Third International Conference

Psychology and Music – Interdisciplinary Encounters

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Psychology & Music
Interdisciplinary Encounters

ZAGREB 2024

Proceedings

Editors
Ana Butković
Sanja Kiš Žuvela

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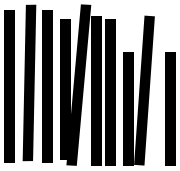

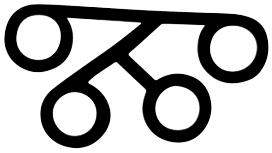

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Zagreb, 2026

Content

MUSIC IN EVERYDAY LIFE

MUSIC AND AFFECT

Editors' Note

As music continues to occupy a central place in human life—shaping identity, emotion, social interaction, and cultural expression—the need for interdisciplinary inquiry becomes ever more evident. The third *Psychology and Music—Interdisciplinary Encounters* proceedings invite readers to engage with contemporary questions at the intersection of mind and music, to consider new empirical findings and theoretical frameworks, and to participate in an ongoing conversation that bridges artistic practice and scientific research.

The establishment and development of the conference series *Psychology and Music—Interdisciplinary Encounters* (PAM-IE) are inextricably linked with the scholarly vision and longstanding dedication of Blanka Bogunović. Through her academic leadership and commitment to international collaboration, the University of Arts in Belgrade, Faculty of Music, has become an important centre for interdisciplinary dialogue between psychology and music. The psychology of music as an interdisciplinary research field was already foregrounded in the initial editions of PAM-IE, convened at the Faculty of Music in Belgrade, as a dynamic and expanding framework in which psychological, musical, pedagogical, sociocultural, and artistic perspectives intersect.

The first conference, organized in 2019, represented a significant milestone for the field in Southeast Europe. Conceived as a platform for empirical, theoretical, and applied perspectives, it brought together researchers and practitioners from diverse disciplinary and cultural backgrounds. Notably, the conference also witnessed the founding of the Regional Network *Psychology and Music* (RNPaM), a crucial step towards strengthening scholarly cooperation, visibility, and continuity within the region.

The second conference, held in 2022, confirmed the vitality and growth of this emerging community. Building on a tradition of music psychology research spanning several decades in the region, the event further expanded its international reach and thematic scope. The proceedings encompassed a wide range of topics—ranging from music perception and cognition to performance, education, creativity, and well-being—demonstrating the richness and productivity of interdisciplinary inquiry.

In its most recent edition, the conference series was brought closer to participants from other regions, thereby ensuring that the original conception is maintained through close cooperation with the University of Arts in Belgrade, Faculty of Music, and with Blanka Bogunović, the concept creator. The third conference was thus held for the first time in Croatia, at the University of Zagreb Academy of Music and the Faculty of Humanities and Social Sciences, from 23 to 26 October 2024. Its interdisciplinary character and focus on experts from various fields, as well as practitioners, ensured that all voices were represented. As in the previous two editions, the aim remained to bring together experts from diverse disciplines and institutions engaged in the broad study of the psychology of music.

The rich programme of the third conference included four plenary lectures, seven workshops, four book presentations, one round table, ninety oral presentations, and ten poster presentations. This hybrid event was attended by speakers from 27 countries around the world (Australia, Austria, Brazil, Bulgaria, Finland, France, Germany, Hungary, Italy, Israel, Canada, Colombia, Croatia, Latvia, the Netherlands, Norway, Palestine, Poland, Portugal, Russia, the United States of America, Singapore, Slovenia, Serbia, Spain, Sweden, and the United Kingdom). In total, 109 presentations were delivered, with approximately 220 participants attending either on-site or online.

Following the tradition of the first two conferences, the opening keynote was delivered by the current President of the European Society for the Cognitive Sciences of Music (ESCOM), Suvi Saarikallio (Jyväskylän yliopisto, Jyväskylä, Finland), titled *Is music and emotion research an act of building a socially sustainable future?* Three other distinguished guests ensured the highest scholarly level of the event through their keynotes on each subsequent conference day: Fredrik Ullén (Max Planck Institute for Empirical Aesthetics, Frankfurt am Main, Germany) spoke on *Gene-environment interplay in skill learning and expertise: what have we learned from research on music?*; Gary E. McPherson (Melbourne Conservatorium of Music, Melbourne, Australia) gave a talk on *The roles of self-determination and self-*

regulation in novice to expert musicians; and Blanka Bogunović (University of Arts in Belgrade, Faculty of Music, Belgrade, Serbia) concluded with the lecture *The personality of musicians and its relationship to musical accomplishments*.

The organization of such an event would not have been possible without the wholehearted support of both organizing institutions: the University of Zagreb Academy of Music and the Faculty of Humanities and Social Sciences, including their deans, Professors Igor Lešnik and Domagoj Tončinić, who also inaugurated the opening ceremony, as well as numerous colleagues—teachers, non-teaching staff, and students—who assisted throughout the process. Blanka Bogunović and Sanela Nikolić from the University of Arts in Belgrade, Faculty of Music, were consistently available and ready to help throughout all stages of preparing the conference and these proceedings. Students of the Academy of Music—members of the Percussion Ensemble *biNg bang* and a saxophone quartet—contributed to the atmosphere during the opening and closing days, while the musicologist Nada Bezić from the Croatian Music Institute guided on-site participants on a musical walk through Zagreb that will remain long in their memories.

Our sponsors—Atlantic grupa d. d., Zagreb; Pandent d. o. o., Zagreb; Pan-Pek d. o. o., Zagreb; and Prava formula d. o. o., Zagreb—provided refreshments and financial support. ESCOM also contributed through financial assistance and promotion. Further thanks are due to our supporters: RNPaM, the University of Arts in Belgrade Faculty of Music, the Zagreb Tourist Board, and the Education and Teacher Training Agency.

A complete overview of the conference programme is available in the Book of Abstracts, and selected papers have been included in this volume following a double-anonymous international peer-review process. The present proceedings comprise 25 contributions divided into four thematic areas: Music Perception and Cognition, Music Performance, Music in Everyday Life, and Music and Affect.

The present volume stands as testimony to the vitality of the field and to the collaborative spirit that has characterized the conference series from its inception. These third proceedings not only reflect the expanded geographical and thematic diversity of contributions but also reaffirm PAM-IE's vision as an important meeting point where psychology, the musical arts, and related disciplines jointly shape new knowledge, creating an open and rigorous space for dialogue. In anticipation of the next PAM-IE edition, to be held at the University of Ljubljana Academy of Music in October 2026, we wish our readers inspiring moments and ideas for new directions in research and professional practice.

Zagreb, February 2026

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Music Perception and Cognition

Unveiling Auditory Evoked Processing: Bridging MEG and EEG

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Abstract

Auditory perception is essential for human communication and development, influencing cognitive and social functions. Electroencephalography (EEG) has long been used to examine auditory evoked potentials (AEPs), while magnetoencephalography (MEG) has more recently enabled the investigation of auditory evoked fields (AEFs), providing complementary spatial detail. However, MEG's high costs and operational complexity limit its accessibility. In this study, we adapted analysis protocols originally developed for MEG to EEG in order to explore their applicability in a more accessible and cost-effective modality. We examined auditory evoked potentials in response to instrumental tones among adults (N=12) using EEG and compared the results with previously published MEG data. Our findings suggest that EEG can approximate MEG-based methodologies, demonstrating similar mean latencies and standard errors for P1, N1, and P2 components. Despite slight variations in standard errors, likely due to the smaller sample size, the results support EEG's continued value for broader application in auditory neuroscience. The accessibility of EEG opens opportunities for large-scale studies, enhancing our understanding of auditory perception across diverse populations. This approach may also contribute to the development of diagnostics and tailored interventions for auditory-related conditions, including ADHD and dyslexia.

Keywords: auditory-evoked potential, auditory perception, EEG

Introduction

Auditory perception plays a central role in human development and communication processes, contributing to cognitive and social functions. In previous research, we used a Neuromag-122 whole head MEG system to record auditory evoked fields (AEFs) in response to different instrumental tones. These stimuli evoke the primary auditory response (P1) within approximately 30-80 ms after tone onset, followed by secondary auditory responses (N1 and P2) that typically manifest at approximately 90-250 ms after tone onset (Schneider et al., 2005).

Musical stimuli affect auditory evoked potentials, particularly the P1, N1, and P2 components (Kühnis et al., 2014; Lee et al., 2024). Musical training enhances these components, reflecting improved auditory processing and sensory specialization. The P1 component is influenced by metrical context and musical training (Polat & Ataş, 2014), while the N1 component is shaped by musical expertise and spectral complexity (Shahin et al., 2005). These findings highlight the profound impact of musical experience on auditory processing capabilities.

Particularly the synchronization and asynchrony of auditory evoked responses play a key role in populations with neurodevelopmental conditions. Asynchrony in AEFs, for instance, has been linked to deficits in auditory processing, which may underlie challenges in language acquisition, attention, and literacy (Groß et al., 2022; Schneider et al., 2022; Seither-Preisler et al., 2014; Serrallach et al., 2016, 2022). Our previous research has identified significant asynchronies in auditory cortex activation and subtype-specific processing differences in individuals with ADHD (Seither-Preisler et al., 2014; Serrallach et al., 2016, 2022). These insights underline the importance of precise neurofunctional assessment tools. However, the use of MEG is confined to specialised facilities due to its high-cost, technical complexity, and the requirement for magnetically shielded environments to minimise external interference. In contrast, EEG provides a more practical and cost-efficient method for investigating auditory processing, particularly in paediatric and clinical populations. Building on this rationale, the present study aimed to evaluate whether analytical strategies developed for MEG could be effectively transferred to EEG.

Therefore, we developed a pilot study to adapt and validate MEG methodologies for EEG. This study aimed to determine whether EEG could reliably replicate the temporal and spatial characteristics of auditory responses observed in MEG, laying the groundwork for more accessible auditory neuroscience research, including research involving ADHD, dyslexia, and other auditory related conditions

Methods

Participants

Twelve healthy adults (3 male, 9 female) participated in the study. Participants' age ranged from 42 to 58 years (M = 48.9, SD = 4.7). None of them had history of neurological or psychiatric disorders. Written informed consent was obtained from all individuals prior to participation. The study was conducted in accordance with the guidelines of the Declaration of Helsinki, and approved by the Institutional Review Board of the Medical Association of Riga (Latvia) 2-PĒK-4/3/2022.

Measures

The study employed auditory stimuli consisting of seven instrumental tones (piano, guitar, flute, bass clarinet, trumpet, violin, and drums) and four synthetically generated harmonic complex tones. The aim was to compare EEG-derived auditory evoked potentials (AEPs) with published MEG data to evaluate consistency in temporal resolution (see Figure 1).

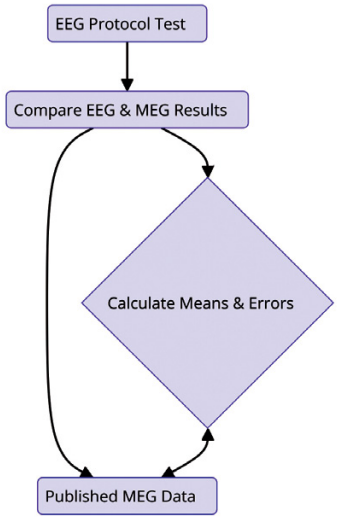

Figure 1. MEG-EEG workflow

The MEG protocols (Bücher et al., 2023; Christiner et al. 2022; Groß et al., 2022; Schneider et al., 2005; Seither-Preisler et al., 2014; Serrallach et al., 2016) used as a basis for this study were adapted to account for the technical and functional differences between MEG and EEG. MEG measures magnetic fields generated by neural activity using superconducting quantum interference devices (SQUIDs) and requires a magnetically shielded room to ensure accuracy. In contrast, EEG records electrical potentials at the scalp using electrodes, which are more susceptible to noise and artefacts from non-neural sources. To address these challenges, we implemented the following adaptations:

Electrode placement. EEG recordings were obtained using the Neuroelectrics Enobio 32 system, which provides 32 channels of data at a temporal resolution of 500 Hz. A standard gel-based 32-channel electrode cap was used, with electrodes positioned according to the extended international 10–20 system, ensuring comprehensive scalp coverage and comparability across studies in accordance with established electrophysiological guidelines (Klem et al., 1999; Oostenveld & Praamstra, 2001). Electrode positions included frontal (Fp1, Fp2, F3, F4, Fz), central (C3, C4, Cz), temporal (T7, T8), parietal (P3, P4, Pz), occipital (O1, O2), as well as intermediate sites (e.g., FC1, FC2, CP1, CP2, PO3, PO4) to enhance spatial resolution over auditory-relevant cortical areas. The system employed gel-based electrodes to ensure low impedance and high signal stability. Signals were amplified and digitised using a compact NECBOX amplifier unit attached to the back of the cap. EEG data were wirelessly transmitted to the Neuroelectrics Instrument Controller (NIC) software (version 2.0.11.1) on a recording computer. To improve signal quality and reduce preparation time, participants' skin was cleaned prior to electrode application, and electrode impedance was checked and maintained below standard thresholds. Electrode placement was designed to optimize coverage of the auditory cortex bilaterally, with particular attention to temporal and centro-parietal sites. This setup allowed for reliable capture of auditory evoked potentials (AEPs) while maintaining participant comfort and data integrity, particularly critical when working with developmental and clinical populations.

Signal processing. EEG data were recorded at a sampling rate of 1000 Hz using the Neuroelectrics Enobio 32 system. A hardware bandpass filter

from 0.0 Hz (DC) to 330 Hz was applied during acquisition using the Neuroelectrics Instrument Controller (NIC) software (v2.0.11.1), and raw data were stored for offline analysis. Further preprocessing and analysis were conducted using BESA Research (Version 7.1; BESA GmbH, Gräfelfing, Germany). EEG epochs were segmented from −100 ms to 400 ms relative to the auditory stimulus onset, and baseline-corrected using the −100 to 0 ms pre-stimulus interval. Artefact correction was performed using BESA's automatic artefact scan tool, which identified and excluded epochs containing eye blinks, saccades or muscle artefacts. On average, 5–10% of trials and 2–5 channels per participant were excluded and subsequently interpolated using spherical spline interpolation where necessary. Following artefact rejection, data were averaged per subject across all stimulus types to ensure a high signal-to-noise ratio. The components of interest (P1, N1, and P2) were identified based on grand-average waveforms across midline and lateral fronto-central electrodes (e.g., Cz, FCz, C3, C4, T7, T8). Peak latencies were extracted individually.

Spatial resolution and source localization. Source localization was performed using current density reconstruction (CDR) within BESA Research 7.1, based on a four-shell spherical head model. Dipole fitting procedures were used to extract source waveforms from bilateral auditory cortices. Regional sources were placed bilaterally in the auditory cortex and fitted around the P1, N1, P2 peak using BESA's dipole fitting procedures. Dipole orientations were optimized to maximize field strength toward the vertex. For each participant, source waveforms were extracted from the left and right auditory cortices, and the peak latency of the P1-N1-P2 complex was determined. To ensure consistency with previous MEG studies used for reference comparisons (Christiner et al., 2022; Serrallach et al., 2016, 2022), the analysis focused exclusively on latency parameters, as amplitude values were not reported systematically across all datasets.

Stimulus presentation. Auditory stimuli consisted of a total of eleven samples: seven instrumental tones (piano, trumpet, flute, plucked violin, bass, clarinet, and timpani) and four synthetically generated harmonic complex tones. Each stimulus had a duration of 500 ms and was presented in a pseudo-randomized order with interstimulus intervals ranging from 400 to 500 ms. Every tone was presented 100 times, resulting in a total duration of approximately 15 minutes per session. Stimuli were delivered binaurally via calibrated headphones at a comfortable listening level. Participants were instructed to listen passively to the stimuli while remaining as still as possible. This paradigm was chosen to ensure comparability with MEG protocols previously published by the group (e.g., Seither-Preisler et al., 2014; Serrallach et al., 2016), where auditory evoked responses were likewise elicited under passive listening conditions with matching stimulus parameters. The high number of stimulus repetitions was selected to ensure a high signal-to-noise ratio, which is essential for robust component identification and waveform averaging in both MEG and EEG. For the present pilot analysis, responses across all tone types were merged for averaging, focusing on the extraction of the most prominent auditory components (P1, N1, P2). This strategy allowed direct comparison of temporal response characteristics with existing MEG data.

To ensure comparability with previous MEG studies, the auditory stimulation protocol was implemented using a custom MATLAB-based application designed to ensure millisecond-accurate presentation and trigger synchronization with the EEG system. The presentation software was re-coded to ensure consistent stimulus onset, interstimulus intervals, and synchronization with EEG triggers. Originally optimized for magnetically shielded MEG environments, the output was converted for EEG-compatible delivery via calibrated in-ear headphones using a USB interface. These modifications ensured that the temporal properties of the stimulus protocol—previously validated in MEG contexts—could be reliably transferred to the EEG recording environment.

The pilot study replicated key elements of the MEG experimental design, including the temporal structure and intensity of auditory stimuli. AEPs corresponding to the P1, N1, and P2 components were recorded and analysed. Latency values derived from EEG were then compared to MEG findings reported in previously published studies. Reference means for P1 (6 means), and for N1 and P2 (5 means each), were established by aggregating data from three MEG studies (Bücher et al. 2022; Christiner et al. 2022; Serrallach et al. 2022) with similar methodologies. The overall mean served as a reference for comparison with our EEG-derived latencies using a one-sample *t*-test.

Results

The analysis of EEG-derived AEPs revealed mean latency values for the P1, N1, and P2 components that closely aligned with those observed in previous MEG studies. Figure 2 illustrates the latency mean values with standard errors derived from EEG for P1, N1, P2.

The mean P1 latency in our sample (M = 63.3 ms [right], SE = 2.2) did not differ significantly from the calculated reference value (M = 64.5 ms [right]). The one-sample t-test yielded $t(11) = -0.54$, $p = 0.60$. The mean P1 latency in our sample (M = 65.2 ms [left], SE = 3.2) did not differ significantly from the calculated reference value (M = 64.6 ms [left]). The one-sample t-test yielded $t(11) = 0.18$, $p = 0.86$.

The mean N1 latency in our sample (M = 118.6 ms [right], SE = 2.8) did not differ significantly from the calculated reference value (M = 113.4 ms [right]). The one-sample t-test yielded $t(11) = 1.86$, $p = 0.09$. However, the mean N1 latency in our sample (M = 121.5 ms [left], SE = 3.2) differed significantly from the calculated reference value (M = 112.8 ms [left]). The one-sample t-test yielded $t(11) = 2.67$, $p = 0.02$.

The mean P2 latency in our sample (M = 210.2 ms [right], SE = 7.3) did not differ significantly from the calculated reference value (M = 199.8 ms [right]). The one-sample t-test yielded $t(11) = 1,41$, $p = 0.19$. The mean P2 latency in our sample (M = 204.77 ms [left], SE = 17.77) did not differ significantly from the calculated reference value (M = 204.61 ms [left]). The one-sample t-test yielded $t(11) = 0.01$, $p = 0.99$.

While P1 and P2 latencies showed no significant differences compared to MEG-derived methods, N1 left latencies differed significantly, potentially due to our small sample size (n = 12) and the variability of aggregated N1 reference values from multiple publications (range: 107.8–121.5 ms). Notably, the highest reference value (121.5 ms) closely aligns with our observed value, suggesting methodological consistency despite the left-lateralized discrepancy.

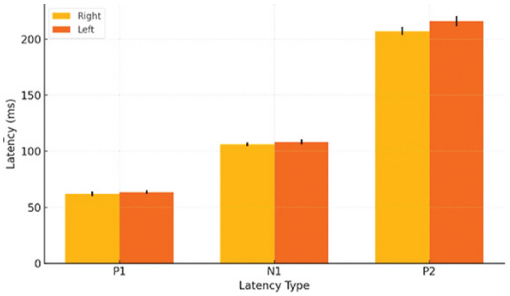

Figure 2. P1, N1, P2 Latency mean values with standard errors derived from EEG

Discussion

The present pilot study explored whether EEG protocols, adapted from MEG paradigms, can yield robust auditory evoked potentials (AEPs) with comparable temporal characteristics. The observed latencies for P1, N1, and P2 components were largely consistent with established MEG findings, suggesting that EEG may serve as a feasible and more accessible method for investigating auditory processing. This approach could be particularly relevant for studies in populations where MEG use is limited due to accessibility, cost, or participant compliance.

While the current sample size limits generalizability, this study demonstrates the technical feasibility of transferring MEG-derived stimulus and analysis protocols into EEG frameworks. These adaptations could enable broader adoption of temporally precise auditory neurophysiological testing across research and clinical settings.

Future research should aim to expand the methodology to neurodivergent populations such as individuals with ADHD and dyslexia, in whom atypical auditory asymmetries have previously been reported (Seither-Preisler et al., 2014; Serrallach et al., 2016, 2022). Longitudinal applications may further support the use of AEPs in tracking developmental or treatment-related changes. In addition, combining EEG with imaging modalities such as fMRI or structural MRI may enhance spatial interpretability.

Although the present results do not directly evaluate the use of AEPs in therapeutic settings, the protocol's non-invasive nature, passive task demands, and temporal specificity suggest potential for clinical and educational use. For example, identifying atypical auditory timing profiles may inform early screening and automated tools or guide individualized interventions (Holt & Özdamar, 2014; Manta et al., 2022). In this regard, music therapy training programs could benefit from integrating fundamental neurophysiological concepts—such as temporal synchrony, hemispheric asymmetry, and neural response plasticity—into their curricula (Bosse et al., 2013; Jackson, 2003; Neuhaus, 2020; Rickson, 2006; Rothmann et al., 2014; Sanju & Kumar, 2016; Timmermann & Oberegelsbacher, 2008). Such translational bridges between auditory neuroscience and clinical practice require further empirical work but represent a promising direction for interdisciplinary collaboration.

Conclusion

To the best of our knowledge, this study represents one of the first systematic attempts to apply EEG methodology in a direct replication of MEG-based auditory paradigms. Our findings suggest that key elements of MEG protocols—particularly in the elicitation and analysis of auditory evoked responses—can be effectively transferred to EEG, yielding temporally reliable results for the P1, N1, and P2 components.

The main advantage of this approach lies in the accessibility and cost-efficiency of EEG, which enables its application in larger and more diverse samples. This, in turn, increases statistical power and allows for the investigation of individual differences in auditory processing. Moreover, the feasibility of source localization within EEG supports its potential as a tool for capturing interhemispheric timing asymmetries and functional dynamics of the auditory system.

By expanding neurofunctional research beyond the constraints of specialized MEG laboratories, EEG can contribute to a more nuanced understanding of auditory perception across different populations. In the long term, this may support the development of targeted assessments and personalized interventions for conditions involving auditory processing deficits, such as ADHD or dyslexia. While further validation in clinical groups is required, the present findings provide a methodological foundation for such translational research.

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Music Notation-to-Colour Synesthesia and an Alternative to Müller's "Law of Specific Nerve Energies"

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Abstract

Music notation-to-colour synesthesia is a neurodivergence that poses an exception to Johannes Müller's "law of specific nerve energies", challenging its core principles. Müller's law is still studied and used in psychology today (Rachlin, 2005, p. 43), proposing that there are no commonalities between the quality of a perceived object and the actual sensorial perception of that object in the brain. This theoretical article explores Müller's law and posits that it is insufficient to describe the perceptual process of music notation on the part of music notation-to-colour synesthetes. Rachlin (2005) suggests that a visual stimulus, once processed by the appropriate sensory organ, yields a single sensation at the cortical level. Solá Chagas Lima (2020) suggests otherwise in a more recent study, proposing that synesthetic concurrent sensations can be multiple and multimodal on a cortical level, thus challenging the single-tier approach in Müller's law. A given musical pitch notated on a page, in this case, may be perceived by the appropriate sensory organ (eyes), engaging various brain regions (Ward, 2013) and eliciting multiple sensations in the brain (Solá Chagas Lima, 2020). Concurrent synesthetic sensations are generally consistent throughout a synesthete's lifetime, presenting both challenges and advantages for music learning (Ward, 2013; Solá Chagas Lima, 2015, 2019, 2020). This article explores the mechanisms underlying this perceptual process, offering further revisions to the model outlined in Solá Chagas Lima's (2020) study, arguing that synesthetes not only experience multiple sensations on a cortical level but also that synesthetic experiences are only indirectly dependent on the perceiving sensory organ.

Keywords: music notation, music synesthesia, synesthesia, music perception, law of specific nerve energies

Introduction

Music notation-to-colour synesthesia is one of the many possible variants of neurodivergence, in which the affected individual experiences automatic, consistent, involuntary concurrent visual sensations of colour when exposed to the visual stimulus of a musical note or other notational symbols (Solá Chagas Lima, 2015, 2019, 2020). In a recent cross-cultural qualitative study, Solá Chagas Lima (2020) surveyed this specific subgroup of synesthetes, concluding that the processing of music notation on the part of these synesthetes has a conceptual basis and that the concurrent sensations of colour depend primarily on the semantic value of music-notational symbols, rather than their shape, contour, or similarity to other grapheme or numeric signifiers. The research also focuses on developmental synesthesia, considering both the proximal components (genetics, structural differences) and distal components (functional differences, environment) that corroborate the manifestation of this neurodivergence, which occurs in approximately 4% of the population (Cytowic, 2018; Simner et al., 2006; Simner & Hubbard, 2013).

Concurrent synesthetic sensations are generally consistent throughout a synesthete's lifetime (Ward, 2013) and may pose both challenges and advantages for music cognition, including music learning. General consistency is a fundamental aspect of developmental synesthesia and should not be confused with "absolute" consistency. Although the "internal mental colours of synaesthetes become less saturated in older subjects," (Simner et al., 2017, p. 407), other qualia of synesthetic perception remain the same. For example, the automaticity of perceptual mechanisms, the involuntary nature of concurrent sensation triggering, the reality of synesthetic sensation, the semantic/semiotic value of the percept (Solá Chagas Lima, 2020), and the concurrent colours themselves are consistent elements of grapheme-colour (visual-visual) synesthetic perception.

The present article focuses primarily on developmental synesthetes' perceptions of music notation, which overlaps with other visually induced forms of synesthesia involving the semantic content

of signifiers, such as grapheme-colour and number-colour. Solá Chagas Lima (2020) argues that purely musical notational symbols (such as pitch notation) are compounded with various other notational symbols denoting elements of sound, such as dynamics, rhythmic duration, articulation, and fingering, to name a few. Many of these elements are found in complex music notation of the Western tradition, as illustrated in Figure 1.

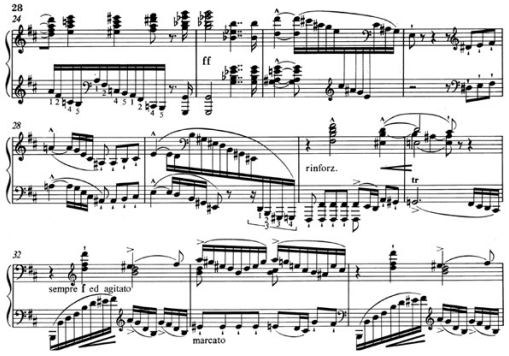

Figure 1. Excerpt (mm. 24-34) from Franz Liszt's Piano Sonata in B Minor (1854), S. 178, showing various notational symbols recurrent in the Western canon of concert music.

This wide variety of symbols and their semantic denotations constitute a language complex enough to generate potential perceptual overload, conceptual overlaps, or incongruence among synesthetic concurrent sensations of colour, thereby impacting behavioural responses among musicians with this mode of synesthesia. This impact is especially significant for music students in the early stages of their education. Solá Chagas Lima's (2020) research discusses the effects of these advantages and challenges on the learning of music notation at the elementary stages of music education, with special attention to differentiated methodologies for teaching music notation to synesthetes with this mode of the condition.

To illustrate this information overload, Figure 2 depicts the author's synesthetic associations elicited by notational symbols and their semantic content.

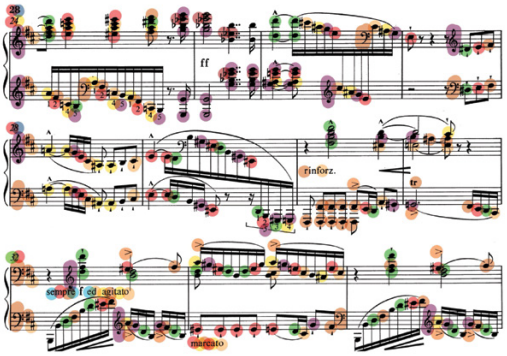

Figure 2. This colour scheme is a rough approximation of how the author experiences this passage of music from Liszt's sonata (S. 178), depending on focal attention.

Notation-to-colour synesthesia thus poses many advantages for recognizing musical patterns, such as an enhanced ability to memorize passages of music and ease in extemporizing according to colour combinations. However, it also poses challenges when involving similar colours elicited in connection with related musical events.

This mode of synesthesia challenges core principles of Johannes Müller's "law of specific nerve energies". Since the present article involves the synesthetic perception of visual inputs in music notation, this theory is worth exploring in greater depth. Müller is considered a paragon in the history of visual sense physiology today (Riese & Arrington, 1963). His law or "doctrine", as it is also called, is still studied and used today in the field of psychology (Rachlin, 2005, p. 43) to understand perception, albeit with adaptations and further contributions. Notably, this principle has dramatically influenced the philosophy of psychology, as evidenced by its priority for both qualitative and quantitative methodologies addressing individual perceptual experiences.

In "The Law of the Specific Energies of the senses", Müller proposes that there are no commonalities between the quality of a perceived object and the actual sensorial perception of that object in the brain (p. 43). Figure 3 illustrates this rationale with nomenclature revisited in the sections below.

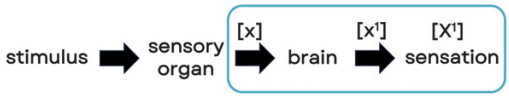

Figure 3. Graphic representation of Müller's law.

In other words, sensory organs merely mediate perception and the neural pathways it involves (Rachlin, 2005). In Hellekant's (2024) words:

> It makes no difference for the sensation, for example in the case of audition, if the receptor in the cochlea or its sensory fiber is stimulated mechanically or electrically, or in any other manner, provided the action potential reaches the auditory area of the cortex." (p. 32)

The same or similar sensations can be elicited by means other than the stimulus with which one normally associates those sensations. Müller (apud Riese & Arrington, 1963) formally addressed the theory for the first time in 1826, and his initial formulation of the law read:

> "The colors do not exist for the sense as a finished and external something, so that the sense when struck has only the sensation of it, but that the visual sense substance itself if activated by any stimulus, whatever its kind, brings its affection to sensation in terms of the energies of the light, the dark, and the colored." (p. 180)

The first version of the law was almost exclusively subjective. Müller's introduction of anatomical considerations in 1840 gains momentum in psychology due to the direction which this field of inquiry took in the second half of the nineteenth century. The growing reliance on scientific methods during the first half of the twentieth century also helped propel Müller's law regarding its anatomical contributions.

Hermann von Helmholtz, famed among musicians for his discussions of acoustics and sound properties, was Müller's pupil at the University of Berlin between 1833 and 1858. Helmholtz propagated Müller's law in an objective, "scientific" sense. Helmholtz is said to have eclipsed Müller's law (Finger & Wade, 2002; Riese & Arrington, 1963, p. 182), "filtering" or "re-rendering" the theory in a purportedly scientific light and for a scientific scholarly community. Helmholtz also suggested that impressions of the qualities of the outer world "depend… solely on the central connections of the affected nerve", thus substituting the brain for the nerve (p. 181).

