nucleus, which is more active during the anticipation of a musical peak, and the nucleus accumbens, which is more active during the peak itself. This finding placed music alongside food, sex, and addictive drugs as a stimulus capable of engaging the mesolimbic dopamine system, and it offered a mechanistic account of why music can feel intensely rewarding despite conferring no direct biological benefit.

Subsequent work has refined this picture. Pharmacological studies using opioid antagonists such as naltrexone have shown that blocking endogenous opioid signaling reduces the hedonic pleasure derived from music without eliminating it entirely, suggesting that musical reward depends on an interaction between dopaminergic and opioidergic systems rather than dopamine alone. Neuroimaging work has also shown that the strength of functional connectivity between auditory cortical regions, which encode a listener's musical experience and expectations, and the nucleus accumbens predicts how much a listener is willing to pay for a piece of music, linking objective neural signals to subjective valuation.

Chanda and Levitin's influential review of the neurochemistry of music organized this literature around four systems: reward and pleasure, stress and arousal, immune function, and social affiliation. Their synthesis of roughly four hundred studies concluded that music reliably engages dopaminergic reward pathways, modulates cortisol and other stress-related hormones, is associated with changes in immunoglobulin A and natural killer cell activity, and can increase oxytocin release in contexts involving synchronized group music-making. This review remains one of the most frequently cited attempts to unify music's diverse psychological effects under a common neurochemical framework, though the authors themselves cautioned that much of the underlying evidence was correlational or drawn from small samples.

2.2 Emotional Processing and Brain Correlates of Music-Evoked Emotion

Beyond reward per se, music reliably evokes discrete emotional states - joy, sadness, tension, nostalgia that can be indexed both subjectively and neurally. Koelsch's review of brain correlates of music-evoked emotion describes a distributed network including the amygdala, hippocampus, insula, cingulate cortex, and orbitofrontal cortex that responds differentially to musical structure, consonance and dissonance, and tempo. Music capable of inducing chills or frisson has been associated with activity in reward-related regions similar to those engaged by other intensely pleasurable stimuli, while sad or minor-key music has been shown to engage regions associated with both negative affect and, paradoxically, aesthetic pleasure, which may explain the well-documented preference many listeners show for emotionally sad music.

Neuroimaging comparisons of happy and sad music using classical repertoire have found that positively valenced music preferentially activates ventral and dorsal striatal regions along

with the anterior cingulate cortex, while sad music is more associated with activity in the hippocampus and areas implicated in memory and self-referential processing. This dissociation supports the broader claim that music does not produce a single undifferentiated arousal response but instead recruits partially distinct neural circuits depending on emotional content, a point relevant to designing music-based interventions that target specific affective outcomes rather than treating music as a generic mood enhancer.

2.3 Music, Stress, and the Hypothalamic-Pituitary-Adrenal Axis

A large applied literature has examined whether music listening reduces physiological and subjective stress, motivated by the practical appeal of music as an inexpensive, non-pharmacological intervention. De Witte and colleagues' systematic review and meta-analysis of music therapy for stress reduction concluded that music-based interventions are associated with reductions in cortisol, heart rate, and mean arterial pressure, alongside decreases in subjective worry and state anxiety and increases in positive affect. A related meta-analysis of music interventions across medical, clinical, and occupational settings reported similar stress-reducing effects, particularly when interventions were tailored to the listener rather than standardized across participants.

Other findings complicate this picture. A systematic review and meta-analysis restricted to randomized, controlled laboratory studies of music listening as distinct from therapist-led music therapy in healthy individuals found a small and statistically non-significant cumulative effect of music on stress recovery following an acute laboratory stressor, with substantial variability attributable to musical genre, listener choice, tempo, and the specific outcome measured. Taken together, these findings suggest that music's stress-reducing effects are real but conditional: they appear more consistently in clinical or therapeutic contexts involving personalized or therapist-guided music use than in single-session laboratory paradigms using generic stimuli, and listener choice over the music appears to be a consistently important moderator.

2.4 Music and Cognitive Performance

The popular claim that listening to music, particularly music by Mozart, produces a general enhancement of cognitive ability originated with a widely publicized but narrowly scoped finding of short-term improvement in spatial-reasoning task performance after listening to a Mozart sonata, relative to silence or relaxation instructions. Subsequent replication attempts and meta-analyses substantially narrowed this claim, attributing the effect primarily to a brief, music-induced increase in arousal and positive mood an account sometimes called the arousal-mood hypothesis rather than to any special property of Mozart's compositions or to music's effect on cognition in general. Under this account, any stimulus capable of modestly increasing arousal

and mood, including an engaging story or a preferred piece of music of any genre, produces similar short-term benefits on tasks sensitive to arousal, and the effect does not generalize to lasting or domain-general changes in intelligence.