Yet Müller used the term "energy" metaphorically, resting on the Aristotelian and metaphysical sense of the term rather than the anatomical or physiological argument. In his "scientific" priority, Helmholtz overshadowed Müller's original proposition, which suggested that the stimulus, as mediated by the sense, precludes and, to some extent, determines sensation. Although Müller predated continental phenomenology as it came to prominence in the late nineteenth and early twentieth century, he was more interested in the experience/phenomenon than the purely anatomical neural activity, which eventually became dominant in psychology.

Perceptual models analysed

The following paragraphs explore Rachlin's (2005) rendition of Müller's law, chiefly articulated in two perceptual models. This analysis is followed by an application of Rachlin's models to the colour-based synesthetic perception of music notation, revisiting a more recent study (Solá Chagas Lima, 2020) and expanding its tenets. Rachlin's (2005) postulations have been superseded since their coinage (Chirimuuta, 2015), yet the present analysis is relevant due to their past use in extant synesthesia literature.

Rachlin's model 1

Figure 4 shows a graphic representation of Müller's law (Rachlin, 2005, p. 42), depicting the perceptual process of visual inputs. Rachlin suggests that a visual stimulus, when passing through the respective sensory organ and processed in the mind, yields a singular sensation. Here, Rachlin discusses the perceptions of red (R) and green (G) colours: $\mathbf{R \rightarrow x \rightarrow x^1 \rightarrow X}$.

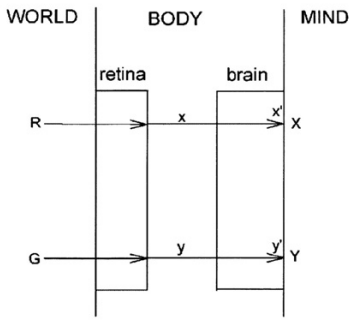

Figure 4. Perceptual model in Rachlin (2005, p. 42).

In applying this model to the context of the present paper, a hypothetical musical note, A, for

instance, as represented by a visual symbol notated on a page of music, would be processed in the brain as $\mathbf{x} \rightarrow \mathbf{x^1}$, ultimately causing the sensation **X**: $\mathbf{A} \rightarrow \mathbf{x} \rightarrow \mathbf{x^1} \rightarrow \mathbf{X}$. This sensation would then be mentally associated with the idea of that musical note, which carries many semantic values, such as pitch, timber, a specific range, a physical area on the keyboard or the fingerboard, etc. According to this model, Müller's law would remain consistent for any other musical notes or notational symbols, e.g., $\mathbf{B} \rightarrow \mathbf{y} \rightarrow \mathbf{y^1} \rightarrow \mathbf{Y}$, and so forth.

Rachlin's model 2

In a critical review of Müller's law and expansion of its theoretical propositions, Rachlin (2005) also posits that different individuals may process stimuli differently, suggesting that the conceptualization or labelling of that sensation is a cultural construct. As illustrated in Figure 5, Rachlin (2005, p. 44) compares "Jill", a "normal" individual, with "Jack", an "abnormal" individual, who hypothetically has switched sensations for the colours red (R) and green (G).

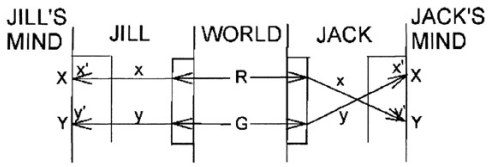

Figure 5. This perceptual model, as depicted in Rachlin (2005, p. 44), shows how different individuals may experience unique sensations elicited by the same stimulus.

Rachlin maintains that the "mental state" between Jill's ultimate X and Jack's ultimate Y sensations is essentially the same. The conceptual labels are, thus, arbitrary. If "normality" serves as the standard for comparison, the sensations are different.

Rachlin's models reevaluated

In considering these historical and scientific narratives, along with qualitative data discussed in Solá Chagas Lima's (2020) grounded theory study, this article proposes that current readings of Müller's theory may be insufficient in describing the perceptual process of music notation on the part of music notation-to-colour synesthetes. It also maintains that concurrent sensations, on a cortical level, can be multiple and multimodal in ways Müller's law does not account for—at least not in its generally held sense.

This article proposes several alternatives. Firstly, as a counterpoint to Rachlin (2005), it compares the perceptual process of visual input on the part of synesthetes and non-synesthetes. It also examines how multiple "mental states" coexist in the synesthete's brain, occurring in normally non-correlated areas. In the "normal" brain, these areas often develop to work more independently and process different stimuli through different senses and brain regions. In other words, in music notation-to-colour synesthetic perception, the quality of colour is not present in external reality (in the Müllerian sense) but is a product of synesthetes' association with the original stimulus as a concurrent, secondary sensation.

Figure 6 illustrates an adaptation of Rachlin's proposition applied to notation-to-colour synesthesia (Solá Chagas Lima, 2020, p. 5). A given musical pitch, A, for example, notated on the page may in this case be perceived by the appropriate sensory organ (eyes) and elicit multiple sensations in the synesthete's brain (in this case, colour) which are a unique and multimodal response to the stimulus: $\mathbf{A} \rightarrow \mathbf{x} \rightarrow \mathbf{x^1} \rightarrow \mathbf{X^1}$; or $\mathbf{A} \rightarrow \mathbf{x} \rightarrow \mathbf{x^2} \rightarrow \mathbf{X^2}$; or $\mathbf{A} \rightarrow \mathbf{x} \rightarrow \mathbf{x^n} \rightarrow \mathbf{X^n}$. The same holds for other musical notes (B, for instance): $\mathbf{B} \rightarrow \mathbf{y} \rightarrow \mathbf{y^1} \rightarrow \mathbf{Y^1}$; or $\mathbf{B} \rightarrow \mathbf{y} \rightarrow \mathbf{y^2} \rightarrow \mathbf{Y^2}$; or $\mathbf{B} \rightarrow \mathbf{y} \rightarrow \mathbf{y^n} \rightarrow \mathbf{Y^n}$, and so forth.

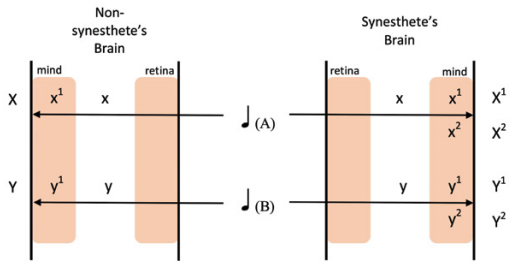

Figure 6. Elaboration of Rachlin's (2005) perceptual model, as found in Solá Chagas Lima (2020, p. 5).

This perceptual process differs from a normal brain's response not only in that the "nerve energy" (or pathway via the sensory organ) is different , , as in Jill and Jack's case, but also in that the additional, concurrent sensations occur on a cortical level. Perceived visual stimuli, such as musical notational elements, can elicit multiple sensations that may involve more than one brain area (Ward, 2013) at the latest perceptual stage, in addition to "normal" multimodal sensations.

Further considerations

In revising the application of Rachlin's (2005) models in Solá Chagas Lima's (2020) study and further arguing that music notation-to-colour synesthesia has a conceptual basis, this essay posits that the multimodal concurrent sensations of colour must take place on a cortical level, as illustrated in Figure 7, rather than as a perceptual bifurcation of the original percept.

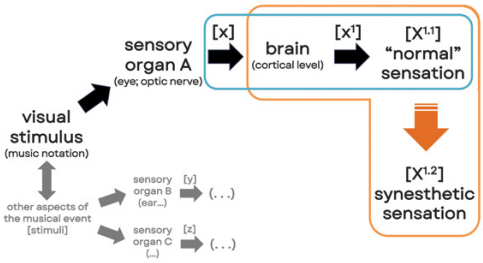

Figure 7. A revision of the graph in Figure 6 (Solá Chagas Lima, 2020, p. 5). This reconceptualization of visual perceptions regards synesthetic sensations as dependent on the primary, "normal" sensation in the brain.

The synesthetic sensation is only indirectly dependent on the sensory organ, which in this article is exemplified by the eye or optic nerve. Hence, the optic nerve is not directly connected to all these adjacent brain areas. Instead, these areas are connected in the synesthete's brain due to the genetic, structural, functional, and environmental differences that cause synesthesia. Therefore, synesthetic sensations of colour lie *outside* the scope of Müller's, Helmholtz's, and Rachlin's perspectives. While they may depend on the same inducing stimulus, they are ultimately concurrent with a primary sensation. This perspective also aligns with Hong & Blake's (2007) suggestion that early visual mechanisms themselves do not influence synesthetic colour:

> Of course, synesthetic colours arise consequent to the presence of alphanumeric characters and not other spatial forms, implying the existence of connections between higher brain areas involved in orthographic processing and colour processing mechanisms. (p. 1024)

The authors also conclude that "all, however, appeal to activity within brain structures involved in the analysis of colour, structures present in all colour-normal individuals" (Hong & Blake, 2007, p. 1024). This theoretical revision, thus, allows for a more overt recognition of other aspects of the musical event. These multimodal perceptions may influence the processing of notational (visual) elements—an aspect of synesthetic perception that remains for further research to uncover.

Finally, it is also important to address the semantic implications embedded in extant definitions of concurrent colour sensations. Since synesthesia is phenomenologically defined, many models and mechanisms discussed in the literature often rely on terminology concerned with the experience or phenomenon. It is in this sense that the present article uses these terms in relation to concurrent synesthetic sensations. Nevertheless, much like other synesthesia research, they ultimately describe neurological processes that demand consistency across disciplines. Chirimuuta (2015; 2024) has aptly pointed to the crystalized tendency of cognate fields to utilize terminology inconsistently and often inaccurately, which poses significant complications for thorough understandings of neurological mechanisms across disciplines, particularly as fields and subfields of academic inquiry continue to evolve and specialize. Literature on synesthesia, insofar as it describes neural mechanisms that are also subjective experiences, needs to continue refining the terminology and concepts in order to differentiate brain activation from potential meanings of the term "experience". This is especially true of inquiries in music notation-to-colour synesthesia research. Although this article recognizes this need for refinement, it is beyond its scope to mitigate this problem.

Conclusion

Since research on synesthesia has advanced significantly in the last five decades, it has prompted a rethinking of models of perception that are neurological (structural, physiological, functional) and, especially, purely phenomenological. The very idea of a model-based theory can pose a rigid and limiting approach to experience and the phenomenon at hand, particularly when exploring or evaluating modes of perception that fall outside the norm.

Müller's theory may have been misappropriated from its original context and is rendered today in a different ("eclipsed") light. The law is usually applied to experimental approaches to visual perception

grounded in "scientific methods" that, while an essential aspect of documenting synesthesia as a neurodivergence today, often fail to account for the experience of the synesthetic phenomenon. This study suggests a return to Müller's original phenomenological scope.

Synesthesia is phenomenologically defined (Jewanski, 2013), and, like many other neurodivergences, prompts the field of music cognition - along with other related fields, such as music psychology and philosophy - to rethink the models that have dominated research and refine terminology (Chirimuuta, 2015; 2024). Scholars emphasize the need to return to the original implications of Müller's doctrine: the "betweenness" that mediates stimulus and sensation (Isaac, 2019). This shift is especially illuminating in the documentation of neurodivergences that are phenomenologically defined and qualified, such as various learning differences and perceptual abilities or disabilities.

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Reflected Intuition: Statistical and Musical Implications of a Listening Experiment in Post-Tonal Music

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Abstract

This study explores listener perception of post-tonal music through a two-step listening experiment conducted as part of the research project *Points of Discontinuity*. In the experiment, subjects annotated aurally "important" musical events during initial real-time listening (step 1) and refined their annotations upon re-listening (step 2). Annotational markers from both steps were analyzed using DBSCAN cluster analysis. Comparing the analyses of the two steps revealed five distinct tendencies in how clusters evolved: (1) clusters became more precise, (2) new clusters emerged, (3) noise (non-matching) areas transformed into clusters, (4) some noise areas remained unchanged, and (5) clusters dissolved into noise areas. Results show that repeated listening often refined initial impressions, with clusters becoming denser and more precise. However, in processual and layered textures, areas of scattered annotations without clusters persisted, highlighting the complexity of post-tonal structures. These findings underscore the individualized nature of listener engagement and highlight the analytical importance of both clustered and scattered markers in understanding post-tonal music.

Keywords: post-tonal music, perception, first listening impression, repeated listening

Introduction

Understanding how listeners engage with post-tonal musical structures remains a challenge within contemporary music research. The Points of Discontinuity (PoD) research project contributes to this ongoing inquiry by building on key insights from psychological and theoretical studies of listening strategies in post-tonal contexts (e.g., Hasty, 1981; Deliège et al., 1989; Clarke & Krumhansl, 1990; Lock, 2020; Utz, 2023). A particularly influential foundation is Irène Deliège's theory of cue abstraction, which posits that salient auditory features—whether discrete events or extended processes—are selectively registered during listening, forming a cognitive thread that shapes the listener's perception of form (Deliège & Mélen, 1997).

The method of repeated listening and its influence on music perception were of particular interest for our project. Repeated listening has been a common feature of earlier experiments investigating musical segmentation, regardless of the repertoire (Deliège, 1989; Clarke & Krumhansl, 1990; Deliège et al., 1996; Hartmann et al., 2014). Although some research has identified differences in brain network engagement between expert and non-expert listeners during real-time segmentation of music (Burunat et al., 2024), the resulting segmentations may be broadly comparable, although experts often provide more detailed analyses (Phillips et al., 2020). This applies to both initial and repeated listening. In an experiment based on Franz Schubert's *Valse sentimentale*, D. 779, op. 50, no. 6, Deliège et al. (1996) demonstrated that first and second listening resulted in similar identification of landmarks and their perceived importance (however, it should be noted that the piece used was very short, lasting less than one minute). Hartmann et al. (2014), employing excerpts from a variety of primarily tonal Western musical styles , found that musicians identified more segmentation boundaries during repeated listening, presumably due to increased familiarity with the material.

Although this body of research has significantly advanced understanding of listening, many empirical studies on post-tonal music have largely focused on case studies (e.g., Deliège, 1989; Addessi & Caterina, 2005; Phillips et al., 2020). The PoD project seeks to expand this scope by investigating a broader spectrum of post-tonal styles. To this end, we conducted a listening experiment featuring a diverse range of instrumental and electronic post-tonal music. From an initial analysis of 100 works, 23 were selected for the experiment (seven of which were presented as excerpts, see Table 1). These selections reflect considerable diversity in

historical era, style, genre, duration, ensemble size (ranging from solo to full orchestra and electronics), instrumentation (and therefore timbre), and degrees of structural complexity.[1] Although not exhaustive, the selection offers a representative overview of the diversity within post-tonal music.

Aims

The experiment aimed to explore how subjects aurally structure post-tonal music during listening and to examine differences in listener perception between initial exposure and repeated listening. Specifically, the study examined the perception of distinct musical "events," a term that was used in a broad sense for various phenomena, ranging from discrete and distinct moments—such as sharp onsets, endings, or abrupt changes—to more gradual and ambiguous processes that evolve and transform over more extended periods of time.

Methods

Each piece in the experiment was listened to by 40 subjects (25 non-experts and 15 experts).[2] The experiment consisted of two steps. In step 1, subjects were asked to identify and rate (on a scale of 1–3) "important events" during an uninterrupted listening session by tapping on a keyboard in real-time. The instructions emphasized that an "event" could be either an isolated moment or an extended process. Subjects were informed that there were no "right" or "wrong" responses and that the perceived significance of events might vary between individuals. In step 2, subjects re-listened the same pieces with the option to pause, rewind, or fast-forward to specific sections. During this step, they could revise their initial annotation by moving, deleting, adding, or re-rating markers on a timescale displayed above the waveform visualization of the piece. No scores or other graphical representations of the music were provided, nor was any information given about the pieces or composers. Additionally, subjects were required to provide verbal descriptors to further explain the placement of each marker.[3] The outputs from the two steps included the timestamps of the markers, their assigned importance ratings, and the verbal descriptors from step 2. Data recorded from both steps enabled tracking changes, including whether markers were deleted, relocated, re-rated, or added in step 2.

The evaluation consisted of a quantitative and qualitative comparison between the markers from step 2 and the model analysis (i.e., the research team's hypotheses about outcomes)[4], as well as a comparison between the markers identified in steps 1 and 2—the primary focus of this paper.

Tracking changes between steps 1 and 2 involved comparing the visual representations of all markers in Sonic Visualiser[5] and conducting a cluster analysis for both steps. The cluster analysis was performed using DBSCAN (Density-Based Spatial Clustering of Applications with Noise) (Ester et al., 1996), an unsupervised clustering algorithm that incorporates noise. DBSCAN requires two parameters to be set: the minimum number of points to form a cluster (minPts) and the distance between points (ε). For this study, minPts was consistently set to 10, representing 25% of subjects—a proportion deemed sufficient to indicate significance, while ε was set in several different settings (0.1–1 second for short and medium-length pieces, and 0.1–2 seconds for longer pieces).[6] As a result of ε setting, a cluster may not correspond to a single point in time but could span several seconds, as long as the density of markers is sufficiently high. Conversely, noise areas denote regions of high activity where

[1] Complexity refers to the difficulty of the task in the experiment and is defined by the research team's consensual assessment on a scale of 1–5. This assessment considers factors such as duration, genre, and texture of the piece.

[2] In the experimental design, an "expert" was defined as someone who has pursued or completed higher education in music (practical or theoretical). The number of non-experts was set higher because their results were expected to show greater variability compared to those of the experts.

[3] For details on experiment design, see "PoD_web_application.pdf" and "PoD_web_application_video.mp4" (https://doi.org/10.5281/zenodo.13981069).

[4] The model analyses are primarily based on listening, in order to mirror the experimental procedure, and are subsequently refined using the score to establish clear textural reference points for later evaluation. The scores including model analyses are available in the respective datasets on the Zenodo community Perception of Contemporary Music – Empirical Research.

[5] Sonic Visualiser is an open-source application for visualization and analysis of music (Cannam et al., 2010).

[6] The different distance settings enable the tracking of changes in cluster formation across different conditions. For instance, if a cluster consistently appears across multiple settings, it indicates robustness. In the following examples, only one setting will be used.

markers are too scattered to form a cluster. These areas can be assessed based on their density, determined by the number of markers within a specific area. Comparing clusters and noise areas across both steps enabled us to interpret how subjects responded to the music during their initial and repeated listening experiences.

Results

Across all 23 pieces, the results of expert and non-expert listeners did not differ pronouncedly. However, in every case, the experts' segmentations aligned more closely with the model analysis (Rebrina & Utz, 2025, pp. 121–22). Although previous research has identified differences in brain network engagement between experts and non-experts during real-time music segmentation (Burunat et al., 2024), the resulting segmentations may still be similar, with experts offering greater detail (Phillips et al., 2020). Across all 23 PoD experiment pieces, listeners provided 27,948 descriptors.[7] The most frequently chosen descriptor was *increase of tension* (11.85%), followed by *change of loudness* (6.71%), *change of timbre* (5.97%), *local beginning* (5.93%), *change of density or texture* (5.03%), and *change of pitch* (4.95%). These aspects and parameters are consistent with findings from previous research on the factors underlying segmentation in post-tonal music (Deliège, 1989, Addessi & Caterina, 2005; Phillips et al., 2020).

The comparison between step 1 and step 2 showed that many subjects reassessed the "importance" of events after hearing them within the broader context of the entire piece in step 2. Some events were deemed less significant, leading subjects to delete markers, while others were recognized as (more) noteworthy only during repeated listening, resulting in the addition of new markers.

In 13 of the 23 pieces analyzed in the PoD experiment, the total number of markers decreased in step 2, while it increased in 10 pieces due to the addition of new markers. Table 1 illustrates the list of pieces and the marker counts in the two steps. The quantitative results can be summarized as follows: In some cases, subjects marked events extensively in step 1 and deleted markers in step 2, while in others, they marked sparingly in step 1 and added new markers in step 2. Notably, these variations did not correlate with duration, complexity, or genre but instead appeared to depend on the unique characteristics of each individual piece.

Following earlier research on musical segmentation (see above), it was hypothesized that clusters identified in step 1 would primarily be "refined" in step 2, becoming denser and more precise in pinpointing the specific events that elicited them. While this pattern was observed in many cases, other trends also emerged. Overall, five distinct tendencies were identified:

1. clusters formed in step 1 tend to become more stable and denser in step 2;
2. new clusters emerged in step 2;
3. noise areas in step 1 transformed into clusters in step 2;
4. some noise areas remained noise areas in step 2, even though subjects adjusted their markers;
5. clusters identified in step 1 dissolved and became noise areas in step 2.

To further illustrate these five tendencies, the following section presents examples drawn from specific musical case studies.

(1) The first tendency can be observed in Salvatore Sciarrino's *Sei capricci* no. 1 (1976)[8], consisting of twelve phrases and an echo-like gesture at the end. The piece is characterized by a constant rhythmic pulse in 32nd and 64th notes. Each phrase is shaped by an increase of tension, followed by a decrease and a caesura. In the second half particularly, most clusters formed in step 1 persisted into step 2. Figure 1 illustrates the clusters formed in both steps ($\varepsilon = 0.3$).[9] Even with the tight setting of ε, 6 out of 7 clusters identified in step 1 persisted in step 2, albeit with slight adjustments, indicating that listeners primarily refined and

[7] See "PoD_global_data.xlsx," table "descriptor population ALL" (https://doi.org/10.5281/zenodo.13981069). The criteria for selecting descriptors are detailed in Rebrina & Utz (2025, p. 120).

[8] Recording used in the experiment (CD Salvatore Sciarrino – Marco Fusi – Complete Works for Violin and for Viola, Stradivarius STR 37057, ℗ 2017 Milano Dischi, Track 2). The complete dataset produced in the experiment for this piece is available at https://doi.org/10.5281/zenodo.13985428.

[9] The higher the ε value, the more likely it is that clusters will span longer durations. Since Sciarrino's piece is brief and features short phrases, a low ε setting was chosen to illustrate the clusters. For the remaining examples, the ε setting was adjusted to correspond to the duration of the pieces: for *Ge Xu (Antiphony)* (7:47), ε = 0.7; for *Quartetto no. 4* (13:52), and for *Lichtbogen* (19:24), ε = 1.5.

Table 1. The list of 23 pieces of the experiment sorted by the absolute percentage difference in the number of markers between the two listening steps (last column).

year	duration	composer	work title	complexity (1–5)	number of markers			
					step 1	step 2	diff.	diff. perc.
1976	01:09	Salvatore Sciarrino	*Sei capricci per violino*, no. 1: Vivace	2	395	483	+88	**+20.05%**
1913	01:17	Alban Berg	*Vier Stücke für Klarinette und Klavier* Op. 5, no. 1: Mäßig	3	278	339	+61	**+19.77%**
1957	01:05	Pierre Boulez	*Le Marteau sans Maître*, no. 7	3	289	351	+62	**+19.38%**
1997	02:30	Liza Lim	*The Heart's Ear* (excerpt)	3	354	301	-53	**-16.18%**
1992	02:09	Mathias Spahlinger	*furioso* für Ensemble (exc.)	4	480	419	-61	**-13.57%**
1998	12:46	Beat Furrer	*spur* für Klavier und Streichquartett	2	1,193	1,064	-129	**-11.43%**
2010	02:10	Natasha Barrett	*Animalcules* (exc.)	3	318	285	-33	**-10.95%**
1957	02:18	Karlheinz Stockhausen	*Gruppen* for 3 orchestras (exc.)	5	471	428	-43	**-9.57%**
1964	13:52	Giacinto Scelsi	*Quartetto no. 4*	5	1,008	917	-91	**-9.45%**
1970	07:08	Helmut Lachenmann	*Pression* for one cellist	3	659	611	-48	**-7.56%**
1994	07:47	Chen Yi	*Ge Xu* (*Antiphony*)	2	1,128	1,046	-82	**-7.54%**
1914	01:54	Igor Stravinsky	*Trois pièces pour quatuor à cordes*, no. 2	1	572	606	+34	**+5.77%**
1959	01:39	György Kurtág	*Quartetto per archi* op. 1, iv	2	518	545	+27	**+5.08%**
1982	01:51	Jonty Harrison	*Klang* (exc.)	2	413	432	+19	**+4.50%**
1931	02:08	Edgard Varèse	*Ionisation* (exc.)	1	344	331	-13	**-3.85%**
1909	01:57	Arnold Schönberg	*Fünf Orchesterstücke* op. 16, no. 1: *Vorgefühle*	2	616	631	+15	**+2.41%**
1977	09:44	Brian Ferneyhough	*Time and Motion Study* I	5	1,221	1,245	+24	**+1.95%**
1986	19:24	Kaija Saariaho	*Lichtbogen*	5	1,185	1,164	-21	**-1.79%**
1999	06:17	Curtis Roads	*Half-life*	3	848	836	-12	**-1.43%**
1981	06:32	Nicolaus A. Huber	*6 Bagatellen*, vi	3	815	806	-9	**-1.11%**
1956	09:38	Iannis Xenakis	*Pithoprakta*	4	903	910	+7	**+0.77%**
1993	02:13	Annette Vande Gorne	*Bois* (exc.)	1	308	310	+2	**+0.65%**
1978	31:07	Morton Feldman	*Why Patterns?*	5	1,492	1,490	-2	**-0.13%**

reinforced their initial impressions. The boundaries of the clusters shifted because subjects moved their markers in step 2, often to mark an event more precisely, mostly aligning with the loudest parts of each phrase (i.e., the "peaks" of the waveform visualization). Out of the 933 descriptors provided, the most frequently used were *increase of tension* (12.33%), *change of loudness* (9.43%), and *climax* (7.29%), which corresponds to the locations of the markers on the "peaks" of phrases.

(2) Some clusters, on the other hand, emerged exclusively in step 2. Particularly in the first half of Sciarrino's piece, these new clusters mostly formed at the beginnings and endings of phrases, as well as at the loudest parts of phrases, due to markers being added or shifted to these positions in step 2. This indicates that, upon reflecting and engaging further in step 2, subjects marked the piece with greater detail. The high number of markers added in step 2 (88, see Table 1) further supports the observation that subjects paid closer attention to new details during this phase.

(3) The first two tendencies—which point to step 2 as a more "sorted version" of step 1—also occur in longer pieces. The difference is that the noise areas therein might span over several minutes.

Even those long noise areas tend to transform into clusters to some degree (tendency 3). In Chen Yi's *Ge Xu (Antiphony)* for chamber orchestra (1994)[10], a piece characterized by clearly perceivable yet extended transformative sections—reflected in the three predominant of the 2,011 descriptors chosen by participants: *increase of tension* (15.07%), *change of timbre* (8.4%), and *local beginning* (6.46%)—a striking example occurs at the 4:30 mark, where the percussion section begins a long buildup. Gradually joined by other instruments, a layered and intense texture is created. In the experiment, this buildup yielded a 73-second noise area containing 115 scattered markers, with a high density of 1.58 markers per second. Subjects distributed their markers across numerous local impulses, such as rhythmic and pitch changes, occurring throughout the buildup. In step 2, after subjects had gained a more profound impression of the piece, this area became partially organized, forming at least two clusters around events where new timbres were introduced. These clusters demonstrated agreement among 21 subjects (52.5%) in the first case and 18 subjects (45%) in the second (Figure 2). However, even after this reorganization, the same area still contained 76 non-clustered markers, underscoring the inherent ambiguity of this section.

(4) Given the experimental setup in which subjects reacted in real-time in step 1, the three discussed tendencies—that most clusters formed in step 1 persist, that new clusters emerge, and that

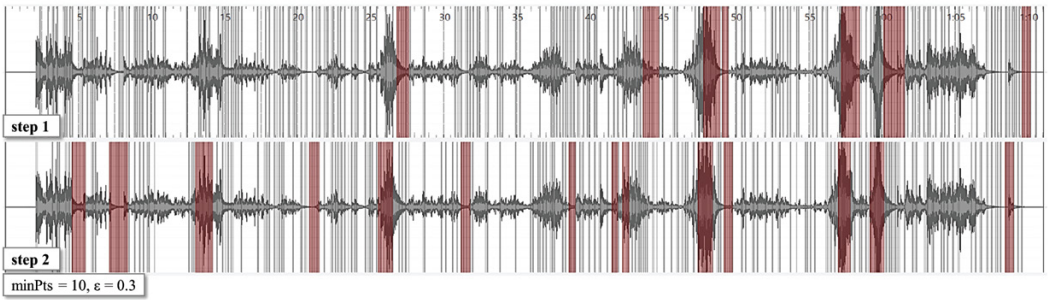

Figure 1. Salvatore Sciarrino, *Sei capricci* no. 1, subject markers (vertical lines) against a waveform visualization of the presented recording. Top: subject markers in step 1, bottom: subject markers in step 2. Red areas indicate the formation of clusters. In step 1, a total of 395 subject markers were recorded (131 clustered in 7 clusters, and 264 classified as noise). In step 2, 483 markers were recorded (239 clustered in 14 clusters, 244 classified as noise).

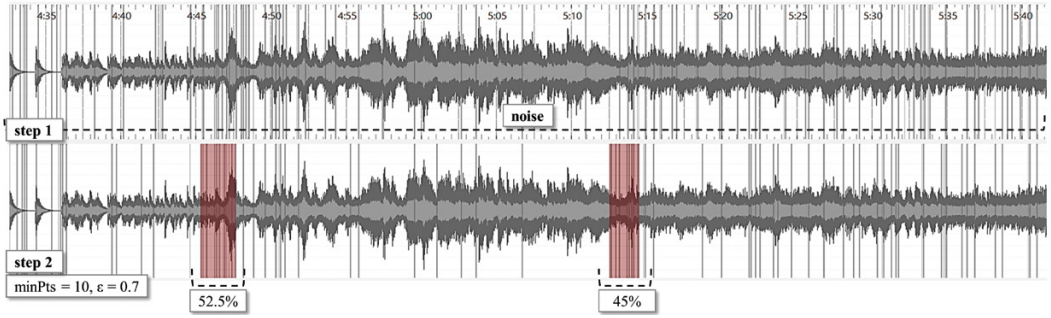

Figure 2. Chen Yi, *Ge Xu (Antiphony)*, 4:33–5:41, top: subject markers in step 1, bottom: subject markers in step 2. Red areas indicate the formation of clusters.

[10] Recording: CD The Music of Chen Yi, Chen Yi – The Women's Philharmonic, JoAnn Falletta, NA 090 CD, ℗ 1996 New Albion Records, Track 3, Complete dataset: https://doi.org/10.5281/zenodo.13982412.

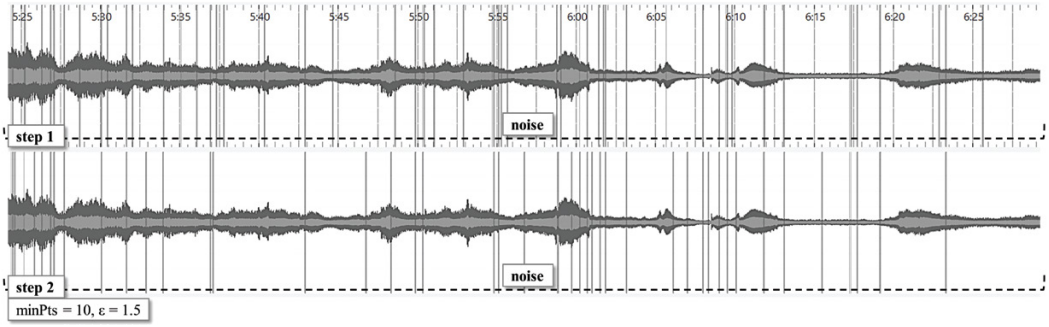

Figure 3. Giacinto Scelsi, *Quartetto No. 4*, 5:24–6:29, top: subject markers in step 1, bottom: subject markers in step 2.

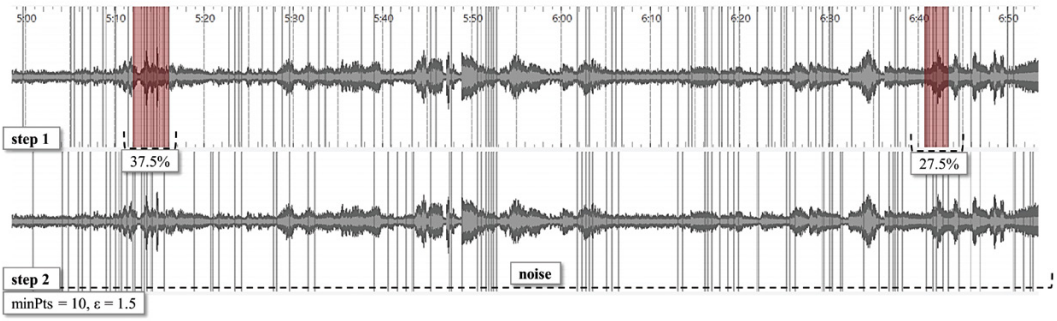

Figure 4. Kaija Saariaho, *Lichtbogen*, 5:00–6:51, top: subject markers in step 1, bottom: subject markers in step 2. Red areas indicate the formation of clusters.

noise areas evolve into clusters—were expected to a certain degree. However, in more complex pieces, additional tendencies were observed. In Giacinto Scelsi's *Quartetto No. 4* (1964)[11], a low-hierarchical piece with a processual texture featuring numerous local cues, the most frequently placed markers (total number: 1,721) were *increase in tension* (16.68%), *change in loudness* (10.75%), *change in pitch* (8.25%), and *change in timbre* (7.09%). In a 68-second-long noise area starting at 5:25, 63 markers were placed in step 1 (density 0.92). After step 2, while subjects moved or removed some markers, the area remained classified as noise, with 48 markers and a reduced density of 0.71 (Figure 3). Despite adjustments, no consensus emerged regarding specific events, and no clusters formed in step 2 in this area.

(5) In the final example, Kaija Saariaho's *Lichtbogen* for nine musicians and live electronics (1985–86)[12], ambiguity in step 2 was even more pronounced. Some areas that contained clusters in step 1 dissolved into noise areas in step 2. For instance, two clusters formed in step 1 in a 114-second long section (starting at 4:57), with agreement levels of 37.5% and 27.5%, no longer existed in step 2. Instead, subjects' adjustments led to the creation of a long noise area containing 98 markers, resulting in a density of 0.86 (Figure 4). This dissolution was probably driven by the presence of numerous local cues—once again, *increase in tension* was the most frequently used descriptor (16.43% of 1,936 descriptors), followed by *change in timbre* (6.92%) and *change in pitch* (5.37%). Additionally, subjects often marked different phases of ongoing processes, resulting in a scattering of markers even when they appeared to refer to the same underlying phenomenon.

[11] Recording: CD Giacinto Scelsi – Klangforum Wien, Hans Zender – Streichquartett Nr. 4 / Elohim / Duo / Anagamin / Maknongan / Natura Renovatur, 0012162KAI, ℗ 2001 Kairos Production, Track 1. Complete dataset: https://doi.org/10.5281/zenodo.13985403.

[12] Recording: CD Endymion Ensemble – Lindberg. Kaipainen. Hämeenniemi. Saariaho, FACD 361, ℗ 1989 Finlandia Records, Track 6. Complete dataset: https://doi.org/10.5281/zenodo.13985390.

Discussion

The five tendencies of cluster formation, or their absence, are closely linked to the textures of the individual pieces and the specific events around which the clusters are formed.[13] These events can be broadly categorized into two types: (A) distinct events that can be pinpointed to a specific moment, such as sudden changes, caesuras, and interruptions; and (B) ambiguous events, such as transitions and transformations, which are processes rather than discrete points.

The first two tendencies—clusters present in step 1 becoming more stable (denser and more precise) in step 2, and new clusters emerging in step 2—are evident in both textures with clear phrasing and in processual textures. However, clusters associated with distinct events tend to become more compact in step 2. Repeated listening not only reinforces the initial impressions but also enables subjects to identify and mark additional details, resulting in a more refined and nuanced interpretation. In this sense, the first annotation functions as a preliminary "sketch" that becomes increasingly precise as the ambiguity and complexity of post-tonal structures are reduced through repeated listening, thereby making them more comprehensible—an effect most likely connected to the well- investigated fact that music becomes more predictable with repeated listening (Huron, 2006, p. 241).

In contrast, tendencies (3), (4), and (5) are more pronounced in pieces with complex, layered, and transformative textures. In such cases, noise areas identified in step 1 are often a result of ambiguous textures. As demonstrated in the example of Chen Yi's *Ge Xu*, these noise areas can become somewhat more robustly organized in step 2, with clusters forming around certain events. However, in more intricate and layered textures, such as in Scelsi's *Quartetto No. 4*, noise areas tend to persist. Even after repeated listening, the uncertainty about marker placement remains unresolved, reflecting a higher degree of ambiguity regarding the determination of structurally "important" cues within the musical flow. The most extreme case of this phenomenon occurs in pieces such as Saariaho's *Lichtbogen*, in which clusters identified in step 1 dissolve in step 2, leaving behind larger noise areas. This dissolution suggests that, for some textures, the ambiguity of the music in fact increases with repeated listening.

Despite the lack of consensus of identifiable "events" represented in clusters in these cases, areas with scattered markers still provide valuable insights for analysis. A high number of scattered markers within a noise area indicates that subjects collectively perceive a particular "region of significance," even if they do not agree on its precise location. For instance, the dissolution of clusters observed in *Lichtbogen* highlights the analytical importance of processual textures. These regions, despite their lack of defined clusters, offer a rich field for exploring subjects' understanding and navigation of complex post-tonal structures.

Further investigation into individual listening strategies could shed light on different ways individuals perceive and orient themselves within complex musical textures. Additionally, the available dataset, which includes detailed information about the reasoning behind marker placement, offers an opportunity for future research. This might involve analysing the descriptors, potentially allowing for a more parameter-sensitive analysis, and further differentiating types of changes in cluster formations between the two steps, an area that remains a promising avenue for further study.

Conclusion

While the differences in subjects' annotational behavior observed between the two listening steps of our PoD experiment are highly context-dependent, two primary tendencies emerge. First, relatively clear segmentation points tend to become more defined and clusters around them more robust as a result of the subject's repeated listening experiences. Second, ambiguous local processes may either come to highlight certain events within the musical flow more strongly after repeated listening or, conversely, remain ambiguous, as evidenced by the lack of or even decrease of cluster formations.

It has to be noted that in all examples, noise areas without clusters are by no means considered "unimportant." A relatively high number and density of markers in such areas might suggest that they are still somewhat "important" to listeners, even though no clear "moment" can unanimously be identified. These areas are meaningful because they might reflect the perception of multiple micro-events occurring in close proximity to one another, pointing to particularly intriguing processual textures. These findings highlight the individualized nature of subjects' interpretations, underscoring how listeners may conceptualize the temporal flow and structure within post-tonal music.

[13] For detailed discussion on cluster formations in various repertoires, see Utz (forthcoming), Wozonig (forthcoming), and Rebrina (forthcoming).

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Exploring *Conceptual Simplification* as a Memorisation Method for Post-Tonal Music: Main Findings from a Study with Recruited Pianists

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Abstract

This paper presents the main findings from testing some strategies of a method for memorisation of post-tonal piano music. The participants were conservatoire piano students and recent graduates, divided into a control group and an experimental group based on the results of a questionnaire that evaluated their musical and educational backgrounds, memorisation strategies, experience with perfect pitch and synaesthesia, sight-reading, emotions, sleep, and mental practice. Participants memorised four excerpts, either using their own strategies (control group) or following a series of instructions (experimental group), which recreated the implementation of Conceptual Simplification. Additionally, the study evaluated whether the suggested strategies could be helpful for the participants' daily performance practice, either as a new approach or in combination with their regular working methods. Finally, it also aimed at testing how the given instructions influenced the results of the experimental group in comparison to the control group; and how sleeping between recalls influenced the results. Participants were asked to perform from memory and audio-record all excerpts in three different recalls: 1) after practice and without sleep, 2) without practice and without sleep, and 3) without practice and with sleep. After each recall, participants were interviewed to evaluate their experience further. Thematic analysis was applied to the transcribed semi-structured interviews, and the audio recordings were assessed both qualitatively and quantitatively by the author. The most successful participants in the control group were those implementing Conceptual Simplification strategies on their own. However, since these participants had no instructions on how to memorise using Conceptual Simplification, they were more successful than their peers in the same group but less than those in the experimental group. The method's strategies worked well in combination with the participants' usual memorisation strategies, and most participants found it easier to recall the excerpts after sleeping.

Keywords: analysis, learning, memorisation, Conceptual Simplification, post-tonal piano music

Introduction

Most soloists, especially pianists, are required or expected to perform from memory during their studies and at a professional level, but memorisation is not a topic frequently taught or discussed at conservatoires (Jónasson & Lisboa, 2016). This is partly due to an existing gap in music performance, education, and psychology regarding how memorisation should be trained (Ginsborg, 2004; Mishra, 2005, 2010), but also, because research findings do not always transfer or are pedagogically implemented at conservatoires (Ginsborg, 2004; Jónasson & Lisboa, 2016; Mishra, 2010).

Similarly, existing research on musical memory is quite extensive, but it has mainly focused on observing how musicians practise and memorise, in order to determine whether some strategies are more efficient than others (e.g., Chaffin & Imreh, 1997; Chaffin et al., 2003; 2010; Fonte, 2020; Soares, 2015; Tsintzou & Theodorakis, 2008). However, the resulting theories, far from proposing a systematic method on how to memorise effectively, solely indicate general guidelines (e.g., Chaffin & Imreh, 1997; Chaffin et al., 2002; 2003; 2010). The literature is even scarcer for post-tonal music (Asimov & Murray, 2024; Fonte, 2020; Soares, 2015; Thomas, 1999; Tsintzou & Theodorakis, 2008).

Performance cue theory is the main approach for studying memorisation of tonal and post-tonal music (e.g., Chaffin & Imreh, 1997; Chaffin et al., 2002; 2003; 2010; Fonte, 2020; Ginsborg & Chaffin, 2011a; Soares, 2015). This theory describes practitioners' memorisation strategies and individual learning differences (Mishra, 2002; 2007) but fails to provide a memorisation method. Furthermore, even if musicians effectively develop a hierarchical retrieval scheme to articulate all these performance cues, such memory hints do not allow the performer to reconstruct or deduce the content to which these provide access. Evidence of this problem is provided by the same studies

applying performance cue theory, which report that memory is more reliable for section boundaries than other locations that tend to be poorly recalled or are forgotten (Chaffin & Imreh, 1997; Chaffin et al., 2002; 2010; Fonte, 2020; Ginsborg & Chaffin, 2011; Soares, 2015).

Consequently, memorisation of post-tonal music is still a taboo with which performers struggle, leaving musicians to find their own ways for achieving this goal (e.g., Chaffin et al., 2002; Farré Rozada, 2024; Fonte, 2020; Ginsborg, 2004; Soares, 2015). These approaches are, however, not always effective under pressure or within tight deadlines (Chaffin & Imreh, 1997; Chaffin et al., 2002; Fonte, 2020; Tsintzou & Theodorakis, 2008). This is one of the main reasons why post-tonal music is likely to be performed from the score, since regular memorisation strategies (namely, using traditional harmony and standard patterns) are not always applicable (Asimov & Murray, 2024; Farré Rozada, 2024; Fonte, 2020; Jónasson & Lisboa, 2016; Soares, 2015; Thomas, 1999; Tsintzou & Theodorakis, 2008). Thus, the Conceptual Simplification method tested and formalised in Farré Rozada (2024) aims to address this gap.

This paper presents the main findings of testing the effectiveness of Conceptual Simplification for memorising post-tonal piano music with recruited pianists of different backgrounds and performing experience. Therefore, the paper begins by providing a general overview of Conceptual Simplification and the aims of the studies presented; then, it outlines the main aspects of the research method (participants, materials, procedure, data analysis); and finally, it presents the main findings, discussion and conclusions.

Conceptual Simplification

Conceptual Simplification is a method that aims to scaffold the analysis, learning and memorisation of post-tonal piano music. Inspired by mathematics and computer science, this is thoroughly discussed in the PhD thesis by Farré Rozada (2024). In general terms, Conceptual Simplification involves three main steps, each with its own pool of strategies:

- **Triage:** This is the initial stage for becoming acquainted with the musical work and identifying strategies that could help address the challenges presented.
- **Simplifying layers of complexity:** This proceeds to slicing complexity into layers, reducing the level of difficulty of the musical score. A layer of complexity could be the range of octaves in which a single melody is displayed, the extended techniques involved in a piece, a repetitive pattern or figuration that cyphers a chord or progression, or any other secondary information that contributes to the music's complexity without being the primary source. This process is preferably done mentally using the piano, but it can be written down if that is more helpful.
- **Conceptual encoding:** this is the reverse process of simplifying layers of complexity, restoring layers of complexity, once a particular modified version of the musical work is successfully internalised.

Aims

These studies with participants aimed to test Conceptual Simplification and assess its effectiveness alongside participants' suggested strategies when memorising four post-tonal excerpts. Participants were divided into a control group and an experimental group. Both groups memorised the same excerpts, but the experimental group received a list of instructions for implementing Conceptual Simplification. Specifically, the Conceptual Simplification strategies tested were: simplifying pitch, simplifying octaves, simplifying chords, simplifying hands, simplifying rhythm, simplifying repetition, simplifying structure, simplifying preceding structure, interval conceptualisation, chord conceptualisation, *solkattu* verbalisation and pattern conceptualisation (see Farré Rozada, 2024). Alternatively, the control group memorised the excerpts using their usual procedures. Semi-structured interviews after each test allowed participants to comment on the strategies used, including their effectiveness. Therefore, this research aimed at testing the following:

- Whether the suggested strategies could be helpful for participants' daily performance practice, either as a new approach or combined with their regular working methods.
- How the given instructions influenced the experimental group's results in comparison to the control group.
- How a night's sleep influenced the results of the morning recall on the second day, as opposed to the afternoon recall, given that participants completed a morning memorisation test, an afternoon recall on that same day, and a next-day recall on the following morning.

Method

The studies with participants consisted in a pilot study followed by a main study, which allowed the author to assess the participants' performance in their usual working environment. The purpose of the pilot study was to validate the research methods used and collect feedback from participants to eliminate potential ambiguities in the questions and instructions provided. Furthermore, its purpose was to evaluate the time participants needed for completing each task and the challenges experienced; check whether the proposed excerpts were representative of the phenomenon being tested, identify participants' response to the excerpts, find out which memorisation strategies were used in both groups, and test the efficiency of data analysis with a small sample of participants. All these served as a baseline and helped in refining the main study.

Participants

The 11 recruited participants consisted of two second-year BMus piano students, one bachelor's graduate, three master's graduates pursuing further postgraduate studies, one PhD student, two professional pianists, one organ tutor and piano accompanist, and one amateur with 15 years of piano playing experience. The pilot study was conducted with three participants and the main study with eight participants. Table 1 provides a summary of participants allocation between the control group and the experimental group for both studies.

Table 1. Comparison of the control and experimental groups by socio-demographical variables and musical skills.

	Control Group	**Experimental Group**
Participants	4	7
Gender	1 Female 2 Males	6 Females 1 Male
Education	1 Bachelor's student 1 Postgraduate student 2 Professionals	1 Amateur 1 Bachelor's student 1 Bachelor's graduate 2 Postgraduate students 1 PhD student 1 Professional
LRT	1 Less than 50% 1 Between 60-69% 2 More than 80%	1 Less than 50% 1 Between 50-59% 2 Between 60-69% 3 Between 70-79%
Performs from memory	2 Sometimes 2 No	5 Yes 2 Sometimes
Sight-reading	3 Yes 1 To some extent	2 Yes 3 To some extent 2 No
Synaesthesia	4 No	2 Sometimes 5 No
Perfect pitch	2 Yes 2 No	4 Yes 3 No
Uses emotions to memorise	1 Yes 3 No	3 Sometimes 4 No
Memorisation strategies	2 Yes 2 To some extent	2 Yes 5 To some extent
Sleep	1 Yes 1 Sometimes 2 No	1 Yes 3 Sometimes 3 No

Materials

Both studies involved a questionnaire, a logical reasoning test (LRT), and a memorisation test, consisting of a morning memorisation test (MMT), an afternoon recall (AR) and a next-day recall (NDR). Participants completed all memorisation tests on a piano on two consecutive days, following the schedule summarised in Table 2:

Table 2. Schedule of the memorisation test.

DAY 1	DAY 2
Morning: Morning memorisation test (MMT)	**Morning:** Next-day recall (NDR)
Afternoon: Afternoon recall (AR)	

The four excerpts selected for the study were:

- **Excerpt 1**, which consisted of the beginning of George Crumb's 'Primeval Sounds' from the piano cycle *Makrokosmos I* (1972). This involves a sequence of chords in the lower register of the piano, where pitches are less discernible, particularly aiming at challenging perfect-pitch possessors with a tendency to memorise by ear. Furthermore, understanding the pitch organisation in this excerpt was needed to engage conceptual memory rather than relying exclusively on hand positions. Participants were suggested a 15-minute indicative timing to memorise it.
- **Excerpt 2**, which consisted of bars 1-18 of David Lang's piece 'Cage' from the piano cycle *Memory Pieces* (1992). Participants were given a 30-minute indicative time to memorise it, since this excerpt presents multiple switches in melody, harmony, and octave changes within the context of a self-referencing texture.
- **Excerpt 3**, which consisted of bars 1-8 followed by bars 38-40 of Philippe Manoury's *Piano Toccata* (1998). Participants were expected to memorise it in 30 minutes. However, participants in the pilot study needed more time. Therefore, the indicated time for the main study was extended to 45 minutes. Excerpt 3 is based on a symmetrical pitch organisation, being particularly challenging in terms of rhythm and tempo.
- **Excerpt 4**, which consisted of bars 1-2 of Roger Redgate's *Trace* (1996), from the standard book of contemporary pieces ABRSM *Spectrum 1*. This atonal excerpt comprises two unrelated cells that lack discernible patterns, and participants were expected to memorise it in 20 minutes.

Procedure

Participants were allocated to a control group or an experimental group based on their responses to an anonymous questionnaire. The criteria were to seek a balance of profiles across both groups, while prioritising allocating more participants to the experimental group to assess Conceptual Simplification with the largest possible sample. The determining parameters when allocating participants were their level of education, results at the Logical Reasoning Test, and whether they

- always performed from memory,
- felt confident at sight-reading,
- experienced synaesthesia,
- had perfect pitch,
- consciously used their emotions to memorise,
- had explicit memorisation strategies,
- used sleep (e.g., regular naps), as part of their practice routine.

The memorisation test involved a memorisation session in the morning of Day 1 (morning memorisation test - MMT), followed by a memory recall in the afternoon without practice (afternoon recall – AR); and a second memory recall without practice in the morning of Day 2 (next-day recall – NDR). Participants were expected to complete the MMT in 2 hours and 30 minutes. This involved memorising and performing the four given excerpts and audio-recording themselves, without the researcher being present. Both groups memorised the same excerpts, but the experimental group received a list of instructions for implementing Conceptual Simplification. Participants were advised to sleep for 8 hours between Day 1 and Day 2.

The given timeframe for the MMT was divided into indicative timings for each excerpt (see Materials), allowing participants more time if necessary. After the MMT, a 30-minute semi-structured interview followed. Similarly, for both the AR and NDR, participants had 30 minutes to recall all excerpts from memory and audio-record themselves, followed by a 10-minute semi-structured interview. The author interviewed each participant individually following Gibbs' (1988) reflective cycle, asking them to reflect on how Conceptual Simplification's approach could be merged with their learning styles and usual working methods. Hence, these semi-structured interviews were organised according to the following stages:

- description of the experience
- feelings and thoughts about the experience
- evaluation of the experience
- analysis to make sense of the situation
- conclusion on what was learned and what could have been done differently
- action plan for how the participant would deal with similar situations in the future, or general changes that might be appropriate

Data analysis

Each participant provided 12 audio recordings: three for each excerpt, corresponding to the MMT, the AR, and the NDR. The author analysed these performances using the following protocol, explicitly developed for this purpose:

1. Qualitative analysis: Recordings were listened to twice: first, without the score, and then with the score. This permitted capturing the performance's expressive component and identify possible hesitations to establish the participant's overall confidence. The benchmarks used were Royal Birmingham Conservatoire's (RBC) performance marking criteria for Principal Study (Years 1-2) and RBC's recital marking criteria for BMus3 and BMus4. This provided a well-established assessment measure. However, as participants had limited time for memorising the excerpts, the marking criterion simply prompted a suitable selection of parameters: technical control, stylistic awareness, fluency, and convincement.
1. Quantitative analysis: Recordings were reviewed while assessing a bi-dimensional measure (pitches, durations). For each excerpt, two scales were established: from 0 to p for pitches; and from 0 to d for durations. Accordingly, p was the total number of pitches, and d the pitches' duration. Therefore, if (p, d) is the maximum score, each recording was punctuated with (x, y), where $x \leq p$ and $y \leq d$.

Then, interviews were transcribed using the AI-software Otter. The resulting transcriptions were revised while listening to the audio recordings. Stuttering and unnecessary words were removed and replaced with '…'. Words added for clarification were written inside square brackets. Finally, confusing statements were highlighted in red, so participants could clarify these. Transcriptions were coded, using both inductive and deductive approaches. A thematic analysis was completed on all transcriptions and questionnaires, following Braun and Clarke's (2012) six-step procedure. The questionnaire's closed questions were analysed quantitatively. Finally, the logical reasoning test was scored according to its sheet of solutions, resulting in either a pass or fail.

Main findings

The main findings were that the participants reacted differently, conditioned by experience, background, abilities, and learning style. Unexpectedly, perfect-pitch possessors and kinaesthetic learners found Conceptual Simplification useful.

No scientific background is required to effectively implement Conceptual Simplification, as demonstrated by the results of the logical reasoning test and the memorisation test. Nonetheless, the experimental group did not implement Conceptual Simplification's three-step procedure on their own but only followed the given instructions that guided them through the process.

The most successful participants in the control group were those implementing Conceptual Simplification strategies on their own. This suggests that this method is the most effective for memorising the excerpts. However, since these participants received no instructions on memorising using Conceptual Simplification, they were more successful than their peers in the same group but less successful than participants in the experimental group who followed the method.

Conceptual Simplification strategies worked well in combination with the participants' usual memorisation strategies. The most efficient Conceptual Simplification strategies were those based on conceptual memory. Amongst these, a substantial effective strategy for memorising complex rhythms was found.

Most participants found it easier to recall the excerpts after sleeping.

Due to the scope of this paper, the discussion of the main findings listed above shall focus on the main results concerning pattern identification, perfect pitch and sleep.

Discussion

During the memorisation test, not all participants in the control group identified the same patterns, while only some in the experimental group noticed additional patterns not included in the instructions. Unexpectedly, this outcome did not always correlate with their expertise in post-tonal music, contrary to findings reported in existing literature (Fonte, 2020; Soares, 2015; Tsintzou & Theodorakis, 2008). Furthermore, participants' ability to detect patterns conditioned their effectiveness in encoding and retrieving the excerpts (Farré Rozada, 2024; Fonte, 2020). This result suggested that Conceptual Simplification strategies were effective in increasing the efficient translation of visual input into meaning, boosting pattern recognition and understanding. This was reported even when participants were

unfamiliar with the style and inexperienced with post-tonal music.

Conceptual Simplification was initially expected to be more useful for relative-pitch possessors, who do not memorise by ear (Ginsborg, 2004), thus having a greater need for alternative memorisation methods. Nevertheless, the study concluded that Conceptual Simplification could also benefit perfect-pitch possessors, allowing them to chunk more musical parameters at once (e.g., pitches, rhythm, harmony, dynamics) than when solely using perfect pitch (e.g., Deutsch, 1970; 2013). By simplifying the music into different manageable layers, they could hear the main melody better, which otherwise was tangled within the musical texture. This downsized aural complexity into memorable musical threads, enhancing their perfect-pitch ability. Consequently, despite Conceptual Simplification being an initial obstacle for perfect-pitch possessors, at presenting an unusual analytical approach to memorisation for them, this eventually ensured long-term retention, as opposed to the rapid decay of kinaesthetic or aural memories (Ginsborg, 2004; van Hedger et al., 2015). Moreover, while previous studies evaluated the influence of detailed instructions on the memorisation of tonal music (e.g., Rubin-Rabson, 1937), they did not focus on the role of perfect pitch, and not all of them recruited pianists or used real-world examples. Moreover, post-tonal music was not considered either. Consequently, this study contributes to an under-researched area of memorisation, perfect pitch, both tonal and post-tonal music.

Furthermore, the AR's and NDR's main purpose were testing the participants' retention without and with sleep respectively, by spacing the tests across two consecutive days. Participants were not allowed to practise between the tests or look at the scores, forcing them to rely exclusively on offline learning (Carter & Grahn, 2016). Additionally, the excerpts required engaging conceptual memory and could not be confidently memorised through perfect pitch or kinaesthetic memory. Still, participants found the most challenging excerpts easier to recall after sleeping, and equally or even more difficult during the MMT and AR. This result coincides with van Hedger et al. (2015), who found that conceptual errors could significantly decrease after a night's sleep.

Finally, those participants in the control group who identified the patterns and devised their own encoding principles recovered the music faster in subsequent recalls. Likewise, the experimental group was generally capable of replicating the instructions from memory and confidently retrieve the excerpts, including filling gaps in their memory. This process was even more effective after a night's sleep since several participants recovered forgotten information in previous recalls and found it easier to substitute their usual strategies for a new approach after sleeping (Robertson, 2009). All these findings suggest that interspersing sleep with practice is an effective strategy for learning and memorisation, confirming what was anticipated in a non-musical context (e.g., Mazza et al., 2016) and for procedural musical memory (e.g., Simmons, 2011).

Conclusions

The results of these studies suggested that Conceptual Simplification:

Provides an effective method for memorisation.

1. Simplifies complexity, not necessarily proceeding linearly.
1. Is flexible, allowing each strategy to be used on its own, or in combination with others.
1. The method's implementation does not require prior expertise in a specific musical genre or composer.

It presents a novel approach to musical memorisation, building on certain areas of mathematics and computer science to enhance human memory and musical performance. However, it does not require any previous scientific training to be successfully implemented and works for different learning styles and types of complexity.

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Vincent d'Indy's Concept of "Significant Keys" Through the Psychology of Perception of the Fin de Siècle Era: Constructing a "Complex" Sign in Music

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Abstract

This article examines the concept of "significant keys" (*les tonalités significatives*) proposed by Vincent d'Indy, drawing on the ideas of his period regarding musical acoustics, the psychology of perception, and aesthetics, particularly the theories of Arthur von Œttingen, Hugo Riemann, and Albert Lavignac, who was d'Indy's teacher. The phenomenon of a "significant key" acts as a complex sign in which the signifier is the sound of a particular tonality, and the signified is a layer of extra-musical meaning, whereby the connotations are determined by the composer at the pre-compositional stage of the work. This layer, as can be deduced from an analysis of d'Indy's texts, consists of two elements: feelings and ideas, which must be "decoded" by the audience. In fact, by assigning a special characteristic to a particular key, d'Indy performs a metonymic transfer (the extra-musical layer of meanings is considered to be the immanent meaning of the chosen key). The aesthetic basis for such characteristics concerns the long-standing idea of the binary opposition of major and minor, realized primarily in the field of sensory reactions to the sound of the two modes. The acoustic principle of this idea is the concept of the complete dualism of major and minor (including "upper" and "lower" resonance and functional inversion) (d'Indy, 1912, pp. 92–93; Lavignac, 1938; Riemann, 1893).

Keywords: Vincent d'Indy, *les tonalités significatives,* Richard Wagner, musical semantics, major-minor dualism, psychology, music perception

Introduction

In the development of French musical theory and practice during the *fin de siècle*, Vincent d'Indy's role is particularly interesting. His merits are diverse: his participation in the founding and later work of *La Société nationale de musique* and the *Schola Cantorum*, his provocative socio-political and cultural positions, his advocacy of Wagnerism as a method for developing real French art, and the implementation of a new teaching style that resembled the medieval "guild" way of communicating between a master and his students, as opposed to what one could observe at the *Conservatoire national de musique de Paris*. All these aspects of d'Indy's work mark him as an extraordinary person. His lectures on contemporary music and theoretical texts (such as books on Beethoven and Franck, articles, and *Le Cours de composition musicale*) attest to d'Indy's brilliant and extraordinary thinking. On the one hand, the composer always sought to stay abreast of contemporary developments and respond to the goals of that period (such as the development and preservation of *l'art latin*), whilst, on the other hand, he associated them heavily with Tradition[1].

One aspect of the latter was the concept of harmony, which was, generally speaking, highly appreciated by his contemporaries, for example, Camille Saint-Saëns (1922, pp. 19–20), and, in particular, the concept of tonality—in terms of its structure, application, and desired effect on the listener. According to d'Indy, tonality is the only acoustically grounded (i.e. natural) way to organize polyphonic music (1912, pp. 92–93). This means that aesthetic perception can be regulated by determining, in advance, those characteristics of tonality that can cause a specific feeling or generate a circle of fairly stable image associations in the listeners' mind.

The semantic mechanisms that d'Indy tacitly implies become the subject of our attention. They are consistent with the ideas of his era concerning acoustics, the principles of the perception of harmonic elements and their aesthetic properties. This aspect of d'Indy's theoretical legacy has not yet been the subject of special study. However, the very fact of the composer's reliance on the tradition

[1] Which has always been a guiding principle for him; the composer wrote this word, like many others significant to him, with a capital letter. See for example d'Indy, 1909, p. 16.

of key semantics was noted by Maho A. Ishiguro (2010, pp. 114–116)[2].

It is apparent that, as a result of reliance on this established tradition, tonality emerges as the principal harmonic element endowed with extra-musical meaning and functioning as a *signifier*, in modern terminology. To formalize this role, d'Indy introduces the concept of *significant keys* (*les tonalités significatives*), which is the focus of our analysis[3]. The essence of this concept and the dramaturgical function of the corresponding phenomenon are explicitly articulated by d'Indy himself in his essay on Wagner (1930, pp. 50–51). Its constructive and semantic roles can be further inferred from his scattered remarks on the structure of specific musical works (d'Indy, 1950, pp. 99, 111, 135, 140, 146–152, 159–160, 171–185, 202, 216–217, 286–308; 1906, p. 138).

However, the composer does not present a systematic exposition of the concept of *significant keys* to the reader. The novelty of our study lies in its attempt, for the first time, to reconstruct (1) the genesis of the composer's ideas concerning *significant keys* and (2) the original algorithm underlying the formation of their semantic content. This dual focus both highlights the distinctiveness of the composer's artistic thought and reflects the integration of existing psychoacoustic theories of tonality (e.g., Riemann, Lavignac) alongside perceptual and synesthetic experiences (César Franck). The primary sources for this research include: (1) the body of d'Indy's own writings in which the concept of *significant tonalities* is articulated; and (2) contextual works by his mentors and contemporaries, which influenced his understanding of the semantic dimensions of tonality.

The concept of *les tonalités significatives*

Adhering to the "music-as-language" paradigm[4], Vincent d'Indy can be said to have been looking for an opportunity to determine which type of extra-musical sense can be conveyed through musical means, and which of them can best serve as a *signifier*. As Mark Evan Bonds points out, "the metaphor of language suggests at least some degree of semantic content, and the task of deciphering music's meaning would remain a challenge throughout the eighteenth century and beyond" (2014, p. 68). D'Indy contributed significantly to the solution of this problem.