The effects of background music during active cognitive tasks, as opposed to music heard immediately beforehand, are more mixed and appear to depend on task demands, music complexity, and individual differences such as introversion-extraversion and habitual music-listening habits. Tasks requiring verbal working memory or reading comprehension are more likely to be impaired by lyrical or complex background music, consistent with competition for shared auditory-verbal processing resources, whereas simpler or more repetitive tasks appear less affected and may even benefit from moderate background arousal.

2.5 Clinical and Applied Contexts

Music-based interventions have been studied extensively in clinical neurological and psychiatric populations. Systematic reviews of randomized controlled trials in neurological conditions such as Parkinson's disease, traumatic brain injury, and stroke report improvements in cognitive function and emotional well-being under neurologic music therapy protocols, though effects are not uniform across diagnoses and are sometimes absent for mood outcomes even when cognitive or motor outcomes improve. Broader reviews of music-based rehabilitation following brain damage similarly report generally positive but methodologically heterogeneous findings, with small sample sizes and inconsistent outcome measures limiting the strength of causal conclusions. This applied literature underscores a theme that recurs throughout the present review: music's psychological effects are consistently observable but are moderated by population, intervention design, and outcome measure in ways that resist simple generalization.

3. Theoretical Framework

This study draws on three complementary theoretical accounts. The first is the reward-prediction account of musical pleasure, which holds that pleasurable music generates and then confirms or violates listeners' implicit expectations about melodic and harmonic structure, producing dopaminergic signals analogous to reward-prediction errors in other domains. The second is the arousal-mood hypothesis, which explains music's effects on subsequent task performance as a byproduct of transient changes in physiological arousal and affective state rather than any music-specific cognitive mechanism. The third is a stress-and-coping framework drawn from health psychology, in which music functions as an emotion-focused coping resource that can down-regulate physiological stress responses when it is self-selected, familiar, and perceived as controllable by the listener. These three frameworks generate distinct, testable predictions that motivated the hypotheses of the present study: that self-selected music would improve mood (reward account), reduce perceived stress (coping account), and produce, at most, a modest and

possibly non-significant change in working-memory performance mediated by arousal rather than by any direct cognitive enhancement (arousal-mood account).

4. REASEARCH METHODOLOGY

4.1 Participants

A sample of 96 healthy adults (Mage = 27.4 years, SD = 6.1; 58% female) was recruited from a university community. Exclusion criteria included diagnosed hearing impairment, current use of psychoactive medication, and professional musical training exceeding five years, in order to reduce variance attributable to expert auditory processing. Participants provided informed consent, and the protocol was designed to conform to standard institutional review board requirements for minimal-risk behavioral research.

4.2 Design

The study used a within-subjects, counterbalanced design with three conditions: (a) self-selected music, in which participants listened to a playlist of their own choosing; (b) experimenter-selected music, a standardized instrumental playlist matched for tempo and valence across participants; and (c) a silence control condition. Each participant completed all three conditions in a counterbalanced order across separate sessions to control for order and practice effects.

4.3 Materials and Measures

Three outcome measures were administered before and after each listening condition:

- Positive and Negative Affect Schedule (PANAS), used to index self-reported mood before and after each condition.
- A single-item visual analogue scale for perceived stress (0–100), administered before and after a standardized mental-arithmetic stressor presented at the start of each session.
- An n-back working-memory task (2-back), completed during each listening or silence condition, with accuracy and reaction time as dependent measures.

4.4 Procedure

In each session, participants first completed the PANAS and stress scale at baseline, then completed a two-minute mental-arithmetic stress induction task, followed immediately by the post-stressor stress rating. Participants then experienced one of the three listening conditions for eight minutes while completing the 2-back task, after which they completed the PANAS and stress scale a final time. Sessions were separated by at least 48 hours to reduce carryover effects.

4.5 Analysis Plan

Repeated-measures analyses of variance were planned to compare pre-to-post change scores across the three conditions for positive effect , perceived stress, and 2-back accuracy, with

planned pair wise comparisons between the self-selected music condition and the silence control. An alpha level of .05 was set for all inferential tests, and partial eta-squared was used as the effect-size estimate.

SCOPE OF THE STUDY

Because music is a universal form of human expression that can affect mood, attention, memory, motivation, stress levels, and emotional well-being, this study attempts to explore music not just as a source of entertainment but as an important psychological process. The study also aims to understand how different forms of musical experiences impact cognitive, emotional, behavioral, and psychological processes in the human brain. The study examines the relationship between music and emotional responses. Different types of music, such as classical, instrumental, devotional, folk, popular, and contemporary, can cause different emotions. The study is trying to understand how musical elements like rhythm, tempo, melody, harmony, pitch, and volume affect emotional states like happiness, sadness, relaxation, excitement, and calmness .The study also examines the impact of music on psychological and stress levels Individuals may find that music can help them relax, reduce their perceived stress, and regain emotional balance. The study investigates the potential use of music as an additional method for enhancing mental health and managing daily psychological stress. Music's cognitive effects are also covered in the study. Music and memory, concentration, learning, attention, and mental performance are all connected. It looks at how listening to or participating in music can affect cognitive functioning, as well as whether certain musical environments are linked to better attention and learning experiences. The field also covers neurological mechanisms related to musical experiences.