Two spheres concerning the formation of extra-musical components of artistic meaning and two fields of semantic analysis were proposed by the composer in texts such as *Le cours de composition musicale.*

The first concerns *l'art du geste* (d'Indy, 1933, pp. 7–8), which is *la musique pure*, including genres such as symphonic and chamber music which have neither text nor programme. Here, musical means appear to serve as *signifiers*. In this context, music—understood as a form of messaging—can convey only one type of extra-musical sense: one that is not tied to language and cannot be fully articulated through verbal means. This pertains primarily to various *sorts of feelings*[5]. "[…] music [...] evokes or expresses feelings of our soul" (d'Indy, 1909, pp. 384–385). In fact, d'Indy made this declaration on the basis of a musical tradition rooted in the Renaissance[6].

[2] Furthermore, the problems of sense-making in d'Indy's later opuses were mentioned, for example, by Jane Fulcher (1990, pp. 295–296) and Esteban Buch (2006, pp. 31–35).

[3] In French theoretical discourse, the term *tonalité* refers both to the system of pitch organisation and to the specific pitch level or key center. D'Indy primarily employs the term *tonalités significatives* in the latter sense, which informs our choice of translation as "significant keys". Nevertheless, in certain analytical contexts, particularly when examining specific compositions, he also considers the internal structure of the tonality and its development in duration. In this context, the term *tonality* may be regarded as more appropriate.

[4] See d'Indy, 1912, pp. 12, 29; 1933, pp. 6, 48–49. Concerning "the language of sounds" (*le langage des sons*), "the language of words" (*le langage des mots*), and "musical discourse" (*le discours musical*) see d'Indy, 1912, pp. 36, 47, 78. The "music-as-language" paradigm was still relevant for French musicians of the *fin de* siècle era like Paul Dukas and Ernest Chausson, and was in contradiction with the second, Eduard Hanslick's (1854), doctrine of the intrinsic value of music as *Tönend bewegte Formen*. On possible translations such as "sounding forms in motion" and others see Payzant, 1981, p. 44.

[5] Besides images, which are produced by the listener's own consciousness through associations (cross-modal correspondences, representations etc.).

[6] Such correlations between musical material and its extramusical sense, as invented by composers in Renaissance treatises, can be seen, for example, in Carlo Valgulio's *De Musica*, 1507, and Nicola Vicentino's *L'antica musica ridotta alla Moderna prattica*, 1555 (Bonds, 2014, pp. 48–49). D'Indy emphasizes the fact that it was during the Renaissance that "the individualistic mindset" (*l'état*

The second sphere of artistic meaning is produced by *l'art (la musique) de la parole,* according to d'Indy's classification, namely, those genres besides opera: cantata, oratorio, as well as "transitional" genres, such as overture, fantasy and symphonic poem, taking into account the presence of an extramusical semantic layer in such genres where verbal components have encoded a meaning. In this case, since the word reflects the work of the intellect, a layer of extramusical meaning contains not only feelings *(les sentiments),* but also ideas. They can be transmitted through musical means as signifiers, generated by a poetic text, a programme in a symphonic work, or a libretto and stage remarks in an opera.

According to the composer, the last genre (originating from *La camerata fiorentina*) can be considered as the highest implementation of this dual extramusical sense (*le sentiment* and *l'idée*) through music[7].

Drawing on d'Indy's reflections, one may infer that, among the musical means, a mode emerges as the most suitable vehicle for conveying this dual musical meaning. As a phenomenon, the mode possesses a long-standing historical association with extramusical significance—beginning with the ancient Greek conception of the ethos of the modes. However, since the composer is concerned not with Greek tragedy but with opera as a form of modern musical drama, his focus shifts to ideas pertaining to the extra-musical correlates of harmonic systems that gained prominence in the modern era (*Histoire moderne*), following the emergence of opera as a distinct phenomenon between 1598 and 1600. Accordingly, he concentrates on the type of harmonic organisation that accompanied the development of this genre—namely, tonality.

Moreover, considering Wagner's musical drama as the culmination of this development, and the operas of Gluck and Weber as its preparatory stage, d'Indy (1950, p. 64) investigates the problem of the semantics of keys (as the concrete implementation of a tonal system) in the aspect of the semantic function that they fulfil in the works of these composers. This is a very important clarification: d'Indy relies not so much on these authors' statements, but on his own opinions about their concepts and their scores, basing his thoughts on contemporary scientific ideas.

Ultimately, the composer was convinced of the need to verify aesthetic judgments. When it comes to the semantics of keys, it is a reflection of ideas concerning musical semantics, resulting from theories of the psychology of perception put forward by the composer's contemporaries (Hugo Riemann and Arthur von Œttingen, cited by d'Indy, and Albert Lavignac, the composer's harmony teacher[8]).

Considering tonality to be the "central point" of an algorithm of semiosis, d'Indy introduces the term *les tonalités significatives* ("significant keys") and is sure that this phenomenon was invented by Richard Wagner (d'Indy, 1930, pp. 50–51). A key acquires the status of "significant" when its repetition is observed in connection with the same extramusical meanings and affects the nodal moments of the drama. D'Indy identifies the first use of this phenomenon of tonality in Gluck's *Alceste* (1776) and *Armide* (1777), then in Weber's *Freischütz* (1821) (1950, p. 135), and after that in Wagner's later-period dramas (*Tristan und Isolde*, Table 1; *Die Meistersinger*, the tetralogy, *Parsifal*). As for Wagner, d'Indy even created schemes of "significant keys" (1950, pp. 151–152, 162, 174–175, 286–287),

d'esprit individualiste) was developed (d'Indy, 1933, pp. 74–75; see also 1912, p. 218); hence it is logical to deduce the value of individual experiences and their correlation to music. D'Indy further coordinates the rise of individualism with the advent of solo compositions, citing *Madrigal dramatique* as an example (1933, p. 75).

Another source of the composer's opinions (not musical, but philosophical) is the definition of art as given by Count Léo Tolstoy, who was highly revered in France during the era in question. D'Indy cites this definition (1912, pp. 9–10): "Art is a human activity, consisting in this, that one man consciously, by means of certain external signs, hands on to others feelings he has lived through, and that other people are infected by these feelings, and also experience them" (Tolstoy, 1904, p. 50).

[7] This judgment can be derived from d'Indy's differing analysis of other composers' music (e.g. 1930, pp. 28, 31, 41, 43, 48, 50–51, 77, 79). Characterizing the works of Richard Wagner, Guy Ropartz and Claude Debussy, d'Indy builds a link between "the order of feeling" (*l'ordre du sentiment*), a specific idea and its embodiment in music. For example, in *Die Meistersinger von Nürnberg*, the "idea of youth" is associated with the emotion of "ardor" (1930, p. 28) and is expressed in various rhythmic and melodic modifications of the original leitmotif, including a whimsical shift of accents, the inclusion of pauses and chromaticism (1930, pp. 29–30).

[8] "Lavignac touches on various topics relating to the idea of key characteristics: acoustics, musical perception, tonality, instruments, counterpoint, harmony, esthetics and the history of music" (Ishiguro, 2010, p. 86).

thereby noting their special abundance and striving to embody the same logic in his own compositions, which he himself defined as "Wagnerian" (*Le chant de la cloche*, *Fervaal*, *L'Étranger*, *La légende de Saint Christophe*; see 1930, p. 66; 1950, pp. 202, 210, 216–217).

Table 1. Tonal construction of *Tristan und Isolde* according to d'Indy (italics were set by the composer[9])

UT et *la*, tons de *l'amour* par enchantement, appliqués plus spécialement au *philtre* d'amour: Dans la grande scène du second acte, l'un de ces deux tons est généralement affecté plutôt à Tristan, et l'autre à Isolde	C major and *A minor*, the keys of *love* by enchantment, applied more particularly to the love *potion*: In the great scene of the second act, one of these two keys is generally assigned rather to Tristan, and the other to Isolde
LA : *passion*	A major: *passion*
SI : *passion exaspérée*. Ce ton sera celui de la fin de l'œuvre ; il y exprimera la plénitude de l'amour	B major: *exasperated passion.* This key will be that of the end of the work; it will express the fullness of love
LA bémol : *repos, calme*	A-flat major: *repose, calm*
fa : prostration, désespoir et une général *dépression*	*F minor*: prostration, despair, and a general *depression*
ut : presque uniquement réservé à la *fatalité* (quelquefois angoisse ou colère)	*C minor*: almost exclusively reserved for *fatality* (sometimes anguish or anger)
SI bémol : héroïsme, chasse (au 2e acte)	B-flat major: heroism, hunting (2nd act)
ré : ton triste, spécial au roi Marke	D minor: sorrowful key, specific to King Mark
FA : *fidélité*, obéissance (Kurwenal), et aussi urbanité, courtoisie	F major: *fidelity*, obedience (Kurwenal), and also urbanity, courtesy
RÉ bémol : illusion volontaire (accessoire)	D-flat major: voluntary illusion (accessory)

The extramusical meanings that d'Indy associates with each significant key can be categorized based on their method of formation and the type of response they elicit from the listener.

1. a) The phenomenon's essence or its image constitutes the genuine signified: for example, in Gluck's *Alceste*, "distant key" (*un ton éloigné*), "B major [is reserved] to characterize the oracle, who logically had to be very different from everyone else" (d'Indy, 1950, p. 64). Another example can be found in d'Indy's *La légende de Saint Christophe*: E major is connected with the specific image of mountains and, later, the heavenly homeland (*la patrie céleste*; 1950, p. 216).

b) Generalizing categories and characteristics (such as holiness, obedience, treachery) also appear as correlates of tonality. They are shaped by the specific staging, the text, and plot developments, and they require *intellectual engagement* from the listener.

2. a) Feelings (sadness, joy, hatred, etc.) as well as nuanced emotional ideas (like passion, fatality, heroism, calm) and b) synesthetically elaborated characteristics (radiant, cold, freshness, etc.) emerge as correlates of the keys. These are designed primarily in relation to the listener's instantaneous reaction and their direct psycho-emotional perception of the sound of the tonalities employed. This primary, instantaneous perception is converted into a lasting feeling. It is developed according to a scheme proposed by d'Indy in relation to the very essence of each art form (not only music): *l'impression — le sentiment — l'émotion — la passion* (instant perception — feeling — emotion — passion, d'Indy, 1912, p. 12). Since, in this case, the composer talks about an algorithm inherent to the aesthetic perception of any person, he cannot disregard the individuality inherent in aesthetic and perceptual experience. Consequently, each key is endowed with multiple layers of meaning, contingent upon the ideological framework of a given work—as interpreted by d'Indy himself, whose analytical readings of other composers' works are filtered through his own perceptual lens.

At the same time, d'Indy's development of this perceptual algorithm reflects a conscious engagement with the continuity of historical musical thought. He elaborates on ideas about the impact of keys which had gradually been developed throughout the Baroque era and were reinterpreted in the 19th century. It is worth pointing out here that this concept is contradictory by nature, and its ulterior contradictions turn out to be partly characteristic of the turn of the 19th–20th centuries. The impact of various temperament systems and timbral representations on tonal colour, in particular, could warrant detailed examination; however, d'Indy refrains from addressing this aspect.

[9] The composer's use of italics reveals the logical emphases he intends, highlighting the concepts he deems most significant and the tonal centers he considers fundamental to the work's dramaturgy.

Harmonic dualism as a source of the semantics of keys

As a staunch follower of Riemann, d'Indy relies on the concept of the dualism of major and minor in the truest sense of the word[10]. He considers minor to be a consequence of "the resonance of the lower tones" (*la résonnance harmonique inférieure*; d'Indy, 1912, pp. 96, 98) and builds a sequence of functions in opposition to the major key. Even Riemann did not go that far in his theory and did not propose a total functional inversion[11]: in A minor, the D minor triad is interpreted as dominant, and E minor as subdominant (d'Indy, 1912, pp. 110–111). However, d'Indy, like Riemann, interprets minor triads as structurally inverted formations, conceptually derived from upper to lower, which leads to confusion in his reasoning when he analyses a piece of actual music, rather than a theoretical construction[12].

D'Indy was convinced of the acoustic authenticity of the complete inversion between major and minor[13]. At the same time, judging by the epithets found in his texts, the composer did not lose sight of the reality and regularity of spatial, kinaesthetic, temperature-related, colour-related, cross-modal correspondences, amongst others. From this foundation, the composer derived a complete semantic opposition; 1) between major and minor[14]; 2) between upward and downward motion within "the circle of fifths" (*l'ordre cyclique des quintes*, 1912, p. 130). This binary opposition becomes central to the system of key relationships he constructs, which, in turn, governs principles of modulation (harmonic development) and directly influences the expressive character of music.

Thus, moving along the chain of ascending fifths (*la quinte aiguë* as a measure, d'Indy, 1912, p. 130) results in keys with an increasing number of sharps. This progression creates "an expressive effect that can be compared to an ascent toward light, symbolizing a sense of luminous expansion" ("*l'effet expressif est comparable à la montée vers la lumière, à l'expansion lumineuse*", d'Indy, 1912, p. 130). Movement towards the flats, on the contrary, generates an effect that "could be compared with a fall into darkness, with a concentration of obscurity" ("*est comparable à la chute vers les ténèbres, à la concentration dans l'obscurité*", d'Indy, 1912, p. 130). By adding harmonic dualism to these basic attitudes, d'Indy proposes a general law: movement towards the dominant produces enlightenment in major (as it goes up in fifths) and "darkening" in minor (as it goes down in fifths; note that the D minor triad in A minor is interpreted as dominant), whereas motion toward the subdominant produces the reverse effect.

From a theoretical point of view, d'Indy may well have relied on Riemann's ideas. The German musicologist proposes this generalization: "Each key, through its type of derivation from the fundamental scale (that is, through the fifth and third chains in ascent and descent), has a particular character. To define it briefly, all steps upward make the character brighter and more radiant, while all steps downward make it darker and cloudier. Since major — as opposed to minor — already has a bright and radiant effect, the brightest keys are the major keys with many sharps and the darkest are the minor keys with many flats" (in Ishiguro, 2010, p. 62).

[10] It should be noted that the real "inverse minor" is the Phrygian mode, since it is the descending scale that is the exact reversal of the major ascending scale. See d'Indy's scales (1912, p. 102). In French tradition, it was Jean Adam Serre who also addressed the problem of the origins of the minor and its "mirror" qualities in relation to the true major in the 18th century (see Sekimoto, 2007, pp. 7–13). However, in the real Phrygian mode there are no functions of dominant and subdominant, as in tonality, because this mode is melodic in its origin; the functional system is formed on other principles.

[11] In addition, d'Indy mentions Arthur von Œttingen's theory of two resonances (1912, pp. 140–141).

[12] See, for example, his own analysis of the main theme of the third part of his Second Symphony (d'Indy, 1933, p. 176).

[13] Concerning Serre's solution of this problem, which anticipates d'Indy's ideas, see Sekimoto, 2007, pp. 13–18.

[14] This can be viewed as a reinterpretation of Baroque ideas, for example in Quantz: "Major is generally used to express the gay, the bold, the serious, and the sublime; minor for caressing, sadness, and tenderness" (cited in Bodky, 1960, p. 229). An additional source of ideas about the semantics of keys could be related to the works of Johannes Mattheson (his name is mentioned in d'Indy's treatises, but in the context of polyphonic techniques; see 1909, pp. 30–31). "In the midst of all this theorizing about the relationship of words and music, thought and emotion, the composer and critic Johann Mattheson (1681–1764) addressed the expressive capacities of instrumental music on a more technical level, proposing that music was a language with its own syntax and semantics" (Bonds, 2014, p. 66).

From a practical point of view, d'Indy's light-dark associations were quite possibly influenced by the synesthetic experiences of his teacher César Franck, for whom, according to d'Indy's memoirs, B major represented an "absolutely luminous" key (*absolument lumineuse*), while F sharp major corresponded to "the heavenly light" (*la lumière paradisiaque*) and "the sparkling clarity" (*la scintillante clarté*; 1906, pp. 100, 198, 204). In *Rédemption,* A minor is interpreted as a "dark tint" (*teinte sombre*), and in *Les Béatitudes,* C minor is connected with Satan (*le prince des ténèbres*; d'Indy, 1906, pp. 125, 207). These associations align with d'Indy's idea concerning the "clouding" of tonal semantics when moving down through the circle of fifths.

Corresponding characteristics of these keys (B major, F sharp major) are observed, for example, in *L'Étranger*, *Fervaal,* and *La légende de Saint Christophe*: in the first case, B major appears as the key of glory, whereas, in the second, as the key of heroism and in the last—as a characteristic of the true development of spirit. F sharp major is reserved for holy love (d'Indy, 1950, pp. 202, 210, 216–217).

D'Indy even entitles the keys as "musical tints" (*teintes musicales*, 1906, p. 124). By causing stable cross-modal correspondences associated with the parameters of lightness and brightness, the keys are thereby interpreted as synesthetic triggers. This method of arousing listeners' reactions would later be in demand by Olivier Messiaen, who develops his modes of limited transposition not only as harmonic, but also as colouristic structures (Wai Ling, 2010, p. 21). Such ideas are rooted not solely in the synesthesia of composers, but also in the judgments regarding the different properties of colours and their effect on the human psyche.

Thus, d'Indy's dualistic concept partly resonates with the innovative colour theories developed throughout the second half of the 19th century, which were based on the idea of a chromatic circle resembling a tonal circle. One can cite the theories of Eugène Chevreul (Gage, 1990, p. 530) and Charles Blanc. For Blanc, the extreme points on the chromatic circle are complementary colours, which in total yield white (the additive principle, "*Loi des couleurs complémentaires*" (1876, p. 562)) and which are as far apart from each other as possible. They contrast with each other, symbolizing struggling opposites — like sharp major and flat minor. Blanc himself said that colour in painting is the same as harmony in music (1876, pp. 22–23). Van Gogh's paintings served as a brilliant embodiment of Blanc's theory: the artist read Blanc's texts and even looked for the most contrasting colours using balls of thread (Veldhorst, 2018, p. 140); (Vellekoop, 2014, pp. 246–249). His goal was to awaken opposing feelings in viewers by endowing additional colours with opposite semantics (see in detail Haziot, 2007, pp. 83–84, 197, 213–214, 220–221, 263–264, 297–299, 307, 309)[15].

The most distantly related keys form similar opposites — the polar points of the circle of fifths, spaced by a tritone. Integrating this principle with the fundamental dichotomy between major and minor results in a formula that produces the most salient contrast in sound and semantic dimensions, especially when keys are compared directly: (sharp) major + (flat) minor, separated by a tritone. This formula can be revealed by analysing d'Indy's judgments on *Parsifal*: "the tone of D minor remains reserved for the idea of *death*" (1930, p. 51), while its "opponent" appears to be in A flat major, corresponding to "the idea of holiness" (*l'idée de sainteté*) (1930, p. 51). D'Indy takes an identical pair of keys as the basis for his *Le Chant de la Cloche*: for embodying wildfire and death respectively—creative energy and life. The substitution of G sharp major with A flat major—despite undermining the fundamental sharp (major) versus flat (minor) opposition—is justified by the principle of enharmonic equivalence and the practical limitations associated with keys involving double sharps.

This principle of enharmonic equivalence, as can be easily demonstrated, contradicts the concept of opposites of flat and sharp tonal spheres, and the very idea of equal temperament, from which enharmonic equivalence follows and which therefore should negate the semantics of tonalities. This problem greatly worried Albert Lavignac, whose views d'Indy also took into account. In the work *Music and Musicians* Lavignac claims that he does not understand why the semantics of tonalities remained in an era of equal temperament, but he accepts this as fact (1938, pp. 423–426).

On the one hand, a reason that may be inferred from Lavignac's own text is the partial or incomplete opposition between major and minor modes, which violates the symmetry of the well-tempered system in terms of both acoustics and the psychology of perception (and hence the effect of tonalities on

[15] On Van Gogh's implementation of the phenomenon of a symphony of colours see Veldhorst, 2018, pp. 137–145.

the psyche). Unlike Riemann, who was a dualist, Lavignac emphasizes the artificiality of the minor scale and compares it to a greenhouse plant, specially bred and therefore bizarre, but somewhat "sick" (*malade*, Lavignac, 1938, pp. 58–59). From this analogy, it is easy to deduce the negative semantics of a minor key, replete with a variety of emotional nuances that can be associated with the idea of suffering and illness. Moreover, Lavignac's scheme reflects the logic that is consistent with d'Indy's ideas: the more flats a minor contains, the darker it becomes, which reaches an almost "lugubrious" (*lugubre*) psychological character—A flat minor, the extreme point (Table 2). Besides the neutral D minor, all other minor keys have negative semantics. In this regard, Lavignac proves to be more consistent in his approach than d'Indy.

Nevertheless, in the works of the latter, certain tonalities occasionally assume meanings that closely correspond to those proposed by Lavignac. For example, in *Le Chant de la Cloche* F minor becomes the key of deep sorrow, symbolizing the protagonist's suffering after the death of his beloved (see the beginning of the fourth scene). The use of F minor can be explained by the influence of the opening bars of the third act of *Tristan*, and the obvious similarity of the melodic structure of musical motifs. In *L'Étranger,* this key is connected with the idea of fatality (d'Indy, 1950, p. 210). However, d'Indy's ideas about the semantic possibilities of a minor are quite diverse, for instance in *Fervaal* in F minor he describes Celtic ceremony (see d'Indy, 1950, p. 202), which could well be due to his familiarity with both the Baroque tradition of semantics of tonalities[16] and its interpretation by Riemann (Ishiguro, 2010, pp. 62–76).

[16] Compare, for example, d'Indy's interpretation of F minor with this description: "F minor was felt by Mattheson to be mild and relaxed, yet at the same time profound and heavy with despair and fatal anxiety" (Lenneberg, 1958, p. 236). In *L'Étranger* F major serves to express the idea of charity (d'Indy, 1950, p. 210), and Mattheson believes that this key "is capable of expressing the most beautiful sentiments, whether these be generosity, steadfastness, love, or whatever else may be high on the list of virtue" (Lenneberg, 1958, p. 235).

[17] As with the first table, Lavignac's original notation is preserved—firstly, because it conveys his uncertainty regarding the semantics of tonalities; and secondly, because it clearly illustrates two opposing vectors of semantic movement: one toward sharp keys, and the other toward flat keys.

Table 2. Tonal semantics according to Albert Lavignac (1938, p. 424). The question marks are set by Lavignac (perhaps they indicate semantic ambiguity[17])

UT# majeur : ?	C# major: ?
FA# majeur : rude	F# major: rude
SI majeur : énergique	B major: energetic
MI majeur : éclatant, chaud, joyeux	E major: bright, warm, jovial
LA majeur : franc, sonore	A major: frank, sonorous
RÉ majeur : gai, brillant, alerte	D major: joyful, brilliant, buoyant
SOL majeur : champêtre, gai	G major: rustic, joyful
UT majeur : simple, naïf, franc, ou plat et commun	C major: simple, naïve, frank, or flat and common
FA majeur : pastoral, agreste	F major: pastoral, rustic
SI ♭ majeur : noble et élégant, gracieux	B ♭ major: noble and elegant, graceful
MI ♭ majeur : sonore, énergique, chevaleresque	E ♭ major: sonorous, energetic, chivalrous
LA ♭ majeur : doux, caressant, ou pompeux	A ♭ major: gentle, caressing, or pompous
RÉ ♭ majeur : plein de charme, placide, suave	D ♭ major: full of charm, placid, suave
SOL ♭ majeur : doux et calme	G ♭ major: gentle and calm
UT ♭ majeur : ?	C ♭ major: ?
La# mineur : ?	A# minor: ?
Ré# mineur : ?	D# minor: ?
Sol# mineur : très sombre	G# minor: very dark
Ut# mineur : brutal, sinistre ou très sombre	C# minor: brutal, sinister or very dark
Fa# mineur : rude ou léger, aérien	F# minor: harsh or light, airy
Si mineur : sauvage ou sombre, mais énergique	B minor: savage or dark, but energetic
Mi mineur : triste, agité	E minor: sorrowful, agitated
La mineur : simple, naïf, triste, rustique	A minor: simple, naïve, sorrowful, rustic
Ré mineur : sérioux, concentré	D minor: serious, concentrated
Sol mineur : mélancolique, ombrageux	G minor: melancholic, gloomy
Ut mineur : sombre, dramatique, violent	C minor: sombre, dramatic, violent
Fa mineur : morose, chagrin, ou énergique	F minor: morose, sad, or energetic
Si ♭ mineur : funèbre ou mystérieux	B ♭ minor: funereal or mysterious
Mi ♭ mineur : profondément triste	E ♭ minor: deeply sorrowful
La ♭ mineur : lugubre, angoissé	A ♭ minor: lugubrious, anguished

Thus, one could assume that this preservation of key semantics in the era of equal temperament was due to cultural memory—if this concept had existed in Lavignac's time. Is this not, in essence, what d'Indy invokes when he traces the stabilisation of the principle of significant tonalities from Gluck to modernity? In developing the harmonic symbolism evident in his own compositions, does he not, in fact, draw upon the long-standing tradition of key interpretation that dates back to the Baroque? This tradition is reflected in the extra-musical meanings he attributes to specific keys within each dramatic work. Might this be the very reason why d'Indy applies the concept of *significant keys* within the realm of musical drama—namely, that the verbal dimension serves to articulate extra-musical meanings already historically encoded in the selected tonalities? After all, due to the initially unequal temperament and the convenience of using a particular key for a particular instrument (and hence the individual timbre and register colouring of a key), these extramusical meanings have already separated from the musical means that originally generated them. From this point of view, the concrete correlation between an "extramusical meaning" and a *significant key*, as well as the principle of such correspondences, shift from the category of psychoacoustic (perceptual) phenomena into the category of real cultural symbols conditioned by tradition and memory.

Conclusion

For d'Indy and his contemporaries, harmony constituted the foundational principle of musical structure and expression, rooted in the belief that harmony is inherent in nature (Saint-Saëns, 1922, p. 19). "In these modern days, harmony is the flesh and blood of music, rhythm is the ossature on which it is built up, and melody is its epidermis" (Saint-Saëns, 1922, p. 16). Saint-Saëns argued that even a chord sequence can produce an interesting melody (as in *Ange si pur* from Donizetti's *La favorita*), and that some melodic lines, such as in the *Sehnsuchtsmotiv*, lack a characteristic expressiveness in themselves: harmony alone gives them brightness and originality (1922, pp. 18–19). In d'Indy's interpretation, the famous "Tristan chord", together with the resulting harmonic sequence, is an example of a "generative" harmonic cell (1909, pp. 234, 238). By generating a chain of "leading motifs", this cell shapes not only the structural features of the work but also its stylistic character, thereby directing its affective impact on the audience.

In d'Indy's view, harmony is a factor in the formation of an innovative musical manner, not only in the modern era, but also, in principle, at any turning point in musical history. He draws attention to the polyphony of the 14th century, and the discoveries of Gluck and Rameau, who dared to introduce "certain enharmonic passages", as well as the work of Bach, Beethoven and Wagner, stating that "each inaugurated a new style that would inevitably lead to a modification in the other two musical elements: melody and rhythm" (d'Indy, 1930, pp. 45–46).

It follows that a special sensitivity to tonal colouring can also give rise to vivid stylistic experiments: the author can be guided by synesthetic representations and experiences, elaborating a tonal plan of composition. In this respect, d'Indy's ideas partly anticipate those of Olivier Messiaen, with his clusters of multicoloured chords, whose lightness, saturation and brightness depend on register, timbre, and method of sound production (see, e.g., Wai-Ling, 2010, pp. 20–21). In addition to the practical, "authorial" implementation of cross-modal correspondences, the concept of *significant keys* resonates with the vector of theoretical reflections on the nature of aesthetic perception, characteristic of Lavignac, who sought to find the "mysterious law" (see Ishiguro, 2010, pp. 78–79) that governs the semantics of tonalities *in toto*.

This is not to say that d'Indy himself was capable of this. By deducing the correlations between Wagner's keys and feelings and ideas, he rather groped for the algorithm of semiosis, which he applied in his own compositions. Focusing on his own feelings (in the case of aesthetic perception, it is impossible not to be a subjective idealist) and on Tradition, he outlined the range of those experiences and images that could be linked to a specific tonal colour, according to a dualistic concept multiplied by the opposition of sharp and flat keys. An additional factor in the development of semantics could be the degree of relationship of a particular key with the other key chosen as the main one, that is, as the semantic core of the work. For example, in *La légende de Saint Christophe* B minor is used, the key of the protagonist before he was baptized and found God; F sharp minor is interpreted as the key of the search for holy love, and D major as the key of sanctity (d'Indy, 1950, p. 216). The semantics of tonalities thus becomes the real code for understanding the process of semiosis in d'Indy's work.

The composer's concept is representative of the *fin de siècle* era. Firstly, it is grounded in the paradigm that "music is a language", which was still relevant

at the turn of the 19th–20th centuries and promotes the interpretation of a work as a message, and its components as signs, the combination of which allows this message to be transmitted to a recipient. Secondly, this concept contributes to the history of musical semantics, whose origins can already be seen in the ancient idea of the ethos of modes, and which became especially relevant precisely in the era of Romanticism, with the development of "descriptive" symphonic music (since it is, in this case, that music *de facto* must correspond to a whole complex of extra-musical meanings in order for the work to be realized as an artistic whole). Ultimately, the specific meanings ascribed to "significant keys"—developed with regard to acoustic and harmonic dualism—render d'Indy's concept a compelling example of combining semantics with relevant concepts in the field of acoustics and harmony during his time. As such, it exemplifies a holistic approach to musical theory and practice. This approach, as both an analytical and practical strategy in itself (adjusted for the huge evolution of ideas corresponding to acoustic phenomena and the very essence of music), was in demand and remains so even in our time, which furthers its value and relevance.

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Sound Mass Music in the Light of Cognitive Transmedial Narratology

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Abstract

This paper examines the narrativity of sound mass music, focusing on works by Edgard Varèse, Witold Lutosławski, and Krzysztof Penderecki. It adopts a transmedial, cognitive approach, arguing that narrative categories such as agent, space, and storyworld are not medium-specific but are high-level cognitive schemas stored in long-term memory. The analyst constructs mental representations of these categories through the process of narrativization, organizing textual signs from music to interpret and expand existing cognitive schemas.

Sound mass music, characterized by unpredictable processes and the absence of linear progression, poses unique challenges for narrativity. The paper explores how multiple temporal dimensions, as articulated by Jonathan D. Kramer's concept of multiply directed time, can be interpreted in post-tonal music. Rather than following a straightforward chronological order, these works create narrative through disruptions, interruptions, and reordering of time, activating universal narrative patterns. The research emphasizes the cognitive processes involved in recognizing and synthesizing these multiple temporalities. Discontinuities in the music require listeners to mentally merge non-chronological events into a causal, coherent sequence. This act of mental configuration mirrors the plot's construction, drawing on Ricoeur's method of narrative construction. The paper also explores the potential of specific plot types, such as agonistic, ludic, and ritualistic, in interpreting the narrative of these works. By applying an interdisciplinary approach, this study lays the groundwork for future research that incorporates insights from other fields, offering a deeper, more nuanced understanding of the narrativity in sound mass music and expanding its hermeneutic potential.

Keywords: sound mass, temporality, linearity, cognitive transmedial narratology

Introduction

This study originated from an interest in examining how music, which organizes its temporal flow through sound masses—discrete blocks of sound that resist decomposition into individual components—conveys meaning. It challenges the view that sound mass music is static and non-teleological by emphasizing its temporal dimension, aiming to understand its meaning through the lens of linearity and purposiveness. In this context, the study primarily explores the narrative potential of this music. The initial idea for this research emerged from analysing the music of Witold Lutosławski, who described his works as narratives, developed through the concept of action (akcja) as a specific musical plot (Reyland, 2005). In post-tonal contexts, Bergson's notion of mental synthesis is crucial for understanding processes, as key events in a work are often presented in a non-chronological manner. Jonathan D. Kramer describes contemporary music as characterized by the fact that its most visible and significant connections do not occur between adjacent events in time (Kramer, 1973, 142; Kramer, 1988). This interplay between the objective sequence of events (the "time of the work") and our mental synthesis, which supports non-objective sequences, gives rise to new forms of temporality. This relates to Bergson's "energetic effort of analysis" and Boulez's "active analysis," both of which highlight the role of mental synthesis in interpretation. Thus, the interaction between surface and deep temporality allows for interpretations of both the time of discourse and the narrative time in these works.

This work highlights the significance of cognitive transmedial narratology as both a theory and a method. It emphasizes its theoretical-conceptual and methodological foundations to underscore the transmedial reconceptualization of narrative and narrativity as transmedial phenomena. The study proposes a new methodology for analysing sound mass music as narratives and offers a classification of approaches to working with sound masses. This classification is based on structural and semantic plot typologies, identifying plot as a fundamental narrative category.

The musical medium functions as a communication model, facilitating the conveyance and interpretation of meaning between the creator and the receiver, effectively conveying the intended message from one to the other. As a semiotic form of expression, music belongs to the semiotic category of media, whose sensory configurations we first perceive ("mediation", presemiotic phenomena) and then cognize in terms of recognizing the activation of the sign's function during semiotic activity (cognitive import) (Elleström, 2019, 23). This illustrates the phenomenon of "representation" (semiotic phenomena), and for a particular media product to communicate meaning, it must provoke interpretation. (Elleström, 2019, 5, 13, 22; 2020, 2; 2014, 16–17). Comprehending the presented "cognitive import" within a given medium, as well as shaping the process of semiosis, is intrinsically connected to and influenced by the interpreter's prior experiences, namely, their knowledge, expectations, memories, and values. In this context, the (pre)knowledge, experiences, memories, beliefs, or "stored mental entities", as collectively described by Elleström (2019, 24–25), may originate from the interpreter's prior encounters with the same medium, other media, or generally from their experiences in the world. In this manner, the author engages with the aspect that Paul Ricoeur identified as the first stage of mimesis in his exploration of the narrative (Ricoeur, 1983).

Transmediality of the narrative

Transmediality encompasses phenomena that are not limited to any single medium; rather, these phenomena generate meaning independently (Rajewsky, 2005, 46; Wolf, 2002, 18). The prefix "trans" in "transmediality" should not be interpreted merely as the transfer of phenomena from one medium to another, but as a transgression of boundaries that enables these phenomena to exist independently of any specific medium. As independent entities, they can be found across multiple media, realized in circumstances and ways unique to each medium, creating meaning within a given medium rather than in relation to others. Following in the footsteps of Claude Bremond, who in the mid-twentieth century introduced a transmedial perspective, the study of narratives was expanded (Bremond, 1964). Bremond emphasized that a story, or any form of narrative message, is independent of the medium through which it is conveyed. This perspective has led to the exploration of other phenomena as transmedial. As a result, narratology has developed into a discipline that transcends the boundaries of individual media. Thus, all the components of a story—characters, events, temporal-spatial perspective—can also be interpreted as transmedial phenomena. The perspective articulated by Marie-Laure Ryan, in which a semiotic object can realize its narrative potential in two ways—either by "being a narrative" or by "possessing narrativity"—allows narrativity to be recognized both as a phenomenon and a quality in media products that are traditionally not considered narratives (Ryan, 2005, 6–7). If any media product can evoke a narrative schema or a macro-framework of narrativity in the observer's mind and stimulate narrativization—reading as a narrative—then it can be said to "possess narrativity". Narrativity, as a characteristic of a narrative text, is hierarchically placed at the level of the story, within the framework of narrative meaning, rather than at the level of discourse, i.e., semiotic encoding.

If the transmedial identity of a narrative is read from the signified—underlying structures of an immutable nature—then the narrative can also be viewed as a cognitive pattern created independently of the signifiers. This mental framework of the narrative entails constructing a mental model of a "storyworld" inhabited by characters who actively shape the course of events and are simultaneously influenced by those changes (Herman, 2009, 106–107). The interpreter uses signs in the text to construct mental representations of worlds or models of situations and events. They then identify the constitutive elements of these worlds, which can also be considered transmedial phenomena. By relying on media-specific signs pertaining to the narrative's textual dimension, the interpreter identifies characters, events, their chronology, and the temporal and spatial dimensions in which these characters exist and in which events and changes occur. This process represents the narrative's cognitive dimension.

The cognitive approach to constructing the concept of a character involves recognizing that the storyworld is perceived as a real world and that characters within it are also considered real entities. These characters, whether human or anthropomorphic entities with human-like qualities such as desires, will, and intention, are understood to have their distinct presence within the narrative. The cognitive aspect of understanding a character as a "text- or media-based figure in a storyworld", or as a participant "in storyworlds created by various

media" (Jannidis, 2009, 14), is also examined through the process of "characterization", which involves attributing certain traits to the character. The process of characterization reflects the active role of the reader in constructing a character and understanding its significance within the narrative by using their own stored cognitive frameworks and applying them during interpretation. Readers interpret a particular character in a specific way, viewing it as a coherent conceptual unit. Thefore, the cognitive approach views characters as textually based mental models of possible individuals, constructed in the recipient's mind.

The role and typology of sound masses

The cognitive construction of the character has been guided by examining the role that the sound mass, as a unique sonic domain defined by pitch, register, and instrumentation, plays in structuring the musical flow of selected compositions. The sound mass is identified as a "referring expression" (Margolin, 2007, 76), an entity that demonstrates uniqueness within the musical flow, maintaining coherence of properties and identity, or temporal continuity throughout the entire piece (considered as a narrative), despite any changes it may undergo. As an active agent within the musical storyworld, the sound mass guides the development of various processes, influencing the emergence of events and changes in state, while simultaneously being shaped by these transformations. By analysing the formation of sound masses in nine selected works by three composers (Edgard Varèse: *Hyperprism* /1922–23/, *Octandre* /1923/, *Intègrales* /1924/, Witold Lutosławski: Symphony No. 2 /1965–1967/, *Livre pour orchestre* /1968/, *Double Concerto* /1980/ and Krzysztof Penderecki: *Dimensions of Time and Silence* /1960-61/, *De Natura Sonoris no. 1* /1966/, *De Natura Sonoris no. 2* /1970/), including the number of instruments and lines that constitute them, their interactions, and the goal-directed processes they govern, it is possible to propose a paradigm-based sound mass typology on three levels, using two criteria: perceptual and cognitive. The first level, or the textual layer, consists of a single instrumental line that develops horizontally and, in further development, can become part of a sound mass as a block. The second one is the level of the sound mass as a "textural block", composed of two or more "textural layers" or planes. The third one is the level of the sound mass as a textural "superblock", consisting of two or more "textural blocks" (cf. Chomiński, 1977, 201, 206; Masłowiec, 2008, 79; Ilišević, 2023, 23–53). Multiple planes, regardless of whether they belong to the same group of instruments, can unite in movement towards a common goal, alongside processes they govern independently. By recognizing the shared processes they engage in, these planes are then identified as parts of a sound mass as a block. Similarly, multiple sound masses as blocks can collaborate in a common process, forming a sound mass as a superblock. Understanding the processes by which sound masses navigate at various hierarchical levels is essential to comprehending the proposed typology. Consequently, sound masses, through their activities and the processes they govern toward diverse objectives across various levels, along with the relationships they establish with one another, significantly shape the temporal perspective of the compositions under analysis.

The typology of sound masses can be related to Aleksandar Pejčić's (2019) actantial model and to his semantic and structural typology of plots. Pejčić enhances the discussion of character by introducing a dynamic model of interstructure. This interstructure is positioned between the deep structure of the actantial model—inhabited by general agents of action (subject, object, helper, opponent, sender, and receiver)—and the surface structure, which is occupied by specific characters and actions. The interstructure of Pejčić's model serves to translate the deep structure into the surface structure through interstructural figures of a transformational nature. These figures include the subject, object, corrector, instigator, director, trigger, and static figure. They facilitate the transition from the abstract domain of actants to the concrete surface structure, where they become involved in actions and character activities. In the proposed model, sound masses occupy the interstructural figures and function as characters based on their activity and direction of action. The dominant sound mass, which governs the majority of processes within the work and serves as the main agent in the musical narrative, assumes the role of the figure of the subject. This dominant sound mass corresponds to the actant subject in the deep structure. The prevailing sound mass is characterized by its intent to shape the progression of the entire musical activity. The activities of other sound masses are organized around it, with their roles delineated in relation to it; they either support its objectives or impede its progress. This primary sound mass pursues local goals associated with specific musical elements. The quantity and nature

of these goals, along with the methods employed to achieve them, enable the interpretation of these action structures as linear, parallel, nested, intersecting, fan-shaped, and so forth. These goals are achieved through the pursuit of resolving the global problem knot, which unveils the narrative's semantic level and encompasses themes such as change, growth, development, and antagonistic relationships.

Results

The analysis revealed that the most common structural type of plot among the selected compositions is the linear type. This type features the activity of a single subject figure focused on a single problem, without twists or escalating obstacles. Dynamism is achieved through the repetition of specific actions and counteractions. Five out of the nine compositions displayed these characteristics. Conversely, the dominant semantic type identified was the ritual plot, with seven out of nine compositions displaying this symbolism. All three of Varèse's compositions exemplify a linear structure and are characterized by a ritual semantics, portraying the symbolism of change. This aligns with Varèse's compositional poetics, which he metaphorically describes as a process of crystallization (MacDonald, 2003, 148). The overall form of the work, including its recognized plot, originates from a single generic cell or primary plane as the main character, the subject figure presenting this idea. This idea is then "projected" into vertical and other dimensions, undergoing various transformations. This process reveals ritual semantics as the dominant semantic core. Penderecki's works are characterized by a relatively small number of sound masses, which he treats primarily as perceptual categories. These sound masses are often homogeneous and exhibit a high degree of independence, unlike those in Varèse's works. In Penderecki's compositions, sound masses typically complete their processes independently and undergo few transformations. This approach creates an environment conducive to the semantics of competition and conflict. Among the analysed works, only Penderecki's compositions feature the agonistic semantic plot types. In these works, conflict, struggle, and competition are depicted through a soundscape with two distinct timbres that do not blend. Listeners remain continuously aware of two separate blocks of sound that develop independently. The conflict begins with the collision of these sound masses, where one penetrates the other, leading to the transmutation of one of them. The most complex actions occurring across two plots are found only in the works of Lutosławski. These compositions, written for the largest ensembles and significantly more extensive than the others, are unique in featuring two intersecting plots. The complexity arises from the activity of numerous sound masses that occupy nearly all the figures of the interstructure. This complexity can be linked to the concept of "akcja" as a purely musical plot, which the composer sought to achieve in his works.

Conclusion

By moving beyond a purely formalistic approach, the proposed poetics of the plot provides a methodological foundation for a deeper, more meaningful understanding of the selected compositions. The cognitive-transmedial narratological approach to analysing sound mass music proves effective, as it provides insights into how this music conveys meaning through both semantic and structural plot types. Sound mass music is realized through unique, work-specific temporal profiles as well as through transmedial qua universal narrative patterns. This allows it to activate a narrative framework in listeners' minds, revealing deeper linearities and configurations within the plots of the analysed works. The approach demonstrates that different plot structures and semantics, as cognitive semantic patterns, are fundamentally universal and independent of the verbal medium. Understanding their transmedial nature enhances our ability to listen to and comprehend music based on sound masses.

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Music Performance

Pianistic Action, Analysis and Motor Coordination Interdisciplinary Application in the Practice Organization

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Abstract

This paper presents part of the research conducted within an interdisciplinary framework, drawing particularly on arguments from motor coordination and biomechanics to enhance the efficiency and quality of pianistic performance, and examining technical strategies applied to instrumental practice. Essential conditions for achieving optimal results in instrumental music performance include knowledge of the bodily aspects involved in action, familiarity with the materials being manipulated (such as the score and the piano), and the organization of the process leading to the desired outcomes. The first condition focuses on understanding the performer's characteristics while the second involves grasping the specific content being rehearsed. The third condition, which is organizational, deals with developing and evaluating the repertoire. This topic has been addressed by researchers across various fields, including motor control, cognition, and performance practices, and is relevant to pianistic action and technical strategies. One example of this kind of correlation is the Movement Cycles and SMRD strategies (Simplification of Movement by Distances Reduction), both proposed by Póvoas (1999, 2006). The primary purpose of this research is to explore interdisciplinary concepts in practice and their impact on motivation during training, as well as the optimization of piano performance through continuous analysis of training and performing repertoire in specific performance musical situations, incorporating the planning of practice and the aforementioned strategies. Describing the issues raised, analysing the information, and diagnosing their causes should contribute to establishing criteria for selecting technical resources to address musical situations, leading to the optimization of pianistic action.

Keywords: pianistic movement, motor coordination, piano practicing, practice organization

Introduction

This research examines technical-instrumental strategies through an interdisciplinary approach. The primary goals are to explore how applying interdisciplinary principles to instrumental practice influences motivation during training, to establish connections between the musical material, technical exercises, and sound outputs, while incorporating Movement Cycles and SMRD strategies into practice planning, and finally to assess the impact of interdisciplinary knowledge on (1) motivation during practice and (2) performance optimization in specific musical tasks, based on results obtained from an experimental group. All strategies application depends on the musical components of a composition to be explored for an artistic realization with its detailed context characteristics.

The central hypothesis of this research is that the application of technical strategies informed by principles of motor coordination and biomechanics enhances the efficiency and quality of pianistic performance. Accordingly, the aim is to establish connections between the musical material, the practice of technical resources, and the resulting sound, incorporating them into the practice planning.

Theoretical context

In this section, we present several concepts that supported this research. Regarding the perception of time and space in communicative processes, Pinto (2010, p. 43) stated that, in a collective space, our body acts as a 'centre of action', adding that movement is perceived as a type of individual action in the context of relationships between the self and the environment. There is a mutual exchange, since the body receives and returns movements in this relationship. In addition, Davidson and Correia (2002, p. 239) explain that, because all bodies are involved in musical production, motor programs must be well established. However, they emphasized that the body is much more than a mechanistic source of input and output. They highlight the fact that, just as there is a wide variety of situations for

musical performance, there are also movements and gestures to meet the needs of performance. Referring to Shaffer (1982, 1984), they noted: "[In] his studies on the skilled performances of typists and pianists, Shaffer explored how motor programs are structured."

Addressing the organization of knowledge and its influence on cognitive abilities, in the Brazilian edition of Sloboda's *The Musical Mind: The Cognitive Psychology of Music* (2008, p. 12), it is mentioned that "The 1970s saw the field expand in multiple directions, with growing interest in higher cognitive processes, the control of complex behaviours". Regarding the organization of practice, if considered as a result of conscious mental and physical work of the body, according to Magill and Anderson (2017, p. 444), this combination will probably create conditions to improve learning and facilitate the application of strategies with their more complex characteristics, since it predisposes the execution of body movements with greater efficiency, aiming at optimizing performance.

The movement cycles application can also be considered from the point of view of gesture integration, presented as both technical and strategic resources for recognition and the acquisition of technical control to be used in building the musical interpretation, aiming to enhance its expressiveness (Juslin, 2003).

Piano planning and practice organization

In discussing piano planning and practice organization, certain conditions and steps are essential for achieving optimal results throughout the stages of instrumental development. This involves not only an understanding of the musical construction elements being developed, but also an awareness and perception of the bodily aspects involved in the action: specifically, the role of the body in expressing musical and artistic intention. Merleau-Ponty (1999, p.32) described the body as a "transmitter of messages." For him, "[the] body is the vehicle of being in the world", and he added: "it is as simple as that". These words point to a foundational idea that the body functions as the primary medium through which musical expression is realized. From this perspective, organizing practice also involves planning physical movements to address both technical and musical challenges, movements that are closely linked to the musical elements being developed and the corresponding sound. The process in this context constitutes an essential aspect of development, that depends largely on motivation.

Regarding motivation, Lehmann, Sloboda, and Woody (2007, p. 44) point out that musicians encounter 'multiple sources' of motivation throughout their lives, distinguishing between intrinsic and extrinsic sources. Although both are important in the preparation of musical-instrumental performances, the strategies applied to this process are considered intrinsic sources and should be considered essential in achieving technical and musical objectivity. The results come from a conscious bodily activity. Therefore, they allow for greater security and satisfaction during performance, which can certainly be experienced.

In general, people make music because of the enjoyment and fulfilment they get from it. However, because acquiring musical skill takes much time and effort, developing musicians also rely on extrinsic motivation, or secondary non-musical rewards that come with musical participation.

Within the context of the present research, assessment is considered from a formative perspective, according to Lebler & Harrison (2017, p. 93). In this way, an evaluation should reflect the result or "standard of the work more holistically than simply presenting correct elements and numbers". Thus, assessments may include both qualitative and quantitative analysis, with data cross-referenced from questionnaires.

The organization of training aims to guide musicians in optimizing and controlling actions (Davidson & Correia, 2002; Kohut, 1992), as well as the steps necessary to achieve the desired results. A system for organizing practice should provide the pianist with greater control over skills, which can be divided into two main categories: cognitive skills and motor skills. Cognitive skills refer to the complex set of mental processes (e.g., memory, perception, logical reasoning). Motor skills are actions, tasks, either simple and basic or complex, that can be performed with varying degrees of success (basic or fundamental, and specific).

It is worth noting that the spatial orientation of movements related to distance planning is also considered an essential technical resource in piano training. This is the reason why performing distant events on the keyboard can be defined as a matter of medium or high complexity.

Method

The organization of a skill refers to the relationship between its components. A skill has a high level of organization when its components are spatially and

temporally interdependent (Magill & Anderson, 2017, p. 432). Schmidt & Wrisberg (2001, p. 21) point out that, during the process of cognitive skills development, it is ideal to focus on strategy, namely, "how and which movement to perform", in order to improve performance know-how. This concept is applied here to musical-instrumental practice. The pianistic action is, in fact, a motor skill that requires voluntary movements of body parts to achieve musical objectives. According to these authors, healthy working conditions and the optimization of practice depend on the systematic organisation of training time through distributed practice sessions (Magill & Anderson, 2017; Schmidt & Lee, 2005; Bangert et al., 2013).

The schematic representation of practice organization, the necessary conditions, means, and materials is shown in Figure 1.

*** Knowledge and perception about:**
- elements of musical construction
- bodily aspects involved in the action

*** Planning of related bodily movements:**
- resolution of technical, musical issues (application of strategies)
- inherent sound qualities

*** Assessment:**
- of the process
- of outcomes

Figure 1. Organization of practice conditions schema

Movement cycle application

To operationalize the practice of this strategy, the direction of the movement of the segments is indicated by the cycle, whose shape and extent guide the movement and displacement of the segments along the X, Y, and Z axes (Póvoas, 2006, p. 666). The length of each line represents the displacement of the pianist's arms and fingers along the X coordinate on the keyboard. The upward or downward orientation of the arrows indicates movement in relation to the Y axis, while the concavity or convexity of the line's design guides movement in the Z axis, corresponding to the extension or depth of the key.

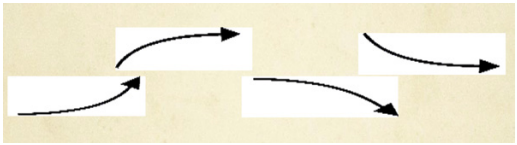

Figure 2. Arrows direction

This explanation is further illustrated by Figures 3, 4, 6, and 7. In Figure 3, we observe the directions of the coordinate axes relative to the keyboard.

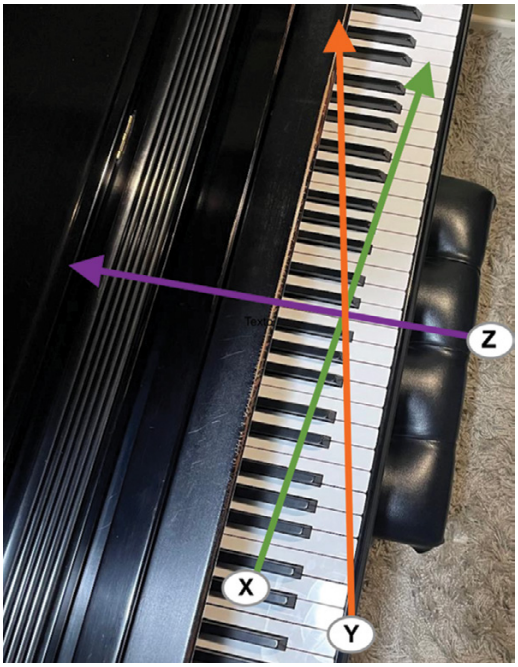

Figure 3. Axes

Figure 4 shows the *Dança Negra* excerpt that pianists played during the experimental procedure.

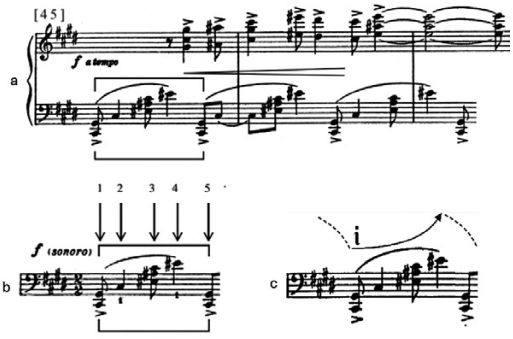

Figure 4. Excerpts from Guarneri's *Dança Negra*, mm. 45-47

The first part of this example shows the musical material used for the pianist's practice. The second part (b) shows the five musical events, while the third part (c), to the right of the figure, represents the musical ostinato selected for the kinematic analysis. The analysis and evaluation were based on this musical material, which is repeated 43 times throughout *Black Dance*. Each note or group of notes (chords or clusters) written vertically in the score was considered a musical event.

Data acquisition

Data were acquired at the Biomechanics Laboratory of CEFID – UDESC**.** On the occasion, each pianist participant played the excerpt in Figure 4a three times. For the analysis, the portion related to the left hand (Figure 4c) was extracted from the performed excerpt**.**

As part of the experimental procedure, images were captured for analysis at a rate of 180 frames per second. Following this step, the software generated an average of more than 200 graphs, of_which 40 were analysed. Two examples are presented in Figures 5a and 5b.

Experimental design

Since this research is both theoretical and exploratory, as well as experimental, the methodological procedures are largely practical and hands-on. They involve continuous feedback on the application of strategies in pianistic training and performance (qualitative analysis), as well as quantitative analysis through biomechanical experiments.

In the context of our research, bodily movement is understood as both a means of operationalizing instrumental action and an element of communication with the objective and perceived world, according to Merleau-Ponty (1999, pp. 23-37). In instrumental practice, the projection of the musical text depends on coordinated movements that result from the development of motor skills. These topics are also explored by researchers across various fields, including motor control (Magill & Anderson, 2017), cognition (Pinto, 2010), and performance practices related to pianistic action and technical strategies such as Movement Cycles and SMRD.

Within the scope of motor coordination, practicing the cited orientations aimed at task optimisation requires skill acquisition, which occurs through a combination of physical and mental practice, according to Magill & Anderson (2017). This context refers to the importance of practice organization, which is intrinsic to instrumental activity.

To assess and validate the effectiveness and applicability_of the Movement Cycles strategy, a biomechanical experiment was conducted. Twelve pianists of varying skill levels were invited to participate in the experiment (kinematic analysis) at the Biomechanics Laboratory of the Physical Education Centre, CEFID-UDESC, Brazil.

Table 1 includes the following participant information: gender, age, level of education (*currently in progress), total study time (TST), and average daily practice time (ADPT). In some cases, ADPT was not provided.

Table 1. Participant information

Participant	Gender	Age	Education	TST	ADPT
1	M	22	B*	08	5h
2	M	36	B*	20	2h
3	M	22	B	10	3h
4	F	30	B*	24	1h
5	M	23	B*	16	3h
6	F	57	B	50	1h 30m
7	F	38	B	31	**
8	M	40	M	30	**
9	M	29	B	23	**
10	M	22	B*	07	2h 30m
11	M	25	M*	14	1h
12	F	50	D*	43	2h
Average	na	31	na	24	3h 33m

Six participants were assigned to the experimental group (EG), and the remaining six to the control group (CG). All participants practiced an excerpt from *Dança Negra* by Brazilian composer Camargo Guarnieri (measures 45–47). The EG received guidance during three training sessions, while the CG worked independently without instruction. Arrows or curved lines were placed above the musical events that constitute movement cycles as illustrated in the last (c) section of the example in Figure 4. The kinematic procedure enabled detailed analysis of movement trajectories, providing quantitative evidence regarding the efficiency gains associated with the application of the movement cycle approach.

Results

Figure 5a presents a Type-A graph showing the X-coordinate curves for each participant, represented by different colours, with unnormalized

time. In Figure 5b, a Type-B graph displays the same data on the X coordinate, with participants represented by colour and time normalized.

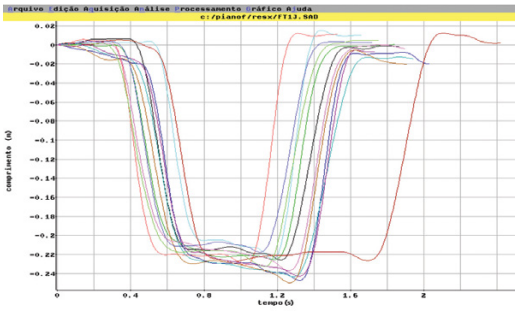

Figure 5a: Type-a curve on X coordinate.

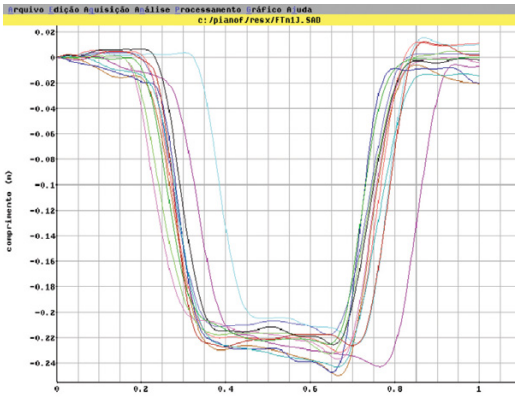

Figure 5b: Type-b curve on X coordinate.

Table 2 shows the trajectory measurements for each participant and group in the X, Y, and Z coordinates, along with individual and group averages. The results demonstrated that the EG's average trajectory was shorter, as was the case for most individual participants in the group. Given that the ostinato is repeated 43 times in the performance of *Dança Negra*, it is possible to infer a significant economy in body movement trajectories.

It can be observed that the CG group showed lower averages on both the X and Z coordinates. As the ostinato presented in Figure 4 (c) was repeated 43 times, the economy of movement was significative. An average difference of 0.9 decimetres between the groups, in favour of the CG group, greatly shortens the distance to be covered during the training and performance of the *Dança Negra*, because of the 43 repetitions of the ostinato.

The basis of the Movement Cycles concept (Póvoas, 1999, 2006) is the direction of musical segments, indicated by arrows or lines placed on the musical events that form a cycle.

It is essential to observe aspects such as preparation for playing distant events and body sensation during the movement execution on the piano. Those actions, combined with kinaesthetic control, may enhance performance. Such conditions allow one to realize more agile movements, for example, allowing for a greater awareness because of the relationship between the movement and the sound results. The data demonstrate that strategies for movement organization may help for a better physical domain when contextually integrated into performance preparation.

To optimize performance learning, it is crucial to apply strategic procedures tailored explicitly to pianistic performance and the demands of motor coordination. However, a lack of clear criteria

Table 2: Trajectory by Participant (TS) and By Group (TG) on X, Y and Z coordinates, Results by Participant (TRS) and Average per Group (AG).

Group	Participant	TP X	TP Y	TP Z	TRP	AG
CG	1	.477	.250	.180	.631	.630
	7	.527	.336	.105	.699	
	8	.455	.178	.109	.540	
	9	.486	.291	.183	.641	
	10	.478	.271	.226	.639	
	11	.483	.275	.143	.628	
AG	---	.484	.267	.158		
EG	2	.503	.189	.132	.629	.621
	3	.457	.108	.135	.511	
	4	.480	.279	.218	.655	
	5	.511	.202	.158	.610	
	6	.516	.529	.210	.684	
AG	---	.494	.264	.165		

in selecting technical procedures aligned with musical construction and sound goals may lead to misunderstandings.

Simplification of movement by reduced distance (SMRD)

Building on previous results, we present SMRD, Simplification of Movement by Reduced Distance, an interdisciplinary approach to planning and guiding medium- and long-distance movements in piano practice. It proposes movement reduction as a strategy to establish clear reference points on the keyboard, integrating with the concept of Movement Cycles.

The application of SMRD is demonstrated in measures 342-345 of Franz Liszt's *Dante Sonata.* Initially, the passage may be practiced using only the first and second fingers, with octaves suppressed, to enhance awareness of the optimal proximity between musical events. This case study is still in development. Figure 6 displays a reduction of this excerpt for right hand realization, where only notes played with the thumb and double notes should be executed. The passage should be approached with elliptical movements, performed as naturally and flexibly as possible during training.

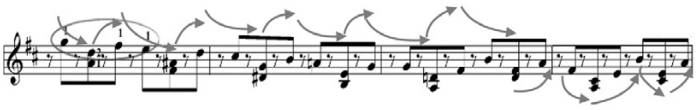

Figure 6: SMRD, Liszt: *Dante Sonata*, mm. 342-345

The same excerpt presented in Figure 5, now arranged for both hands and incorporating the Movement Cycles. It is recommended to play the musical text, performing the events with elliptical movements in the most organic and flexible way.

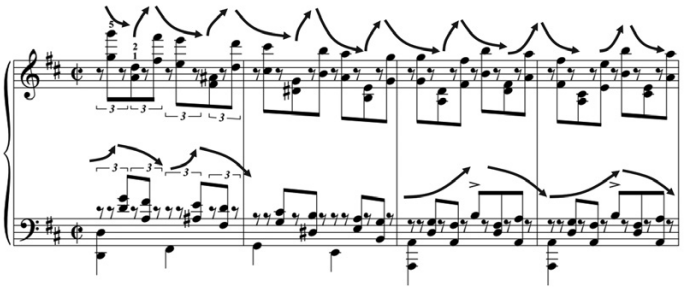

Figure 7: SMRD strategy. Liszt: *Dante Sonata*, mm. 342-345

A conscious approach to manipulating different musical parameters may be note suppression or even an octave displacement. Thus, it "proves to be a valuable tool for adaptation and improvement of motor efficiency", as Ardigo observes (2024: 68). Adding to this strategy, we may create references on the keyboard. Notably, the cycles for the right hand in measures 344 and 345 were adjusted to meet the musical design demands for the right hand.

Conclusion

Within the analytical framework of bodily and musical interactions, it is suggested that, as an integral part of the process, relationships be established between recurring patterns, such as similarities in musical configurations, articulations, and their corresponding body movements during the conditioning process and technical musical mastery. Additionally, there is an association between previously experienced technical-musical situations and those present during performance practice. These actions can enhance the efficiency of training by optimizing both time and energy. Such relational strategies may also support increased focus, greater objectivity in movement planning and execution, and improved neuromuscular performance, thereby positively influencing the aesthetic and sonic quality of performance. This paper presents only the results of cycle strategy analysis. The investigation into SMRD is still in development.