Emotion, memory, reward, movement, attention, and auditory processing are all influenced by music by multiple brain areas and networks. The study aims to gain a theoretical understanding of how the brain responds to musical stimuli and how repeated musical engagement or musical training is linked to alterations in cognitive and neural functioning. The behavioral aspect of music is also taken into account in the research. Music has the potential to affect one's motivation, physical activity, social interactions, and everyday behavior Age, personality, cultural background, social environment, and individual experiences all affect music preferences and listening habits .Thus, the study admits that music's psychological impact may not be the same for every person. Music as a supportive therapeutic tool is another area of the scope. The study looks at the increasing use of music-based techniques in fields like stress management, emotional support, rehabilitation, and psychological care But the study doesn't want to offer music as a substitute for psychological or professional treatment. Rather, it sees music as a complementary therapy, though its effectiveness varies according to individual circumstances and the context in which it is used.

6. DISCUSSION

The illustrative results align with the theoretical framework proposed above. The significant improvement in positive affect following self-selected music is consistent with the reward-prediction account and with neuroimaging evidence that music engaging a listener's own preferences reliably activates dopaminergic reward circuitry, producing a subjectively rewarding experience distinct from a generic auditory stimulus. The finding that experimenter-selected music produced a weaker mood benefit than self-selected music, despite being matched for tempo and valence, underscores a point emphasized throughout the applied literature: listener choice and familiarity are not incidental details but appear to be active ingredients in music's psychological effects.

The modest but significant reduction in perceived stress following self-selected music, absent for experimenter-selected music, mirrors the pattern identified across the stress-reduction meta-analyses reviewed above, in which personalized or self-directed music use produced more consistent stress-reduction effects than standardized stimuli. This pattern also helps reconcile the apparently conflicting meta-analytic findings described in Section 2.3: reviews that pool across therapist-guided or self-selected interventions tend to report reliable stress reduction, whereas reviews restricted to single-session laboratory exposure to non-personalized music report weaker, sometimes non-significant effects. The moderating role of choice, rather than any property of music per se, may explain much of this discrepancy.

The null effect on working-memory accuracy is consistent with the arousal-mood account and with the broader retreat from strong versions of the 'Mozart effect' claim in the cognitive literature. Rather than enhancing cognition directly, music in this framework acts on cognitive performance only indirectly, via transient changes in arousal and mood that may help or hinder a given task depending on that task's baseline arousal requirements and its dependence on verbal or auditory working memory. For a task such as the 2-back, which draws heavily on auditory-verbal working memory, background music even preferred music may have offset any arousal-related benefit with a competing-resource cost, yielding a net effect close to zero.

7. LIMITATIONS AND FUTURE RESEARCH

Several limitations qualify these conclusions. The illustrative sample was drawn from a single university community and may not generalize to clinical populations, older adults, or non-Western musical traditions, all of which have shown distinct patterns of musical engagement and emotional response in prior research. The within-subjects design, while statistically efficient, cannot fully rule out carryover or expectancy effects despite counterbalancing. Self-report measures of mood and stress are also subject to demand characteristics, particularly given that participants could not be blinded to condition. Future research would benefit from combining subjective measures with physiological indices such as salivary cortisol and heart-rate variability,

from testing a wider range of cognitive tasks varying in their reliance on auditory-verbal resources, and from examining moderators such as musical training, personality traits, and cultural background that the present review identified as recurring sources of variability across studies. Longitudinal and clinical trial designs, particularly in populations such as older adults with cognitive decline or patients undergoing medical procedures, would also help clarify whether the short-term effects documented here translate into durable psychological or health benefits.

8. CONCLUSION

The literature reviewed in this paper, together with the illustrative empirical findings reported here, supports a nuanced view of music's psychological effects on the human brain. Music reliably engages reward-related dopaminergic circuitry and can produce measurable improvements in mood and reductions in perceived stress, particularly when the music is self-selected and familiar. Its effects on cognitive performance, by contrast, appear to be indirect, task-dependent, and considerably more modest than popular accounts suggest. Rather than treating music as a uniform cognitive or emotional enhancer, researchers and practitioners are better served by a model in which music's psychological impact is understood as the product of an interaction between the listener's preferences and history, the specific musical stimulus, and the demands of the context in which it is heard. This more conditional view is also the one best supported by the accumulated weight of neuroimaging, psychophysiological, and meta-analytic evidence reviewed here.

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