The proposal to simplify complex movements was initially implemented in pianistic practice and pedagogical contexts through the application of two strategies: Simplification of Movement by Reduced Distance (SMRD) and Movement Cycles. These strategies are currently being employed in targeted musical excerpts to examine their practical relevance and pedagogical value. We still intend to conduct evaluations through biomechanical studies, involving motion capture of performances by groups of pianists. While the kinematic method provides quantitative data on movement trajectories along the X, Y, and Z axes, a complementary qualitative analysis will be necessary to evaluate the musical results and the motivational dimension of training with the proposed strategies. A thorough understanding of these issues, along with a detailed analysis of relevant

data and identification of underlying causes, may help establish more precise criteria for selecting technical resources. This process is expected to support the development of more effective piano strategies focused on the musician's health, ultimately leading to performance optimization. Based on the obtained results, it can be concluded that all work depends on the pianist's understanding and engagement with the practice of strategies in an organized manner, focusing on technical and musical demands. In this way, the musician could achieve greater progress and optimize their performance.

The kinematic data collected during the participants' execution of the selected excerpt allowed a detailed analysis of the movement trajectories, providing quantitative evidence regarding the efficiency gains associated with the application of the movement cycle approach.

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Exploring the Competencies of Collaborative Pianists in Music Education: A Pilot Study

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Abstract

Collaborative pianists prepare and perform music pieces with singers, instrumentalists, or ensembles. In educational settings, they are expected to possess artistic, pedagogical, and specific collaborative piano competencies. Given the scarcity of research on collaborative pianists in Croatia, it was important to identify the key competencies required for conducting collaborative piano lessons in Croatian music schools and academies. The aim of this study was to develop an instrument to assess students' perceptions of collaborative pianists' competencies relevant to teaching and conducting collaborative piano lessons in educational contexts. Another aim was to explore differences in students' perceptions by study major, age, gender, and year of study.

The preceding phase of the research involved collecting the opinions of collaborative pianists (N = 9) and fifth-year students (N = 9) at the University of Zagreb Academy of Music regarding essential competencies. Using qualitative content analysis, the responses were categorized into five competency categories: Performance and Artistic, Planning and Organisational, Communication and Pedagogical, Facilitation, and Reflective Practitioner Competencies. In this pilot study, 88 students from the University of Zagreb Academy of Music completed the *Collaborative pianists' competencies* online questionnaire. Participants rated 73 initial items using a 5-point Likert-type scale.

Principal component analysis (PCA, with Varimax rotation and Kaiser-Guttman criterion) was applied and four factors were extracted: Performance and Artistic Competencies (α = .92), Communication and Pedagogical Competencies (α = .89), Facilitation Competencies (α = .88), and Reflective Practitioner Competencies (α = .88). Gender-based differences were observed in overall competency ratings, with female students assigning higher scores. A statistically significant difference emerged within the Facilitation Competencies factor between the 16-19 and 20-22 age groups, with the younger group attributing greater importance to these competencies.

The *Collaborative pianists' competencies* instrument demonstrates strong alignment with a theoretically grounded competency framework, shows high structural validity, and is recommended for application with a larger student sample.

Keywords: collaborative pianist, competencies, music education, pilot study

Introduction

Ever since White (1959) introduced the concept of competency to explain aspects of human behaviour previously unaccounted for by existing motivation theories, research into an individual's ability to efficiently communicate with their environment and engage in gradual learning has become increasingly prominent in the literature. In its broadest sense, competency can be defined as a combination of knowledge, skills, abilities, and ethical awareness applied when working and interacting with others. Competence occupies an important place in all spheres of human activity, particularly in education. Since the role of the teacher is dynamic and constantly evolving, teacher competencies and personal traits directly impact the development of children and youth (Mravunac Fabijanić et al., 2024). Consequently, modern-day teachers are expected to strengthen their role in the students' educational process and effectively respond to the challenges of contemporary society. Lifelong learning, professional training, and continuous development is a right and an obligation for all teachers.

Collaborative piano lessons include individual work by the collaborative pianist with a voice or instrument student in the classroom, where they rehearse a musical piece with the student, as well as a public performance of that piece that showcases what the student has learned. Therefore, in both settings, the collaborative pianists' teaching artistry lies in integrating artistic and pedagogical elements (Wildschütz, 2018; Witt, 2020). A similar duality has

been recognized in vocal and instrumental teachers (Polifonia working group for instrumental and vocal music teacher training, 2010). The broadly designed conceptual framework of competencies, classified into six categories (Performance and Artistic, Planning and Organisational, Communication and Pedagogical, Facilitation, Reflective Practitioner, and Networking and Collaborative Competencies), is based on various roles they play in the classroom, especially taking into account the change in teaching paradigm from teacher-focused to student-focused. This allows teachers and institutions to further develop it in practice and thus adjust to the peculiarities of the profession within a specific educational system (Polifonia working group for instrumental and vocal music teacher training, 2010).

In addition to artistic competencies, such as interpretation, highly advanced musical and technical piano skills (Katz, 2009; Moore, 1956) and pedagogical competencies, collaborative pianists should also have specific collaborative piano skills in order to work effectivelly with singers and instrumentalists (Roussou, 2017; Yang, 2023). Academic research on collaborative piano and pianists, that began with American doctoral theses (Lippmann, 1979; Mann–Polk, 1984; Rose, 1981), continues to develop today. This body of research has explored educational systems from the perspective of collaborative piano lessons (Lee, 2009; Yang, 2023), as well as competencies required for working with singers (Rich, 2002) and choirs (Lee, 2016), professional and musical competencies (Lee, 2009; Yang, 2023), and practical skills and roles (Roussou, 2017). Other studies have examined non-musical competencies (Wildschütz, 2018; Witt, 2020), partner relationships (Lee, 2009; Kiik-Salupere & Ross, 2011), interpersonal relationships and empathy (Cota, 2019), and performance cues established during rehearsals and applied in public performances (Lisboa et al., 2013). However, research in this field in Croatia remains extremely limited (Mravunac Fabijanić, 2021).

Aims

The aim of this study was to design an instrument for assessing the key competencies that collaborative pianists should possess when conducting collaborative piano lessons in Croatian music schools, as well as music and art academies. Another aim was to examine differences in students' perceptions of these competencies based on their study major (voice, string, or wind/brass instrument), age, gender, and year of study.

Based on the assumption that collaborative pianists require specific skills when working with singers, with string and wind/brass instrumentalists (Roussou, 2017; Yang, 2023) and that both collaborative pianists and students have particular expectations of one another (Roussou, 2017), it was expected that significant differences in students' estimation of collaborative pianists' competencies would be found depending on their study major (H_1). It was further assumed that there would be no significant differences in students' opinions regarding the required competencies based on age (H_2), gender (H_3) or year of study (H_4).

Method

Sample

The convenience sample included all students from the voice, string, and wind/brass departments of the University of Zagreb Academy of Music, as well as percussion, harp, and tamboura students who work with collaborative pianists (N = 283). The questionnaire was completed by 114 students; however, not all met the criteria for inclusion in the research sample. As a result, 77% of the submitted responses were included in the analysis. The final sample consisted of 88 students (age range: 16–32; M = 21.28, SD = 2.77; 52 female, 36 male; 19 vocal, 21 string, 35 wind/brass department, 13 other).

Measure

A Questionnaire for assessing collaborative pianists' competencies was developed specifically for the purposes of this study (see Appendix).

Phase 1: Defining competence categories and preparing the *Collaborative pianists' competencies* questionnaire. In a previous study (Mravunac Fabijanić, 2021), a total of 181 statements were collected from fifth-year students of the voice and instrumental departments at the University of Zagreb Academy of Music (N = 9), as well as from collaborative pianists (N = 9). These statements reflected what respondents considered to be desirable competencies in collaborative pianists. Responses with similar meanings, such as "being very patient and having strong nerves" and "no productive work can be done with distressed and nervous pianist", were replaced with a single item: "A collaborative pianist must be very patient and have strong nerves". This process resulted in a refined list of 73 items, which were then categorized

into five competence categories (Performance and Artistic, Planning and Organisational, Communication and Pedagogical, Facilitation, and Reflective Practitioner Competencies), in line with the Polifonia framework (Polifonia working group for instrumental and vocal music teacher training, 2010). Content and substantial validity were evaluated in this phase by nine collaborative pianists, two experts in psychology and music pedagogy, and one person from the student population. All agreed that the items adequately represented the relevant aspects of collaborative pianists' competencies. Thus, the *Collaborative Pianists' competencies* questionnaire was prepared.

Phase 2: Pilot study. Items 1–4 of the questionnaire collected socio-demographic data (age, gender, study major and year of study), and the subsequent 30 questions pertained to competencies required for conducting collaborative piano lessons. Respondents were asked to indicate the extent to which they agreed with each statement using a 5-point Likert-type scale (1 – *strongly disagree*, 5 – *strongly agree*). The questionnaire took approximately 10 minutes to complete.

Procedure

Following the approval from the dean of the University of Zagreb Academy of Music, students completed the *Collaborative pianists' competencies* questionnaire via an online Google Forms survey between February and May 2021. A statement preceding the survey explained the purpose of the study, the nature of the questions, and participants' rights. Participation was voluntary and anonymous, and the research was conducted in accordance with ethical guidelines. By submitting the completed questionnaire, participants consented to the use of their data for academic purposes. It was clearly stated that individual responses would not be analysed, in order to encourage honest and thoughtful participation.

Data analysis

The quantitative method of data analysis was conducted using IBM SPSS Statistics, Version 26. The main statistical methods applied included principal component analysis (PCA) with Varimax rotation and the Kaiser-Guttman criterion, one-way analysis of variance (ANOVA), and independent samples t-test. These methods were used to examine the factor structure of the questionnaire and to assess differences in students' responses based on demographic variables.

Results

Factor analysis

Multiple factor analyses were conducted using principal component analysis (PCA) with Varimax rotation and the Kaiser-Guttman criterion, based on the initial set of 73 items defined in Phase 1 of the research. In the first step, 16 factors were extracted. Items with non-significant loadings (< .50) and those with multiple loadings were excluded. A second iteration yielded 8 factors, followed by another exclusion of items with non-significant/multiple loadings. Prior to the final analysis, the necessary assumptions for factor analysis were checked and confirmed: the Kaiser-Meyer-Olkin (KMO) measure was .882, and Bartlett's Test of Sphericity was significant at 1% level (χ = 1929,01, df = 435), indicating that the data were suitable for factor analysis. Based on the Kaiser-Guttman criterion (eigenvalues > 1), four factors were retained, explaining 64.675% of the variance. The factors were as follows: Performance and Artistic Competencies (eigenvalue = 12.879) accounted for 22% of the variance, Communication and Pedagogical Competencies (eigenvalue = 2.795) explained 15.83% of the variance, Facilitation Competencies (eigenvalue = 2.040) accounted for 13.81% of the variance, Reflective Practitioner Competencies (eigenvalue = 1.671) explained 12.99% of the variance. This factor structure was supported by the Scree plot test.

Following the determination of the final factor structure, basic descriptive statistics were calculated for each item. The questionnaire demonstrated excellent internal reliability, with a Cronbach's alpha of .95 for the entire scale. The final version of *Collaborative pianists' competencies* questionnaire consists of 30 items grouped into four factors: Performance and Artistic Competencies (11 items; M = 4.54, SD = 0.56, α = .92), Communication and Pedagogical Competencies (7 items; M = 4.56, SD = 0.62, α = .89), Facilitation Competencies (7 items; M = 4.17, SD = 0.70, α = .88) and Reflective Practitioner Competencies (5 items; M = 4.15, SD = 0.72, α = .88). The final version of the questionnaire is provided in the Appendix.

The importance of competencies

Students rated Performance and Artistic Competencies as the most important. Of those, the highest-rated items were item 1.5 "It is important for a collaborative pianist to be able to adjust tempo", (M = 4.85, SD = 0.54), item 1.2 "A collaborative

pianist should perform melody and phrase nicely." (M = 4.80, SD = 0.57), and item 1.1 "A collaborative pianist must be musical and musically engaged" (M = 4.76, SD = 0.63). Following this, Communication and Pedagogical Competencies were rated highly, with item 2.3 "The signals, glances and synchronized breathing developed between a student and a collaborative pianist are important" receiving a mean score (M = 4.76, SD = 0.66) comparable to item 1.1 from the previous factor. Facilitation Competencies ranked third in importance. The highest-rated items in this factor were item 3.2. "A collaborative pianist should be psychologically stable and know how to act and what to say in the moments preceding the performance" (M = 4.51, SD = 0.80), and item 3.6. "Prior to a performance, a collaborative pianist should know how to deal with different people; the personal, human, and friendly moment is extremely important before going on stage" (M = 4.42, SD = 0.83). Within this factor, the item with the lowest overall agreement was 3.1 „A collaborative pianist is like a conductor; using breath, head or other signs to signal to a soloist when to step in" (M = 3.73, SD = 1.17). Reflective Practitioner Competencies received the least importance overall. This factor includes two items that ranked as the 2nd and 3rd least agreed with statements in the entire study: item 4.2 "A collaborative pianist should always meet the expectations of their colleagues teaching the study major" (M = 3.77, SD = 1.00), and item 4.1 "A collaborative pianist should always be well-practiced, well-prepared, accurate and precise, and must not be sloppy" (M = 3.81, SD = 0.98).

Overall differences in respondents' perceptions

This study examined whether students' assessments of collaborative pianists' competencies differed based on their study major, age, gender, and year of study, in order to test the proposed hypotheses.

Study major. A one-way ANOVA was conducted to explore whether students from different study majors rated collaborative pianists' competencies differently. The mean scores were relatively close across groups: singing (n = 19, M = 4.36, SD = 0.45), wind/brass (n = 35, M = 4.38, SD = 0.66), and string instruments (n = 21, M = 4.52, SD = 0.39). Tests for normality and homogeneity of variance supported the use of ANOVA. The analysis showed no statistically significant differences between study majors, $F(2, 85) = 0.60$, $p > .05$. The effect size was very small (partial $\eta_p^2 = .016$), indicating that study major explained only 1.6% of the variance in competency ratings. Thus, the first hypothesis, which predicted differences based on study major, was not confirmed.

Age. A one-way analysis of variance was conducted to examine differences in respondents' opinions based on age. Students were divided into three age groups: 16-19 years (n = 29, M = 4.46, SD = 0.38), 20-22 years (n = 34, M = 4.33, SD = 0.67), and 23-28 years (n = 24, M = 4.42, SD = 0.43). Despite minor deviations from normality, the data met the assumptions for ANOVA. The test showed no significant difference in competency evaluations by age group, $F(2, 84) = 0.54$, $p > .05$. The partial eta squared value (.012) indicated that age accounted for only 1.2% of variance. The Pearson correlation, $r(87) = -.19$, $p > .05$, also showed a weak and non-significant relationship, confirming the second hypothesis that age does not influence students' opinions on competencies.

Gender. An independent samples t-test was used to compare male (n = 36) and female (n = 52) respondents. The Levene's test confirmed homogeneity of variances (F = 2.31, p = .132). Results revealed a statistically significant difference, t (86) = -2.13, $p < .05$, with females rating the competencies higher (M_{female} = 4.5) than males (M_{male} = 4.3). The effect size was moderate (partial $\eta_p^2 = .05$), indicating that gender explained 5% of the variance in responses. This finding contradicts the third hypothesis, indicating that gender does influence perceptions of collaborative pianists' competencies.

Year of study. A one-way analysis of variance was conducted to examine differences in competency evaluation based on respondents' year of study. Students were grouped into first year (n = 40, M = 4.46, SD = 0.35), second and third year (n = 29, M = 4.31, SD = 0.71), and fourth and fifth year (n = 19, M = 4.91, SD = 0.48). Although minor deviations from normality were observed, the assumptions of homogeneity and symmetry were met. The ANOVA showed no significant differences based on year of study, $F(2, 85) = 0.64$, $p > .05$. Partial eta squared was .015, indicating a minimal relationship, with the year of study explaining only 1.5% of variance. These results support the fourth hypothesis that the year of study does not significantly affect students' competency evaluations.

Since the results turned out to be quite homogeneous across respondent groups, no statistically significant differences of opinions were found based on study major, age, or year of study. The only statistically significant difference was

observed between male and female respondents, with female students rating competencies slightly higher overall. To gain deeper insight, further analysis was conducted to determine whether differences existed within each of the four identified competency factors.

Differences per factor

Gender. To explore whether gender differences existed across the four factors, a series of independent samples *t*-tests was conducted. The analysis revealed that the differences between male and female respondents were not statistically significant for any individual factor. Although female students rated overall competencies slightly higher than male students, gender was not a significant variable when the factors were examined separately.

Age, study major and year of study. Several multivariate analyses of variance (MANOVA) were performed to determine whether students' responses differed significantly across the four competency factors based on age, study major, and year of study. A significant difference was detected by year of study. To explore this further, a one-way analysis of variance (ANOVA) was conducted with age as the independent variable, specifically examining its relationship with the Facilitation Competence factor. The results indicated a statistically significant difference among age groups, $F(2, 85) = 2.66$, $p < .05$. Post hoc comparisons (Tukey HSD and Scheffé tests) revealed a significant difference between the 16-19 ($M = 4.43$, $SD = 0.45$) and the 20-22 ($M = 4.00$, $SD = 0.85$) age groups, with the younger group assigning higher ratings to Facilitation Competencies.

Discussion

This research was conducted with the aim of creating a new instrument for assessing collaborative pianists' competencies important for maintaining collaborative piano lessons in Croatian music schools and music/art academies and examining the differences in students' opinions depending on their study major (voice, string or wind/brass instrument), age, gender, and year of study. Results show that the questionnaire containing four factors and 30 items adequately represents the required competencies. The instrument has a high structural validity and reliability and can be a useful research tool in the future.

Respondents think that Performance and Artistic Competencies are the most important, which is in line with earlier research. Setting and maintaining tempo is important when playing music together (Roussou, 2017), but equally important are occasional deviations from tempo (Katz, 2009; Moore, 1956; Morgenroth, 2015) and flexibility (Lippmann, 1979). Furthermore, it is also important that collaborative pianists are able to play melody beautifully, in a "singing tone" (Lippmann, 1979, p. 13) or "singing, sustained, tone" (Rose, 1981, p. 77). Musical engagement also involves making analytical considerations related to issues of harmony, phrasing and voicing (Pow, 2016; Savella, 2023). In this context, breathing together refers to non-verbal communication needed for the two performers playing together in an ensemble (Katz, 2009; Wildschütz, 2018). Similarly, performing in public calls for a combination of auditory, visual and social communication (Roussou, 2017). Giving clear non-verbal messages is an important strategy in overcoming communication obstacles (Lee, 2016). It is therefore no wonder that in this research students found Communication and Pedagogical Competencies the second most important set of competencies. Collaborative pianists as facilitators respond to the different needs of their students and create a supportive and collaborative learning environment (Polifonia working group for instrumental and vocal music teacher training, 2010; Witt, 2020). Surprisingly, this Facilitation Competencies factor contains an item that respondents least agreed with in the whole research (3.1 "A collaborative pianist is like a conductor, using breath, head or other signs to signal to a soloist when to step in"). On the one hand, perhaps students do not expect one-way cues and communication from a collaborative pianist but consider these to be a jointly shared responsibility (Lisboa et al., 2013; Wildschütz, 2018). On the other hand, it is also possible that students, soon to be professionals, do not need assistance to the extent that primary and secondary music schools' pupils do. Results would probably be different if the opinions of pupils were also taken into account, which is a recommendation for a future piece of research. As for Reflective Practitioner Competencies, it seems as if Croatian students care least about them. The finding that they should not always meet the expectations of their colleagues teaching the study major will bring particular joy to collaborative pianists. Previous research has also shown that students value other characteristics in collaborative pianists: experience, musicality, listening, adaptability (Haddon, 2016, as cited in Roussou, 2017, p. 46) and expect

partnership in the teaching/learning process between collaborative pianist, vocal teacher, and student (Kiik-Salupere & Ross, 2011).

In addition to the four types of collaborative pianists' competencies confirmed in this research (Performance and Artistic, Communication and Pedagogical, Facilitation, Reflective Practitioner Competencies), the conceptual framework developed by Polifonia working group for instrumental and vocal music teacher training (2010) suggests two additional competency areas (Networking and Collaborative Competencies, Planning and Organisational Competencies). Although collaborative pianists regularly perform in concerts at institutions for which they work or elsewhere, participate in the music life of the school/academy, community and society, and promote music, respondents seem to have focused only on the artistic and pedagogical context of collaborative piano classes in the classroom and in the qualitative phase of the research (Mravunac Fabijanić, 2021) not a single statement they made was included in the Networking and Collaborative Competencies. Similarly, the results of this pilot study did not show the existence of Planning and Organisational Competencies, which refer to teachers using their knowledge and skills to plan, monitor, and evaluate different learning and teaching situations in ways that facilitate students' musical development (Polifonia working group for instrumental and vocal music teacher training, 2010). Upon further review, competencies that had previously been listed here belong to some other category. For example, statements 1.8 "A collaborative pianist should be knowledgeable enough to be able to advise students in their personal development", 1.9 "A collaborative pianist is very important in the musical education of students" and 1.10 "A collaborative pianist should always readily help students" have now been classified as Performance and Artistic competencies. On the one hand, results show that in practice, teacher roles and competencies are intertwined (Mravunac Fabijanić, 2021, p. 35), which is also highlighted within the competence framework (Polifonia working group for instrumental and vocal music teacher training, 2010). On the other hand, such results are not in line with previous research. In fact, Witt (2020) finds that the development and application of skills of collaborative pianists as art advocates can enrich the entire collaborative piano work process as well as collaboration with the audience and community.

Another aim of this research was to examine the differences in respondents' opinions about desirable collaborative pianists' competencies, depending on study major, age, gender, and year of study. The assumption that pianists working with singers, string, or wind/brass instrument players need different skills has not been confirmed, contrary to previous research (Roussou, 2017; Yang, 2023). This may be due to the small size of the sub-sample of singers and instrumentalists, which was insufficient to encompass the differences. It is therefore recommended that this be analysed on a larger sample of students. As expected, no differences were found in students' opinions on collaborative pianists' competencies that depended on their age or study major. However, contrary to the expectations, gender differences have been found. Furthermore, the observation that female respondents assigned higher ratings in all dimensions of the scale should be carefully interpreted, as subsequent analyses have shown that the differences in male and female responses were statistically non-significant in all of the factors. Looking at other results within each factor, the only statistically significant difference was found in Facilitation Competencies, between the 16-19 and the 20-22 age groups, where the younger group assigned higher ratings. Within this factor, students placed the greatest importance on items concerning collaborative pianists' psychological stability, appropriate behaviour, and personal and individualised approach prior to public performances. This indicates that students primarily expect their needs to be taken into account, followed by an adaptation of acts and behaviour of collaborative pianists in line with those needs, particularly when performing. Extensive research has confirmed the importance of interpersonal relations (Cota, 2019; Rose, 1981; Roussou, 2017). In line with earlier literature (Witt, 2020), Croatian students too seem to appreciate supportive relations and environments that make them feel safe and empowered. It is unclear, however, why students aged 16-19 find it more important. This finding suggests that younger students may place greater value on the psychological support and interpersonal sensitivity provided by collaborative pianists, possibly due to less experience and greater performance-related anxiety in earlier stages of their education. A possible reason could also lie in the fact that at the beginning of study (approximately that age), they usually have more psychological and pedagogical subjects. These explanations are, however, a mere assumption that would need to be empirically verified.

Conclusion

The contribution of this research lies in identifying the key competencies of collaborative pianists that students consider important. The results obtained through this research have both practical and theoretical implications. They may inspire changes in practice, paving the way for future collaborative pianists to develop their competencies during their studies, such as through the design of new study programs and professional training programs within existing piano studies, as well as the establishment of collaborative piano studies, which currently do not exist in Croatia. Additionally, this could encourage the organization of a system of traineeships for collaborative piano, the induction of collaborative pianists into the profession, the introduction of state examinations in collaborative piano, and the adaptation of career advancement systems to better accommodate this profession.

The study had several limitations, including a relatively small sample size, a large number of items, and the selection of respondents from a single music academy, which limits the generalizability of the findings. Nevertheless, the newly developed instrument *Collaborative pianists' competencies*, is a valid representation of the theoretically defined competencies. It demonstrates high structural validity and is recommended for application with a larger sample of students from various music and art academies. Furthermore, it would be valuable to extend these findings by examining the perspectives of pupils as well as vocal and instrumental teachers regarding the importance of specific competencies required of collaborative piano teachers. This research will hopefully stimulate further investigation into this important area, which significantly influences students' learning and performance outcomes.

Finally, although the herein stated competencies do not in their own right make an expert collaborative pianist, they most certainly can help become one, which seems particularly important for the process of collaborative piano classes in an educational setting.

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Appendix

The *Collaborative pianists' competencies* questionnaire

Performance and artistic competencies
1.1. A collaborative pianist must be musical and musically engaged.
1.2. A collaborative pianist should perform melody and phrase nicely.
1.3. A collaborative pianist should play a clear harmony.
1.4. A collaborative pianist should be technically adept.
1.5. It is important for a collaborative pianist to be able to adjust tempo.
1.6. A collaborative pianist should have a broad education, considerable knowledge and good familiarity of repertoire.
1.7. A collaborative pianist must be well acquainted with musical styles and the compositions that they are working on.
1.8. A collaborative pianist should be knowledgeable enough to be able to advise students in their personal development.
1.9. A collaborative pianist is very important in the musical education of students.
1.10. A collaborative pianist should always readily help students.
1.11. A collaborative pianist should be able to organize their own practice time.
Communication and pedagogical competencies
2.1. A collaborative pianist should be communicative and know how to properly speak with students and teachers of the study major.
2.2. A conversation between a collaborative pianist and a student is of utmost importance.
2.3. The signals, glances and synchronized breathing developed between a student and a collaborative pianist are important.
2.4. A collaborative pianist must love their job.
2.5. It does matter who is at the piano.
2.6. Collaborative pianists should always work on perfecting themselves.
2.7. A collaborative pianist should know when to lead and when to follow.
Facilitation competencies
3.1. A collaborative pianist is like a conductor, using breath, head or other signs to signal to a soloist when to step in.
3.2. A collaborative pianist should be psychologically stable and know how to act and what to say in the moments preceding the performance.
3.3. A collaborative pianist must be very patient and have strong nerves.
3.4. A personal, individualized approach and good interpersonal relations are just as important as collaborative pianists' piano skills.
3.5. A collaborative pianist should provide students with emotional support in classes and when performing.
3.6. Prior to a performance, a collaborative pianist should know how to deal with different people; the personal, human, friendly moment is extremely important before going on stage.
3.7. A collaborative pianist should be attentive to the needs of others and their feelings.
Reflective practitioner competencies
4.1. A collaborative pianist should always be well-practiced, well-prepared, accurate and precise, and must not be sloppy.
4.2. A collaborative pianist should always meet the expectations of their colleagues teaching the study major.
4.3. Public performance is a prominent dimension of collaborative piano, and a collaborative pianist should be psychologically prepared to perform publicly on a daily basis.
4.4. A collaborative pianist should be easy to adapt and constantly ready to learn.
4.5. A collaborative pianist should be skilled, quick, flexible, resourceful, and prompt in reacting to new situations and new literature.

Characterization as a Motor Skill of a Right-hand Stroke on the Classical Guitar Technique Regulatory Conditions and Action Goals

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Abstract

In this paper, we propose a characterization of an isolated right-hand stroke in the classical guitar technique as a motor skill in terms of its goals and regulatory conditions. The choice of this element is important due to the constitution of the produced sound characteristics in the moment of string release. Thus, we conducted an exploratory investigation within a bibliographic framework, establishing connections between the fields of motor learning and guitar technique (Carlevaro, 1979), focusing on the physical parameters of finger-string interaction during the stroke. Initially, we resorted to a distinction between the movements that make up a given action and the motor skill being performed (Magill & Anderson, 2017) through the concepts of action goals and regulatory conditions. Then we considered parameters of interaction between the finger and the string (Pavlidou, 1997), seeking to strengthen our characterization with a physics background. We hope to contribute to a better understanding of this technical component and to offer the instrumentalists a conceptual framework that allows them to evaluate the motor aspects of his technique, regardless of the technical school practice. In this sense, the concepts of regulatory conditions and action goals allow us to contextualize the parameters of interaction within the elements of the instrumental technique, which can serve as a meaningful reference to consider the movements available at a given stroke.

Keywords: classical guitar, motor learning, instrumental action, right-hand technique

Introduction

This paper presents a characterization of an isolated right-hand stroke as a motor skill in terms of its action goals and regulatory conditions. The choice of this technical element is related to the importance that the instant of string release has for the constitution of the sound characteristics produced. This work is derived from an investigation into Abel Carlevaro's instrumental theory for the classical guitar (1979), specifically his system for right-hand strokes and the use of joint fixations (*fijaciones*). To better understand this technical resource and the other propositions made by Carlevaro, a theoretical framework was developed through interdisciplinary, bibliographical research. The characterization presented here is a part of this theoretical study, which comprised three main phases.

Firstly, a literature review was conducted focusing on the classical guitar technique, highlighting right-hand actions and the reception of Carlevaro's ideas in academic research. Interdisciplinary research papers that focused on the classical guitar were also considered, even if they did not directly approach musical performance. The relevance of his work in the field of instrumental technique and its development is presented, given that his proposals are constantly considered in research such as Walt (1996), Barros (2008), Roos (2009). Cardoso (2015), and Tsai (2018). Although Carlevaro's precepts have been considered in more recent works, the use of fixations in the right-hand technique was assimilated in perspective to the use of the five-stroke system and associated with definitions such as the simultaneous work of extensor and flexor muscles (Fernández, 2000). In general, the utilization of this system is seen as the five described strokes for the right-hand technique, although it was made clear that there is no delimitation, but a spectrum starting with free strokes and incrementing the muscles recruited to the task (Carlevaro, 1979, p. 51). The concepts of fixations were studied directly by Abeijón (2020), focusing on its precedents and reception by the guitar community. Considering the interdisciplinary research reviews in the first stage, such as Simões (2019), Centeio (2019), and Rabaioli (2020), although related to bimanual coordination on the classical guitar, a characterization of a single right-hand stroke, in terms of its regulatory conditions, was not carried out.

In the second phase, to address the research gap concerning the applicability and comprehension of

these concepts, we brought together topics from the fields of structural kinesiology, motor control and learning, as well as theoretical aspects of the interaction between the finger and string in the right-hand technique. From the combination of these aspects, we were able to propose a characterization of an isolated right-hand stroke as a motor skill. In the final stage, we analysed Carlevaro's instrumental theory based on the literature review conducted in the first phase and the theoretical framework developed in the second. Understanding of a guitar stroke through concepts such as regulatory conditions and action goals allowed for a broader comprehension of Carlevaro's theories and the interlocking between other Carlevarian concepts with fixations, such as muscular aggregates and restraining momentum. Those results and kinesiological aspects of the theoretical framework developed for this investigation were not covered in this paper and will be addressed in future publications.

The approach presented here aims to offer a complementary perspective on the practical knowledge of the right-hand technique, while also connecting with the field of motor learning. In this sense, the understanding of movements as components of the skill in question, as the assessment of technical elements in terms of regulatory conditions and goals, favours a renewed approach to instrumental practice, which can serve as a theoretical framework for the development of new practice strategies or the evaluation of the utilized means to achieve the intended artistic goals.

Characteristics and components of a motor skill

The concept of motor skill is usually associated with "activities or tasks that require voluntary control over the movements of the joints and body segments to achieve a certain goal" (Magill & Anderson, 2017, p. 3). The coordinated use of movements, which are components of these skills, is the means through which the action is carried out or even the way in which its goals are achieved. The purpose of a motor skill is to cause some type of change in the environment or in the person's relation to the environment. The ability to play the piano could be taken as an example, since it involves the goal of striking the correct keys in the proper sequence and at the right time, and it requires control over posture and finger and hand movements to achieve that goal (Magill & Anderson, 2017, p. 6).

Although instrumental action appears as an example of motor skill, some of its elements may remain without proper characterization. It is a challenge faced by a musician who turns to interdisciplinary research involving the study of movements, which does not affect the merit of these theoretical structures and the applicability in the context of instrumental practice. In this context, four properties necessary for the characterization of a motor skill are established:

1) a goal to be achieved;
2) voluntary execution;
3) movement of the joints and body segments required to achieve the goal; and
4) necessity of learning or relearning. (Magill & Anderson, 2017, p. 7).

As components of motor skills (actions), we will consider movements as "specific patterns of motion among joints and body segments" (Magill & Anderson, 2017, p. 7). From this perspective, we are considering three levels of study for the acquisition of motor skills: 1) the skill (action) itself; 2) the movements used to achieve the action goals; and 3) the neuromotor processes involved. In the context of guitaristic action, given its interaction properties, it is necessary to clearly define its goals. Guitaristic action is adapted from the concept of pianistic action, developed within a theoretical framework that establishes an interconnection between body movements, the written music, and the desired musical results in piano performance (Póvoas, 1999, p. 80). That is a conceptual background through which the technical aspects of classical guitar technique and its analogous movements can be approached in relation to artistic goals (Pedroso, 2022, p. 38). In consideration of the movements that are fundamental to the realization of a motor skill, Magill & Anderson (2017) note that "too often, practitioners ignore this hierarchy of priorities and *introduce skills as movement patterns to be learned rather than as action goals to accomplish*. Learners are less actively involved in the learning process when this happens and are less likely to develop the problem-solving skills needed to become independent learners." (p. 9, italics ours)

The problem of presenting the skill as the probable movement pattern for its execution is contextualized in sports practice, and it is plausible that this mistake manifests itself in the context of instrumental teaching and learning as well. Considering the differences between sports and musical practices, it is worth remembering the congruence present between the means through which their actions are performed: motor skills, constituted by movements and controlled by neuromotor processes. In this context, it is pointed out that "the second reason

to distinguish the different levels of study is that not all people can accomplish the action goal using the same movement pattern or perform the same movement using the same neuromotor processes" (Magill & Anderson, 2017, p. 9).

In this sense, the lack of clarity between motor skill and the "movement pattern" used can lead to inhibition of the search for new motor solutions. This distinction between the skills that constitute instrumental action and the movements that compose it becomes especially relevant if we consider that the development of instrumental technique should focus more on expanding the resources available for musical interpretation than on adequately reproducing a discrete sequence of movements.

In the next section, concepts from Gentile's taxonomy for motor skills classification are discussed. Centeio (2019) demonstrated the applicability of this system by contextualizing the guitaristic action, and we will start from this point of view to expand the understanding of the action goals and the regulatory conditions of a right-hand stroke.

Guitaristic action and Gentile's taxonomy

Gentile's two-dimensional taxonomy expanded the one-dimensional approach to motor skills by considering two general characteristics: 1) the environmental context in which the skill is performed and 2) the function of the action that characterizes the skill. By subdividing these two characteristics, this expansive taxonomy produces sixteen categories (Magill & Anderson, 2017, p. 14). The environmental context dimension has two basic characteristics: regulatory conditions and intertrial variability. According to the authors:

"The term regulatory conditions refer to those features of the environmental context to which movements must conform if they are to achieve the action goal. They regulate spatial and temporal characteristics of the movement as well as the forces that underlie these characteristics. [...] It is important to note that regulatory conditions do not refer to characteristics of a person's movements but only to characteristics in the environmental context in which a skill is performed." (Magill & Anderson, 2017, p. 16)

Intertrial variability, in turn, refers to the maintenance of regulatory conditions across different attempts to perform a given skill (Magill & Anderson, 2017, p. 17). A motor skill can be distinguished by the presence or absence of intertrial variability. Some characteristics of the environment, referred to by Gentile as "non-regulatory conditions", can influence the way a skill is performed. The presence of an audience, the temperature of the environment during the performance of the action, whether the skill is being performed during the day or night; all these are characteristics that can affect the outcome of the execution, but not as directly as the regulatory conditions (Magill & Anderson, 2017). Ideally, the regulatory conditions for guitaristic action are maintained, as the instrument's physical characteristics do not change significantly during performance. Even if errors or inaccuracies occur during a performance, they are not related to intertrial variability, as they concern the movements that make up a motor skill, rather than the regulatory conditions under which it is performed.

The second dimension on which Gentile's taxonomy is based concerns the action's function. This can be determined by considering whether the result of executing the skill involves the movement of the body from one location to another, or whether it involves the manipulation or use of an object. In this taxonomy, body orientation refers to the maintenance or change of body location, and two of these orientations are of interest for classifying motor skills: body stability, which refers to skills that do not involve changing the location of the body, and body transport, which implies displacements, such as walking and swimming (Magill & Anderson, 2017).

Considering the manipulation of objects as a function of action, the taxonomy describes it as "maintaining or changing the position of an object, such as a ball, a tool." (Magill & Anderson, 2017, p. 20). Another way to express this function is to hold or use the object. Skills that require object manipulation are more difficult to perform than skills that do not, since "the person must do two things at once. First, the person must manipulate the object correctly, and second, he or she must adjust body posture *to accommodate for the imbalance created by the object*" (Magill & Anderson, 2017, p. 21, italics ours).

Overall, the guitaristic action, characterized as a motor skill, fits in category 2B in Gentile's classification because it involves manipulation of an object (the instrument) and not bodily transport; furthermore, regulatory conditions are static and there is no variability between the attempts to perform the action, since the physical characteristics of the instrument are ideally preserved during the instrumental performance.

This taxonomy offers a valuable resource for assessing the possibilities and limitations of movements, as well as a tool for selecting a progression of actions that are functionally appropriate for overcoming motor difficulties or increasing performance capacity (Magill & Anderson, 2017, p. 23). The classification of guitaristic action also sets up a conceptual background to investigate elements of instrumental technique in a contextualized manner within the field of motor learning.

Regulatory conditions of a right-hand stroke

As discussed, the regulatory conditions will be related to the environmental characteristics in which the motor action is performed, rather than to the movements that constitute it. In the context of a right-hand stroke, they will be linked to the physical characteristics of the guitar considered relevant to the interaction between the finger and the string immediately prior to its release. These parameters are related to the direction of the displacements made, the friction between the finger and the string during the stroke, and the instrument's characteristics and physical dimensions (Pavlidou, 1997).

It is also important to consider the influence that the longitudinal location of the stroke exerts on the intensity and sound quality of the guitar, as exemplified by Taylor (1978, p. 24). The possibility of pulsing the string in different regions is a well-established resource recognized by theorists of the instrument and widely used by guitarists.

Recognizing that the modification of the longitudinal point of contact with the string has implications on the force required to obtain the same level of sound power, we will take the resistance performed by the string as opposed to the movement of the finger as the main regulatory condition for the isolated performance of a stroke on the guitar. The resistance exerted by the string is proportional to the displacement occurring in the direction opposite to the movement of the finger and needs to be accommodated by the action at the moment when the stroke is performed.

All the actions described are being considered on the same region of the string, close to the sound hole, corresponding to the natural position described by Carlevaro (1979, p. 22). In the same sense, we will use the division of digital stroke into the agonist phase, referring to the contact of the finger with the string, and antagonist phase, referring to the beginning of the release of the string and replacing the finger for the next stroke (Carlevaro, 1979, p. 52).

The second regulatory condition is related to the material constraints on the vibration of the string without contact against the instrument or other strings. This condition can also be linked to the length and diameter of the string being played, but, in general, its proximity to the scale is the main factor limiting the maximum vibration amplitude. The lateral distance between the strings is the third regulatory condition considered for the action in question, since this property limits the possible trajectories that the finger can develop to start the stroke. Recognizing that the material and diameter of the strings used are relevant factors for the interaction with the finger, we chose not to count these characteristics as regulatory conditions in this elaboration. Since the characterization carried out aims to describe the skill to perform an isolated stroke, the condition referring to the resistance offered by the string already includes the possibility of differences in the interaction caused by the diameter of the string and the material that constitutes it. These differences are more relevant when combined actions are considered, which is beyond the scope of this paper. The following table (Table 1) lists the regulatory conditions considered in the characterization conducted here.

Table 1: Regulatory conditions: right-hand stroke

Regulatory conditions:	Notes:
String resistance exerted by the string in each stroke;	Proportional to the displacement and in the opposite direction to the movement;
String's maximum amplitude of vibration;	Limited by the proximity of the string to the frets;
Lateral distance between strings.	Constrains finger approach trajectories.

Action goals characterization for an isolated right-hand stroke

A given motor skill needs, among other elements, a goal to be achieved. As highlighted, the most important moment in a right-hand stroke as a motor skill is the instant immediately prior the string's release. It is the moment in which the guitarist can establish the parameters that define the characteristics of the sound (Rabaioli, 2020, p. 79). Understanding the goals to be achieved by a motor skill is a crucial element to enable the search for strategies to achieve it (Magill & Anderson, 2017), especially in musical practices, where the anthropometric characteristics of each instrumentalist substantially alter the viability of some techniques.

Once again, the importance of distinguishing the goal of a motor skill to be performed from the pattern of movements used is reinforced. Although the same motor action performed by different individuals shares similar goals, the motor availability (Pedroso, 2022, p. 48, 97) of each instrumentalist guides the choice of the pattern to be used to achieve them. In the same sense, the action will be guided by the environmental context in which it is carried out, as represented by the regulatory conditions described in the previous section.

The primary goal of the action of the right hand in guitar technique is then related to the control over the parameters of interaction with the string available for sound emission (Pavlidou, 1997). Based on Taylor (1978), Pavlidou highlighted the importance of the angle of string release from the two most widespread ways of pulsing the string for the guitar technique: the free and rest strokes. The author points out that the difference between the two approaches is the angle of string release, and that this variance in the release of the string, from perpendicular to parallel, can be exploited according to the desired musical effect. Due to its physical characteristics, specifically the soundboard, the guitar is more prone to react to perpendicular than to parallel forces, since the transfer of energy to the top is more efficient (Pavlidou, 1997, p. 9). Another contribution of Pavlidou's theoretical model worth considering is the friction between the finger and the string at the moment of the stroke. A restorative force arising from the friction between the finger and the string at initial contact can, by rotating the string on its own axis, alter the initial vibration parameters at the instant of release.

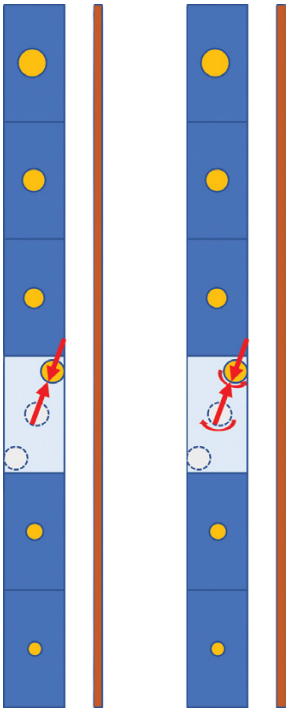

Figure 1: Break down of the acting forces on a right-hand stroke based on Pavlidou (1997)

In Figure 1, we have presented the side view of the guitar strings highlighting the displacements and forces involved in a right-hand stroke. In this example, the third string is moved obliquely towards the soundboard. The red arrows denote the opposing reaction of the string in relation to the stroke, including the rotation of the string on its own axis as a function of friction with the finger. This characteristic can also be related to the material difference between strokes with or without nails.

Without nails, the moment of string release is marked by contact only with the surface of the finger, which can lead to a sound with little definition and amplitude, especially on the three highest strings. A stroke performed with a fingernail, in turn, has more defined and controllable characteristics since the point of contact has a more regular surface and a lower coefficient of friction with the string than using only the digital surface. In the same sense, the width of the area of interaction between the finger and the string plays a significant role, as it influences the number of vibrational modes activated in each stroke. The author explains that "The number of harmonics that exist in the sound spectrum of an ideal string are theoretically infinite. However, in the sound spectrum of a real string there is always a frequency above which higher partials are almost absent. The cut-off frequency is created and modified by two mechanisms, (i) the stiffness of the string mentioned above, and (ii) the width ω of the plectrum that excites the string. […] While playing, the guitarist adjusts the cut-off frequency in order to alter the sound quality, by changing the angle of attacking the string" (Pavlidou, 1997, p. 21).

In addition to the direction of the displacement applied to the string, the guitarist also has the possibility of controlling the area of the point of contact with the string to obtain variations in the characteristics of the sound produced. Figure 2 illustrates the possibility of changing the width of the contact area between the finger and the string at the time of touch. On the left side of Figure 2, it can be observed that the index finger develops a

trajectory perpendicular to the string, resulting in a larger contact area. On the right side, an oblique trajectory is used, which results in a smaller contact area. We emphasize that the contact area which influences the characteristics of the sound emitted will be the area in contact with the string at the time of the release.

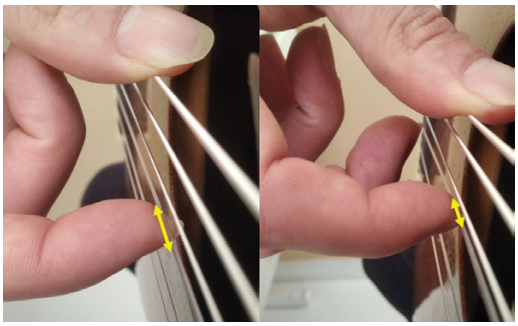

Figure 2. Different contact width for a right-hand stroke

Another interaction parameter considered by Pavlidou refers to the response of the finger to the displacement of the string at the moment of release: "The interaction process is also strongly influenced by the response of the finger-muscle. The model showed that the string trajectory and release conditions are very sensitive to any alterations in the function which describes the relation between the muscle expansion and the restoring muscle force. [...] The importance of the finger-muscle response in the sound quality points out the need for an experimental evaluation of its form. It is very likely that finger-muscle responses differ among individual players" (Pavlidou, 1997, p. 178).

Returning to Gentile's taxonomy, we highlight the function of action linked to the manipulation of objects, in which it is necessary to accommodate the imbalance created by the object in the skills with this characteristic. This aspect can be related to the establishment of the guitarist's posture, which plays a crucial role in the technical conception of the right hand.

In the agonist phase of the stroke, the finger moves the string to the desired position, which, in turn, exerts a force on the finger proportional to this displacement. Considering these conditions, it is possible for an imbalance in the disposition of the hand to occur, because at the beginning of the antagonist phase, the finger will no longer balance the load carried out by the string immediately before release. Ideally, the string should be released preserving the parameters established by the guitarist while keeping the postural stability of the right hand. Thus, we can consider four goals of the action for a given touch of the right hand, listed in the following table (Table 2).

Table 2: Right-hand stroke: characteristics and action goals

Action Goals	Notes:
String displacement	Amount and direction of the displacement imposed on the string;
Contact area	Width of the contact area with the string at the moment of release;
Keeping the parameters	Conservation of the established parameters at instant of string's release;
Postural balance	Accommodation of the postural disruption caused by the stroke.

Conclusion

Within the scope of this article, we presented a theoretical framework favouring a comprehension of right-hand strokes in the classical guitar technique as a motor skill. We emphasized the difference between the movements that constitute a given action and the skill being performed (Magill & Anderson, 2017). This distinction is pertinent in the teaching and learning of instrumental technique, considering the risk of describing motor skills only as patterns of movements to be performed without considering the goals to be achieved through action.

Regulatory conditions, as described in Gentile's taxonomy, are related to the physical properties of the instrument, as they are the material constraints for the performance of the action. The action goals arein turn linked to the interaction parameters that influence sound production the most and that can be considered during the conception of a right-hand stroke. The action goals and regulatory conditions were derived from the parameters of interaction between the finger and the string (Pavlidou, 1997). In this sense, it was possible to identify a relationship between the postural disturbances generated by each stroke and the possible implications for the conception of hand positioning.

Through this elaboration, we hope to contribute to a better understanding of this component of guitaristic action and offer guitarists a conceptual structure that allows them to evaluate the motor aspects of their technique, regardless of the orientation or technical school practiced. In this

sense, the concepts of regulatory conditions and action goals allow us to contextualize the interaction parameters with elements of instrumental technique, which can serve as a reference to consider the movements available at a given stroke of the right hand. Although this theoretical approach was developed to understand premises of the technical paradigm proposed by Abel Carlevaro, this framework has the potential to be applied in any instrumental setting mediated by motor skills.

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Participating in a Project with Practical Stage Experience: Effect of Project-Based Learning on Opera Singing Students' Well-Being

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Abstract

This study explores how project-based learning with practical stage experience influences the well-being of young opera singing students. Drawing on Martin Seligman's (2011) PERMA model of well-being and situated learning theory, eight semi-structured interviews were conducted with participants six months after their involvement in the project "Opera: Past, Present, Perfect!". All participants had limited or no prior stage experience. The thematic analysis revealed four interconnected themes: Stage Experience and Acting, Interpersonal Relationships, Working Attitude, and Achievement and Personal Change. Participants described how experiential learning within a collaborative and professionally mentored environment supported both their artistic development and personal well-being. The findings suggest that situated learning activated all five PERMA components, with particularly strong effects from interpersonal relationships, which often facilitated positive emotions, meaning, and a sense of achievement. Participants also reported that gaining stage experience, working under fair and engaged mentors, and feeling respected contributed to lasting improvements in self-confidence, social skills, and motivation. The study highlights the importance of integrating performance-based experiences into formal vocal training, not only for developing professional competencies but also for supporting students' psychological resilience and well-being during the critical transitional period between education and professional life.

Keywords: well-being, opera singers, situated learning, participative learning

Introduction

The most common approach in psychological research on what contributes to a "good life" focuses on reducing symptoms of poor mental health and managing existing problems (Ascenso et al., 2017). In contrast, positive psychology argues that feeling good is not simply the absence of disorder or illness (Seligman, 2008). Within this framework, the idea of merely "surviving"—or as some authors put it, getting by in life—is replaced with the goal of living life to its full potential (Ascenso et al., 2017).

Research on the well-being of professional musicians shows that being professionally involved in music can lead to various psychological and emotional difficulties. This contrasts with engagement in music in a non-professional context, which is often beneficial (Ascenso et al., 2017). As a result, studies on professionals tend to address specific problems, their causes, and possible solutions. The most frequently discussed topic in this context is anxiety (e.g., Fehm & Schmidt, 2006; Fernholz et al., 2019; Mirović & Bogunović, 2013; Mor et al., 1995; van Kemenade et al., 1995). A similar trend is seen in research on professional opera singers, where the focus usually lies on the difficulties associated with singing (e.g., Barefield, 2012; Cupido, 2018; Kokotsaki & Davidson, 2003; Spahn et al., 2010). While well-being has been explored among opera singers, these studies typically involve already established professionals (Allison, 2021; Cupido, 2016). Studies on young opera singers cover a range of topics, from differences in experience, knowledge, and anxiety at leading conservatories in the U.S. (Kwak et al., 2014), to the influence of vocal classification (Fach selection) on young singers (Nguyen, 2015; O'Bryan, 2015), and the impact of health, personality traits, and sociocultural context on their development (Sandgren, 2005). However, what is noticeably missing is a perspective grounded in positive psychology, particularly when it comes to students in the educational phase of their professional journey.

This gap is significant, as the formative years of higher opera education are critical not only for the development of technical skills but also for shaping students' psychological and emotional resilience. Opera students face intense pressure to perform at a high level while simultaneously developing

their artistic identity. Sandgren's (2005) research emphasizes that this developmental phase involves complex interactions among health, personality, and educational demands, during which self-concept and artistic autonomy gradually emerge. At the same time, Kirby (2021) notes that many undergraduate vocal performance programs do not provide adequate support for holistic well-being, often neglecting dimensions such as emotional balance, physical health, and the ability to manage the occupational realities of the opera profession. Integrating applied stage practice with structured wellness education could offer a more supportive framework for students navigating this high-stakes environment.

This shift in focus—from pathology and professional burnout toward proactive well-being in the educational context—aligns with the core tenets of positive psychology. It recognizes that supporting students' flourishing during their studies can build a healthier foundation for their professional lives. Therefore, this paper aims to explore how project-based learning with practical stage experience may influence the well-being of young opera singers still in training, offering a rare intersection between applied pedagogy and positive psychology in music education.

Project-based experience as a framework for situational learning

This study specifically examined the impact of situational, practice-oriented learning on the well-being of young opera singers. Although one case study explored the effects of situational learning on young opera singers within a professional opera production (Dullea, 2017), its focus was on the process of acquiring professional skills, that is, the skills developed during such an experience. By contrast, the present research emphasizes how situational learning within a project involving practical stage experience influences the well-being of young singers.

Drawing on Lave and Wenger's (1991) theory of situated learning, which frames learning as a social process embedded in participation within communities of practice, Dullea's (2017) study explored how young opera singers gained access to real-world artistic practices through involvement in a professional production. The findings revealed that experiential learning in this context—working alongside professional directors, coaches, and singers—allowed young artists to develop not only technical and interpretive competencies but also a sense of belonging and identity as emerging professionals (Dullea, 2017). The rehearsal and production processes were understood as sites of legitimate peripheral participation, through which singers moved toward fuller participation in the professional opera community.

Similarly, Hamilton (2015) emphasized the importance of learning in authentic performance settings in her study of acting training for opera singers. Interviews with performers and directors confirmed that technical and creative stage skills are most effectively developed through participation in staged projects, rather than through isolated classroom instruction. Her findings support the value of incorporating performance-based experiences into conservatoire training, highlighting that professional expectations today demand not only vocal excellence but also collaborative adaptability, physical expressivity, and interpretive initiative—all of which are developed in the context of practical rehearsal work.

Kirby (2021) also argues for a curriculum that integrates applied stage practices through real or simulated production environments. His research highlights significant gaps in undergraduate vocal training, particularly in areas such as movement, character development, and wellness, which are crucial for preparing for professional stage performance. He advocates for embedding project-based experiences that mirror professional practice to effectively address these gaps.

Taken together, these studies support a situated learning framework in which project-based operatic experiences serve as critical learning environments. They point to the potential of such environments, not only for the acquisition of skills and the formation of professional identity, but also, as is yet to be examined, for supporting the well-being of young singers. The present study builds on this hypothesis by examining how situational learning within a practical project context affects well-being outcomes.

Martin Seligman's theory of well-being: The PERMA model

The framework used in this study is Seligman's theory of well-being (2011), in which well-being is defined as a five-dimensional construct, known as the PERMA model, that consists of positive emotions, engagement or the state of being absorbed while doing something, relationships (especially feeling loved and valued), meaning (feeling that we are doing something significant), and achievement

(sense of accomplishment). Each of these five components meets the following: (1) they enhance well-being, (2) they are pursued for their own sake, and (3) they are individually defined and measured separately from each other (Seligman, 2011).

Positive psychology assumes that the components of the well-being construct—positive emotions, engagement, relationships, meaning, and achievement—if present in a former experience may "predict future positive outcomes, besides relating to higher psychological and physical levels of functioning in the present" (Ascenso et al., 2017, p. 2). Applied to the context of young opera singers, this implies that good feelings are more likely to persist into the next phase, the beginning of professional engagement, if they exist during formal education.

"Opera: Past, Present, Perfect!" project

The situational learning context for this study was the project "Opera: Past, Present, Perfect!" organized by the Belgrade-based NGO Musical Opera Theatre Organization (MOTO), funded by Creative Europe, and carried out from February 2021 to February 2023. The program was intended for young opera artists, including all professional profiles participating in staging an opera (singers, instrumentalists, composers, conductors, directors, etc.). The project was conceived as a series of workshops, lectures, masterclasses, panel discussions, concerts, exhibitions, and, most importantly, several opera productions. Its primary aim was to connect and educate young professionals, fostering a cross-sectoral, cross-national, and intergenerational dialogue between emerging talents and their mentors. A specific goal was to establish a strong network of young professionals involved in the opera production process. Participants worked under the mentorship of distinguished artists from the field of opera and theatre.

The design of the "Opera: Past, Present, Perfect!" project as a multi-phase, collaborative, and participatory program aligns with pedagogical frameworks that emphasize situated learning and learner-centred environments. According to Lave and Wenger (1991), learning occurs most effectively within communities of practice, where individuals develop competence and identity through active engagement in authentic, socially embedded contexts. This is particularly relevant in artistic domains, such as opera, where knowledge is not transmitted solely didactically but co-constructed through performance, rehearsal, and mentorship. From a psychological perspective, research shows that music-related activities—especially those involving active participation such as performing, rehearsing, and collaborating—can lead to improvements in emotional well-being, self-efficacy, and social connectedness (Viola et al., 2023). Schmid (2024) further suggests that well-being should not be viewed as a by-product but as an intentional teaching objective in music education, arguing that learning environments that support autonomy, creativity, and emotional expression have a profound impact on learner flourishing. The MOTO project fulfils several of these pedagogical and psychological conditions by offering participants the opportunity to rehearse and perform operas under professional guidance. It provides a socially supportive learning setting, enables meaningful artistic engagement, and encourages the formation of professional identity. While this research investigates these effects from the perspective of well-being, existing literature supports the hypothesis that such project-based experiences have the potential to promote psychological and social resilience in young opera professionals.

Aims

We intended to find out the answers to the following questions:

1) Did participation in a project with practical stage experience help singers increase their well-being, and how?

2) What affects the well-being of young opera professionals in a negative way?

3) How can the positive effects be incorporated into formal education more effectively, to influence the sensitive transition from student to professional life and their future careers?

Method

Sample

The project "Opera: Past, Present, Perfect!" involved more than 250 young artists and professionals from several European countries and the Western Balkans region, including singers, instrumentalists, répétiteurs, composers, conductors, stage directors, and students of visual arts. The research sample consisted of eight singers (five female, three male, aged 20 to 28) who had participated in multiple activities within the project, including at least one full opera production.

Participants were selected based on their availability and willingness to participate in an interview conducted six months after the project's completion. All of them had little or no prior experience performing in staged opera productions before their involvement in the project. The main selection criteria were: (1) participation in more than one component of the project (e.g., productions, workshops, or masterclasses), and (2) having performed a leading role in at least one opera production. These criteria ensured that participants had substantial, practice-based engagement and could offer in-depth reflections on the learning and performance process.

Instruments

The research technique was a semi-structured interview, based on the PERMA model, consisting of eleven questions designed around each of the five components. The questions were specifically designed for this research by the first author (see Appendix). However, the methodology is based on the aforementioned study on the well-being of professional musicians (Ascenso et al., 2017).

Procedure

This study was designed as an *ex post facto* investigation. Participants were interviewed six months after completing their involvement in the project. No data had been collected before or during the project itself; therefore, the study is based entirely on participants' retrospective reflections. The interviews were conducted individually and recorded with participants' consent. Each interview lasted between 30 and 45 minutes, and the recordings were fully transcribed manually by the researcher without the aid of transcription software.

Data analysis

The interview data were analysed using a qualitative thematic analysis approach, following the method described by Braun and Clarke (2006). The process was conducted in four steps. First, the recordings were manually transcribed in full by the first author without the use of transcription software. Second, the transcripts were segmented, and initial codes were generated by identifying meaningful units of text. Third, related codes were grouped into sub-themes based on conceptual similarity. Finally, these sub-themes were clustered into overarching themes that captured key patterns across the data. All coding and theme development were conducted by the first author.

Results

Analysis of the interview transcripts resulted in four main themes: Stage Experience and Acting, Interpersonal Relationships, Working Attitude, and Achievement and Personal Change. Each theme reflects a distinct aspect of the participants' professional and educational experiences, particularly in relation to their perceived well-being. The theme of Interpersonal Relationships was especially prominent and included several recurring sub-themes.

Theme 1: Stage experience and acting

The first theme concerns stage experience and acting. When asked about their professional activities and feelings regarding their careers before participating in the project, the singers emphasized the unfortunate reality that gaining stage experience in high school is generally not possible (except for concert performances). The opportunity to take part in a staged performance was described as an exception, typically made possible by the enthusiasm of certain singing teachers or through personal initiative.

> "Before college, I was lucky to have a professor who actually worked with us. We basically did not have any courses [concerning staged performance]. That was terrible for me, no acting, no stage movement, nothing. You do not even have stage movement at the university, and in high school, you have nothing." (P1)

The lack of stage experience led to negative feelings, such as self-doubt and an awareness of being unprepared for one of the essential aspects of a professional singing career.

> "I did not have any doubts about my voice, as much as I doubted my acting ability because no one had ever done that with me. I thought I was completely incapable." (P1)

> "I did not know how skilled I would be at it, and I did not know what would be asked of me exactly. I was just worried about that uncertainty, what it would look like." (P2)

When asked which activities during the project evoked positive feelings, the majority of respondents—besides mentioning the masterclasses with conductor S.D.—highlighted the acting workshops, stating that these had a very positive impact on their mood and even a therapeutic effect. One participant also mentioned the masterclass

with stage director J.M., enthusiastically stating that it changed him both personally and professionally.

Theme 2: Interpersonal relationships

The second theme concerns interpersonal relationships and is divided into three sub-themes: communication, support, and fairness. All participants clearly stated that the interpersonal relationships within the project evoked positive emotions, as well as a sense of meaning and engagement. They also emphasized the impact of a positive group atmosphere on their well-being, sense of purpose, and motivation to work.

Sub-theme 2.1, *Communication*, encompassed two contrasting experiences: mostly negative ones related to the past, and mostly positive ones connected to the project experience. The majority of the negative examples stemmed from formal higher music education settings, while others came from rare stage experiences outside of school. These included a complete lack of communication, disrespect from teachers or senior colleagues, digressions from singing to private matters during lessons, and a general disregard for others' opinions.

> "Someone who is an authority decides not to listen to you, that is the most terrible thing that can be done to me. He will not communicate properly on a human level." (P3)

> "Few soloists wanted to communicate with us [with younger colleagues, A/N]. I know that there are acrobatic things in this business, and when someone reaches that level, I understand—you want your peace, your environment, because it is stressful for you. But these performances were more like a play. And yet, everyone created an atmosphere that felt like 'high school drama'" (P4)

> "It got to the point where she yelled at me, and I cried in class, many times." (P2)

> "The older colleagues were nice to me [speaking about the experience in theatre, A/N]. But of course, I also had the opportunity to see how unpleasant it is when the choir addresses the soloists inappropriately. And the freedom that everyone can say anything to anyone is horrible to me. Mutual disrespect." (P5)

In contrast, when reflecting on their experience in the project, participants highlighted open communication as a key element of the positive group atmosphere. They felt accepted and respected by both colleagues and superiors/professors, and they felt free to ask questions and express their opinions—even when those opinions differed from others'.

> "I expected a little more gossiping, hypocrisy, and so on. I was surprised that everyone [colleagues, A/N] accepted me so easily and that they were sociable. There was no that 'Who is this person? What do they want, coming here from high school?' attitude." (P6)

> "At MOTO, we had the opportunity to ask questions directly if something interested us, and there was a sense that each of us was being noticed and considered individually. Everyone even knew my name. It was remarkable because it's not usually like that in the theatre—nobody really seems to care." (P4)

Support emerged as sub-theme 2.2. The participants' statements indicated that the project leaders carefully monitored their needs and progress. They felt respected and accepted, which had a positive impact on them. This aligns with the third component of the PERMA model. One participant specifically highlighted the direct influence of support from their environment on their achievements.

> "Everyone wanted to connect, get to know each other, sing together, and offer support. [...] What stood out to me was how everyone supported one another, from the lecturers to the last colleague. I am grateful that they (colleagues, ed.) accepted me immediately and that I succeeded (in completing the project tasks, ed.) because they are older, more experienced, and they were all at the university. I was the only one from high school, and it meant a lot for my progress." (P6)

This reflects the link between relationships and the achievement of goals, which corresponds to the fifth component of the PERMA model. In relation to the second component, engagement, some participants mentioned negative reactions from colleagues or professors toward their efforts and willingness to work. They contrasted this with the positive experience in the project, where their effort was recognized and appreciated.

One statement was particularly significant, as it illustrates the connection between several components of the model: positive emotions, relationships based on respect and support, the value

of engagement and effort, resulting in excellence and precision in work, and a clear sense of direction.

> "Masterclass with S. D. – I was more than satisfied (*positive emotion*). You know when someone else tells you that you're worth something. Someone who isn't protecting you, who hasn't listened to you for a long time, and who is not your professor (*relationship*). You come, you stand, and he says that 'this' and 'that' need to be improved (*achievement*), but you're worth it. Also, he paid a lot of attention to who was present, who was punctual, and who knew their part (*engagement*). You know, all criteria had to be met to get a chance. At 10:00, he would be there, punctuality, precision." (P1)

The third important sub-theme (2.3) that emerged within the theme of interpersonal relationships is *fairness*. In connection with the sub-themes of support and communication, most of the negative experiences described prior to the project were related to fairness—specifically, the lack of recognition for effort.

> "I put so much of myself into my work, yet I'm not even sure if the opera director in *** knew who I am. Or anyone else there. Despite being right, I've even had situations where I was scolded during rehearsals. I'm meticulous and a perfectionist. I review videos before every rehearsal, analyse every step and choreography, and practice tirelessly behind the scenes. Meanwhile, someone else, perhaps a soloist, might be less prepared, yet I ended up being subjected to mobbing." (P4)

When asked about interpersonal relationships during the project, six out of eight participants spontaneously mentioned the recognition of effort — that is, fairness in the role selection process.

> "Those who worked hard were given more opportunities, while those who put in less effort received fewer. I recall instances where people were even removed from the performance, either because they didn't show up, had other commitments, or failed to learn their lines. Moments like those happened, and I believe that both we and those who made mistakes learned something valuable from the experience." (P6)

Whether through communication, support, or fairness, most participants noted that positive relationships fostered a constructive working atmosphere. This, in turn, led to effective teamwork and professional collaboration, which often developed into friendships. Participants reported that they worked voluntarily outside of rehearsals to improve performances, nurtured mutual respect, and supported one another during rehearsals. In the long run, this constructive atmosphere contributed to better singing outcomes and the successful achievement of goals.

Theme 3: Working attitude

The third theme concerned the participants' working attitude—that is, their own and their colleagues' approach to work. The discussion took two different directions. On the one hand, participants reflected on how (a lack of) engagement in the working environment could negatively affect their sense of meaning.

> "And I found it terrifying when someone said: I don't need rehearsals. It still horrifies me to this day. 'I've sung it 70 times, I don't need rehearsals.' Wait, what's the point of this profession then?" (P5) (previous experience in opera theatre, A/N)

> "They have no idea who's at fault (during the performance, ed.). All that matters to them is that the show goes on. They've never blamed anyone for such mistakes; they just let it slide. In their mind, the only thing that counts is that it happened. It's like when someone insists on having someone perform 'Queen of the Night' at a concert – even if it's a complete disaster – so that they can later say it was part of the program. It's utterly pointless." (P4) (previous experience in opera theatre)

On the other hand, participants described what dedicated, in-depth work looked like, how deeply they were involved in the staging process during the project, and how this positively influenced their emotions and sense of meaning.

> "It all makes sense when there's a clear process—when you think things through and strive to make everything better. When you're on stage, fully aware of every word, knowing what you're singing, what it means, and the purpose behind every movement—why you raised your hand at that moment. It's about dedicating yourself completely, right to the very end, so that when it's over, you're satisfied with having considered everything, understood it all, and ultimately made it work." (P7) (commenting on the staging process during the project, A/N)

Theme 4: Achievement and personal change

The fourth theme, Achievement and Personal Change, relates to the period following the project and its impact on the participants' professional lives. Participants recognized numerous benefits to their professional development as a result of the project. They mentioned several achievements, including becoming accustomed to working in a group, gaining experience with an orchestra, learning how to adapt programs to their vocal abilities, developing a sense of professional responsibility, understanding the process of preparing a staged performance, communicating with superiors, expanding their repertoire, gaining a clearer sense of direction in their future work, and accessing new opportunities that arose through their participation in the project.

> "Everything that happened on stage meant so much to me. Of course, the master classes and music rehearsals were important as well, but I was especially eager for the stage experience because that's something we really lack at university. Many things I use in my work today are things I wouldn't have learned without my experience at MOTO. During rehearsals, I didn't just focus on my own role—I paid attention to what everyone was doing and observed the entire process of creating a production, which I found incredibly fascinating." (P8)

> "That moment (participating in the project, A/N.) marked the beginning for me. People started reaching out, introducing themselves, and I was amazed to realise how many already knew about me or had met me during that time. I gained valuable experience that has helped me move forward, and I would love the opportunity to participate in similar projects or situations again. I feel more confident now, though I know there's always room for improvement." (P6)

In addition, participants reported changes in their personal lives, including the achievement of specific internal goals such as increased self-respect, calmness, relaxation, reduced fear of failure and stage fright, as well as greater confidence.

> "The main difference I notice between that period and now, after the project, is a significant reduction in fear and hesitation." (P8)

> "It helped me not only with singing but also in everyday life. It also had a significant impact on my acting. It helped me relax, and that's the greatest success. In general, once you get past those challenges, everyday things become easier. I was quite reserved before, but after all the rehearsals, the premiere, and everything else, I became more open, and that change had a lasting effect on me." (P7)

Discussion

This study investigated the relationship between situated, project-based learning involving practical stage experience and the well-being of opera singing students. The selected participants were at a pivotal stage in their development, either at the beginning of their higher education or in transition to professional life. This period is particularly sensitive, as these transitions represent some of the most demanding phases for young musicians and can significantly challenge their well-being (Ascenso et al., 2017).

To frame the discussion and clarify the study's contribution, it is important to return to the three main aims.

PERMA Model and project participation. The study's results indicate that all five components of the PERMA model were mentioned in the participants' reflections, but their interrelation was especially striking. Although the questions were designed around individual components, the responses often overlapped: positive emotions were frequently tied to interpersonal relationships, meaning was associated with collective creative effort, and a sense of achievement emerged from shared success. This finding aligns with Ascenso et al. (2017), who emphasize the relational nature of musicians' well-being and suggest that these components are deeply interconnected rather than isolated.

However, this study does not prove such interconnections; rather, their presence is suggested by the data, and further research with more rigorous methods would be required to establish causality. The qualitative approach made it possible to disclose how young singers interpret their experiences, revealing clear patterns of connection between different domains of well-being.

Key Aspects of situated learning affecting well-being. The most prominent theme to emerge was the importance of interpersonal relationships in the learning environment. Participants highlighted the contrast between isolated, individual singing lessons (typical for their formal education) and the collaborative nature of the project. Working within a team under fair and engaged mentors fostered not

only motivation but also emotional safety, which helped activate other components of well-being.

This aligns with situated learning theory (Lave & Wenger, 1991), which emphasizes participation in a community of practice as central to learning. In this sense, well-being and learning were not parallel outcomes, but rather mutually reinforcing: being included and valued in a shared professional process contributed to both personal confidence and professional growth.

Another important finding relates to engagement and competence. Several participants reported feeling more competent after the project, despite the relatively small number of performances. The simulated professional environment provided realistic challenges, but within a supportive context. According to Ascenso et al. (2017), perceived competence is a critical component of musicians' well-being, often deriving not only from technical mastery but also from successful real-world applications.

Interestingly, performance anxiety was not a dominant topic in the interviews. When mentioned, it was usually attributed to a lack of experience or preparation, rather than to the performance situation itself. This supports Ascenso et al.'s (2017) finding that anxiety tends to decrease when musicians feel supported and sufficiently prepared.

Psychological framing and situated learning. From a psychological perspective, the results support key principles from positive psychology, particularly that well-being is influenced not only by internal traits but also by context and relational dynamics. Group work, mentoring, and visible effort-based progress created a sense of purpose and belonging. These are all aspects that Seligman's (2011) PERMA framework highlights as central to well-being.

The project created a setting in which young musicians could feel that their contributions mattered. This concept is closely related to the concept of meaning within the PERMA model, as well as to the psychological idea of self-determination—specifically, the needs for competence, relatedness, and autonomy (Ryan & Deci, 2000). The situated learning model employed in the project enabled the fulfilment of all three of these needs.

While most participants reported overwhelmingly positive outcomes, the interviews also included reflections on individual experiences and expectations, some of which pointed to challenges related to stage preparedness or self-confidence. These perspectives remind us that even well-designed learning environments are experienced differently by each participant.

This study does not claim to generalize all opera singing students or young emerging artists, nor to isolate specific causes of well-being. However, it does offer insights into how carefully structured, collaborative, and mentored experiences—embedded in practice—can support psychological well-being in a crucial phase of artistic development.

Future studies might combine this qualitative perspective with pre- and post-project measures or explore similar models in other musical disciplines.

Limitations

This study has several limitations that should be considered when interpreting the findings.

First, the research was conducted on a small, non-random sample of participants who completed the "Opera: Past, Present, Perfect!" project and were actively involved in all phases. This means that the study did not include those who dropped out early or participated to a lesser extent—individuals who might have offered different, potentially more critical perspectives.

Second, the selection criterion favoured participants who had been given more significant learning opportunities through leading roles in the opera productions. This introduces a potential bias toward individuals with more positive and affirming experiences.

Third, the interviews focused exclusively on well-being as it related to the project experience. Personal characteristics, such as personality traits, mental health history, or life circumstances outside of music, were not considered. Moreover, previous research (Ascenso et al., 2017) suggests that musicians with broader life interests tend to report higher well-being.

Fourth, the coding and thematic analysis of the interviews were conducted by a single researcher. While every effort was made to ensure rigor and consistency, having only one coder increases the risk of subjective interpretation and limits inter-rater reliability.

Future studies could address these limitations by including a broader participant group, comparing well-being outcomes between those more and less involved in the project, and applying a mixed-method approach to triangulate results.

Conclusion

The results of this paper suggest that the well-being of young singers significantly benefits from participating in a project that provides practical stage experience simulating their future professional lives. From their answers, it is also clear that formal education programs should strive to provide them with stage experience alongside vocal training as early as possible. Meaningful relationships have a significant impact on musicians' well-being, emphasising the need for social skills training (Ascenso et al., 2017). The participants confirmed this, highlighting greater dedication to work in their working environment, more open communication, and relationships based on respect and appreciation as the most beneficial aspects of the project.

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Appendix: Interview questions

1. Let's begin by talking about your life before this project. How would you describe your professional life and sense of well-being at that time?
2. Which specific professional activities make you feel satisfied, and why?
3. Is there anything in your professional life that has negatively affected your well-being?
   (Follow-up: How would you describe your relationships with colleagues, the sense of meaning in your work, or your engagement with tasks? What kinds of things might worry you, discourage you, or make you question your desire to pursue this profession?)
4. I'd like to talk a bit about the challenges of your profession. What kinds of problems do you face?
   (Follow-up: Did participating in the project help you resolve any of these issues or change the way you approach solving them?)
5. Which activities within the project triggered positive emotions for you?
   (Why do you think that was?)
6. How did you feel after going through the rehearsal and performance process?
   Describe the preparation process in terms of how immersed you felt in it.
7. Let's talk about your relationships with colleagues. What were your beliefs about peer relationships before the program? How did you feel about interpersonal relationships during the project?
   In what way did the project activities influence your understanding of relationships with colleagues?
8. Let's talk about meaning: why do you do what you do? What does it mean to you?
   How does your everyday work influence your sense of purpose? How did the project affect this, and why?
9. I'd like to talk about your sense of achievement. What is your goal in pursuing singing, and how have you worked toward it?
   How realistic did that goal seem before the program, and how did you feel about it? Did any project activities influence this, and in what way?
10. In what ways do you feel different after the program?
    Which activities or aspects of the project contributed most to that change, and how?
11. How has this experience influenced your overall sense of well-being—both in your personal life and in the professional activities that followed?

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Improvisational Theatre as a Tool for Enhancing Musicians' Expressiveness

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Abstract

This paper emphasizes the importance of rethinking the concept of *expressiveness* and how we approach it in higher music education (HME). It highlights that current teaching practices often focus on acoustic elements of performance, while overlooking the visual ones, despite evidence that ancillary gestures, body movement, and facial expressions can significantly impact the perception of *expressiveness* in music. Drawing on embodied cognition and theatre approaches—particularly improvisational theatre—the paper explores how these practices can support musicians in developing expressive skills. Improvisational theatre provides a flexible and safe environment for musicians to explore new ways of playing their instruments, allowing them to engage with and embody diverse emotions, as well as to abstract expressive concepts that they link to their repertoire. This may enable students to effectively connect sound, movement, and expressive intention, and communicate with audiences more convincingly. The paper also acknowledges challenges such as the need for specialized educators, interdisciplinary curricula, and openness to explorative teaching approaches, advocating thoughtful implementation to enrich and broaden teaching approaches to *expressiveness* in HME.

Keywords: music expressiveness, emotion, embodiment, theatre, improvisation

Rethinking 'expressiveness' and teaching approaches

Expressiveness is a consistently discussed topic in higher music education (HME), but its definition remains ambiguous and there are remarkable differences in how the term is conceptualized (Fabian et al., 2014). A substantial body of literature revolves around emotion as an essential component of expressive performance (Gabrielsson & Juslin, 2003; Juslin & Laukka, 2003; Juslin & Sloboda, 2010; Van Zijl et al., 2013; Weintraub, 2016). Others adopt a broader view, also considering atmosphere, ideas, imagery or motions associated with the musical work (Meissner & Timmers, 2020). Weintraub (2016) argues that ideas, imagery, or motions can also be linked to emotions and that emotions are, therefore, at the core of any expressive performance, while Fabian et al. (2014) state that seeking to delineate *expressiveness* from emotion might make it more concrete and attainable for some individuals. This persistent conceptual ambiguity poses significant challenges for both students and educators.

Despite varying conceptualizations, there is a general consensus that *expressiveness* is achieved (or rather perceived) through the manipulation of both acoustic elements such as articulation, dynamics, or tempo, as well as visual elements like ancillary gestures, body movement, or facial expressions (Davidson, 2007; Fabian et al., 2014). Yet, in HME, most teaching approaches to *expressiveness* focus primarily on the acoustic elements of performance (Juslin & Petri, 2000; Juslin & Sloboda, 2010), neglecting the visual ones, despite growing evidence of their critical role in the perception of *expressiveness*.

The role of visual elements in expressive performance

Expressiveness is not only heard but also seen. Research has shown that musicians' motor behaviour during performance is a significant source of perceptual information, as it helps audiences better differentiate musicians' expressive intentions and often serves as a performance quality indicator (Davidson, 1993; 2007; Waddell & Williamon, 2017; Tsay, 2014; Rea, 2015). In fact, according to Davidson (1993, 2007), visual information perceived through the musicians' movements can indicate *expressiveness* more effectively than purely sonic information. Juchniewicz (2008) found that physical movement also increased ratings of sonic expressive elements such as phrasing, dynamics, and rubato, providing evidence of the influence of

visual elements on the processing and perception of sound.

Beyond enhancing the perception of expression, visual cues can also influence how audiences evaluate performance accuracy. Studies by Behne & Wöllner (2011) and Rea (2015) confirm that it is relatively easy to manipulate perceived sound through what is perceived by the eye, leading listeners to overlook or "forgive" a performer's mistakes when these are accompanied by a confident facial expression (Waddell & Williamon, 2017).

The interplay between sonic and visual elements also affects how convincingly emotions are conveyed. In a live music performance that combines acoustic and visual elements, contradictory body language can influence how the audience perceives what the artist is trying to convey through the music. Visible physical tension in a joyful theme, excessive movement linked to a sad motive, or lack of animation during an upbeat tempo may affect the audience's perception of the performance (Rea, 2015). Allingham and Luck (2022) found that "different approaches to body movement can affect ratings of audible expressivity". For instance, restricting movement reduced perceived expressivity in 'sad' melodies, while in some cases reduced movement enhanced expressivity in a 'happy' melody. Similarly, Van Zijl & Luck (2013) showed that "distinct emotions are often associated with certain qualities of body movement". Taken together, these studies suggest that movement interacts with the emotional character of the music in nuanced ways, rather than simply increasing expressivity by itself.

While there is still limited understanding of how particular movements can express emotional content in music (Saarikallio et al., 2024), many musicians agree that emotional expression requires the performer to feel the emotion internally (Lindström et al., 2003; Persson, 2001). This idea is not new, as it is in line with historical perspectives already present in the Baroque era, such as the "doctrine of affects". In addition to supporting the idea that music had the ability to arouse affective states within the listener, the "doctrine of affects" also provided instructions on how performers could better convey affective states to the listener. For instance, in his treatise "True art of playing keyboard instruments" (1753) C.P.E. Bach wrote:

> "A musician cannot move others if he is not moved himself; therefore, he necessarily needs to be able to induce himself all emotions which he wants to arouse in his audience [...] In languishing, sad passages, he becomes languishing and sad. You see and hear it in him."

These perspectives contrast with sonic-centred models of *expressiveness* by recognizing the body and its affective experiences as vital to expressive performance (Bania & Skowroneck, 2020). However, inducing emotions in order to express them is a challenging process. Although musicians often use different approaches to it, they are not always successful (Van Zijl & Sloboda, 2010). Furthermore, if musicians engage themselves in intense veridical emotions, their performance could be negatively affected. According to Gabrielsson & Juslin (2003), musicians should "strive for emotional identification but still have some conscious control of performance", while Wöllner (2017) suggests that musicians must *act as if* they are experiencing certain emotions. When musicians learn to do that, audience members are moved in ways similar to their emotional involvement when watching actors in a theatre play.

Broadening the framework for teaching expressiveness

The conceptual ambiguity presented earlier and the overemphasis on acoustic elements of performance when teaching *expressiveness* in HME pose challenges that need addressing. Furthermore, instructional strategies often lack clear goals, specific tasks, and systematic teaching patterns (Karlsson & Juslin, 2008; Meissner, 2021; Nieto, 2015). Some scholars have suggested that the reason for this might be that a musician's knowledge of expressive skills is often tacit or intuitive (Chávez Prado, 2016; Lindström et al., 2003; McPhee, 2011, Meissner, 2021) and therefore cannot be easily taught. As a result, learners are often expected to acquire these skills on their own and intuitively.

Given the strong evidence that visual (embodied) elements play a critical role in the perception of *expressiveness*, there is a clear need to rethink *expressiveness* and broaden the framework for teaching it. The previous section suggests that understanding the relevance of the visual elements in performance, as well as the constant interplay between acoustic and visual elements, can enable musicians to better connect with their audiences. However, developing control over such interplay and learning to master it requires a more explicit process of thought (Minafra, 2021), along with embodied educational strategies that address it properly. Inspired by Wöllner's *act as if* concept and

their comparison to theatre, the following section explores theatrical approaches to *expressiveness*, drawing parallels with musical performance to identify transferable practices that could be used as teaching strategies for *expressiveness* in music.

A glimpse into theatre approaches

The belief that performers must embody affective states in order to arouse them in the audience is also central to some of the most renowned theatre training approaches. For centuries, theatre training techniques have used physical exploration (motion) to stimulate imagination and create affective states (emotions) in actors. These approaches allow actors to engage emotionally and mentally with fictional circumstances (Kemp, 2012), facilitating development of *expressiveness*. Konstantin Stanislavsky, the creator of the 'Method' (method-acting) stated that acting comes from *living through* (embodying) the given circumstances of a part (Clare, 2017). Similarly, Michael Chekhov, another influential theorist, emphasized "proprioceptive awareness of movement as a path to attaining psychological states relevant for embodying characters and inhabiting fictional spaces" (Olenina et al., 2019).

Theatre methods such as Stanislavsky's or Chekhov's are grounded in embodied cognition theories**.** These theories claim that physical experience shapes conceptual thought, and this is always contingent upon the body's interactions with both the physical and social environments in which it is immersed (Kemp, 2012; Schneegans & Schöner, 2008). Cognition is generated by a continuous body-mind relationship in which the moving body constantly interacts with the environment. Consequently, consciously chosen physical activity can lead to attaining affective states and help individuals understand and therefore express an emotional truth (Kemp, 2012), facilitating communication with their audiences. This is also true for music, since bodily movement also shapes the way we feel, experience or understand music (Leman, et al., 2018). For that reason, embodying emotions that musicians link to the repertoire while playing their instrument —or rather using the musical text as a script they need to embody— could enable them to connect movement-sound-expressive intention in a meaningful way (Bremmer & Nijs, 2022). Such strategies could also extend to the expression of more abstract concepts, such as atmosphere, ideas, imagery, or motion associated with a piece of repertoire.

Improvisational theatre: a promising tool for musicians

Even though theatre strategies may provide useful tools for teaching *expressiveness* in music, their direct application to music training is not without obstacles. If such approaches are to avoid posing additional challenges for music students, their strategies should be integrated with the specifics of music performance. One way to facilitate this integration is to focus on a feature common to many theatre pedagogies: the use of improvisational exercises to develop skills that can later be applied in scripted roles. In this respect, improvisational theatre offers a more flexible and accessible framework that closely aligns with the spontaneous nature of musical performance.

Improvisational theatre (improv) is a form of unscripted performance that relies on individual and group spontaneity as a means for creation. Unlike traditional theatre, where actors work with pre-written scripts, improvisational theatre actors create the characters, dialogues, and narratives on the spot, usually based on prompts provided by the audience. Viola Spolin, American theatre academic and educator, unknowingly laid the foundation for this groundbreaking form in the 1950s and improvisational theatre soon gained worldwide popularity. Spolin's premise was the following: "Everyone can act. Everyone can improvise. Anyone who wishes to can play in the theatre and learn to become 'stage-worthy'. We learn through experience and experiencing only, and no one teaches anyone anything" (Spolin, 1963). While in standard theatre the 'outcome' might be paramount, in improvisational theatre the 'process' (experience) takes precedence, serving as the basis of any insight the individual may acquire.

During an improvisational theatre performance, actors give propositions (whether verbal or physical) to one another and slowly move the narrative forward in co-creation. There is no pre-agreement, and every detail of the interaction is completely made up on the spot and built upon what is previously said. There are several principles that allow individuals to do this successfully (Jackson, 1998; Drinko, 2016). Although different sources have described them slightly differently, I would like to summarize them in three main principles, based on my experience as both an improv trainer and trainee: 'Here and Now', 'Accept and Build', and 'Make your Partner Look Good'. Each principle is described below, along with its practical implications.

- **'Here and now':** for co-creation to take place, improv actors need to stay fully present, avoiding distractions from the past or future (Drinko, 2012). To achieve this, active listening serves as an anchor, as it helps individuals ground themselves and react to their surroundings appropriately. Active listening is one of the most important skills that improv training focuses on.
- **'Accept and build':** commonly referred to as 'Yes, and', this principle means that improv actors must accept what is offered in the scene and add to it, going along with what is first suggested (Jackson, 1998). This requires minimizing judgment towards their partner's offers as well as their own impulses, while letting go of pre-conceived ideas or expectations.
- **'Make your partner look good"**: although not always explicitly discussed in improvisation literature, this principle can be viewed as a logical extension of the previous two. In my teaching practice, I emphasize this concept as a distinct and vital principle. Spontaneous creation requires a sense of trust that allows individuals to embrace vulnerability and take risks. Focusing on making one's partner look good fosters collegiality and enhances the effectiveness of the core principles.

These principles foster an environment of mutual trust, effective collaboration, and expressive risk-taking, freeing individuals from approval or disapproval mindsets and encouraging them to explore their identity and find new ways of self-expression while engaging with others without feeling judged (Spolin, 1963). These features can benefit both solo and ensemble performance.

It is, however, in the acting practice itself that we can find key elements to potentially enhance musicians' *expressiveness.* For example, improvisational theatre exercises can help musicians engage with and embody different emotions represented in the musical work and learn how to physically portray the changes between them. As seen in Czepiel & Luck (2018), emotional engagement can lead to improvements in both technical and expressive performance in musicians. In their research, they observed that while musicians engaged with the specific emotion they linked with the music, their general movement increased, especially in expressive areas of the body, such as the torso, head, and shoulders. Moreover, jerkiness and visible signs of nervousness were reduced in technically difficult parts, resulting in smoother and more fluid playing. Participants even claimed that they felt 'freer' and 'as if mistakes did not matter". This suggests that the effects of 'emotional engagement' during performance could potentially improve musicians' experience, as well as the outcome and audience's perception of it. This could be taught effectively through improvisational theatre exercises that focus on portrayal of emotions. Nevertheless, as previously stated, abstract concepts such as atmospheres, ideas, imagery, or motions, could also be explored through similar means. In improvisational theatre, actors are not constrained by a fixed script, predefined roles, or physical form. For that reason, actors can inhabit a wide array of expressive concepts, fostering imagination beyond physical limits. This could enable musicians to connect with different 'ways of being', no matter how different from the real form, and therefore, different 'ways of playing' their instrument. Trying to embody atmospheres, ideas, imagery, or motions while playing their instrument can allow for new insights on how to move for expressive purposes, and provide them with wider flexibility to adapt their motor behaviour to the requirements of the musical piece.

Considerations and challenges

While an approach based on improvisational theatre may offer significant benefits for many musicians, practical research is needed to test its feasibility. In addition, it is essential to recognize associated challenges, particularly within the context of traditional conservatoire pedagogy.

For example, exposing musicians to theatre-based methods may not suit every individual. People with highly introverted personality traits might feel uncomfortable or threatened when encouraged to step outside their comfort zones (Rea, 2015), leading to a detrimental effect. Furthermore, strategies that encourage engagement with emotions should ideally be facilitated by experienced theatre trainers to ensure effective and sensitive implementation.

Resistance from educational institutions may also arise. The integration of these practices requires specialized educators and a shift toward more interdisciplinary curricula. Moreover, it steers away from traditional models of instruction such as the one-to-one lesson format and the master-apprentice model, instead advocating for group work and a more explorative way of learning.

Finally, since improvisational theatre techniques are rooted in spontaneity, they conflict with the common belief—especially prominent among

classical students—that there is a 'right' way to perform a piece of repertoire (Ford, 2013). Nevertheless, providing a space for experimentation within formal music education where students can move beyond technical proficiency and break free from learned frameworks, may foster creativity, and a more authentic performance (Spolin, 1963), allowing individuals to discover new modes of expression through direct experience and ultimately, empowering students.

While fully replacing traditional methods is not needed, broadening them by integrating embodied tools, such as improvisational theatre, could significantly enrich how *expressiveness* is understood and approached in HME.

Conclusion

This paper highlighted the relevance of visual elements in creating an expressive performance and emphasized the role of the body in teaching strategies for *expressiveness*. It also explored the potential of improvisational theatre techniques as an educational tool for this purpose. Improvisational theatre can help musicians engage with and embody different emotions, which may lead to improvements in both technical and expressive performance (Czepiel & Luck, 2018). These exercises can also stimulate imagination through body movements (Zinder, 2007), connecting an individual with a different sense of "self" (Petit, 2009). This may help performers connect with more abstract expressive concepts, such as atmosphere, imagery, or motion, making improvisational theatre-based methods a promising tool for teaching *expressiveness* in music.

While challenges such as the need for specialized educators, the implementation of interdisciplinary curricula, and the openness towards a more explorative way of teaching and learning *expressiveness* require thoughtful planning, the urge to broaden teaching approaches to *expressiveness* is non-refutable. Improvisational theatre could be a stepping stone towards implementing more embodied pedagogical approaches in higher music education.

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With a Pinch of *Sats*: The Psychological Significance of Performative Impulse in the Performance of Classical Music

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Abstract

The theoretical background of this paper lies in interdisciplinary research focusing on similarities and synchronicities of the performing arts (Carlson, 2004). The focus is on the *sats*, which is defined both as a theoretical and practical phenomenon. The anthropology of performance defines *sats* as an impulse and a counter-impulse, while describing all performing arts as sharing a similar base. The aim of this research is to rethink the specific expertise of classical music performers from the perspective of performance theory. More specifically, the aim is to highlight the phenomenon of *sats* (Barba, 1995) and to have it reviewed and considered as a practical tool for classical music performers. The knowledge, expertise, and artistry of classical music performers have persisted and improved for centuries. Recently, new ways and forms of mental training for musicians have emerged as a significant aspect of the performance process, creating a substantial difference (Lehmann et al., 2007). This paper presents options to enrich the quality of classical music performers' expert knowledge and artistry by applying the *sats* phenomenon, both in theory and practice. The case study and examples are based on the interaction of psychology for musicians, performance psychology, performance theory, and experience from pedagogical and artistic practise.

Keywords: *sats*, classical music, performance theory, psychology of performance, psychology for musicians

Introduction and method

Not so long ago, a famous European conductor visited Bali, where he stayed for two weeks and was fascinated by Balinese musical theatre and native gamelan music. What amazed him was the ability of the dancers and percussionists to control vast, gradual speeding-up and slowing-down actions "without a conductor, and without any obvious leadership or physical cues" (Service, 2014, p. 161). "How did that happen?" Maestro asked a little ten-year-old Balinese girl. She replied, "You've been here two weeks, and you still haven't noticed that it's the dancers who control it? When they lift their left hand, we play faster, and so on. That's how it works" (Service, 2014, pp. 161-162). This is a true story about Maestro Simon Rattle and his visit to Bali. The significance of this story came to his mind during a rehearsal with the Berlin Philharmonic, while conducting the orchestra through Jean Sibelius' *Fifth Symphony*. Rattle used a poetic shortcut by telling the above-mentioned story in order to motivate orchestral players to achieve a long, gigantic *accelerando* in the second part of the first movement. There is an obvious reason for that—as Tom Service (2014, p 160) writes— "a paradoxical phenomenon: the increase of tempo should be imperceptible, since it happens continuously rather than in stages, but the accelerative effect needs to be physical". Rattle decided to communicate with the orchestra by using a story "to tell them how he discovered the secret to creating this kind of motion" (Service, 2014, p. 161). More precisely, Rattle's idea comes from his ambition to expand the 2009/2010 Berlin Philharmonic's season repertoire beyond German authors to the music by Jean Sibelius, a Finnish composer not so familiar to German orchestras. This story serves here as an introduction to the case study that considers the potential interdisciplinary and intercultural layers in performance of (Western) classical music: 1) anthropology of performance and performance theory, 2) psychology for musicians, and 3) psychology of performance.

Inspired by the story about Simon Rattle and the Berlin Philharmonic, I'll take the analyses based on a theoretical background of anthropology of performance and performance studies. The intention is to detect how the Balinese performative technique can be helpful for a classical music performer. The methodological approach in the case study is a comparative analysis and synthesis of performative techniques from the East and the West, in order to identify useful similarities.

Based on the conclusion of the case study, the second part of this paper offers examples from the field of piano playing and choral conducting, as a proposal for an application of *sats* as a body-mind technique. I will try to explain examples in simple but detailed steps and narrative, visually supported by graphic facilitation in the form of figures, with the importance of a positive psychological impact on the preparation and performance of classical music in mind.

Case study: From Bali to Berlin – *sats* is in the air

The intuition of a renowned conductor, such as Simon Rattle, to use his experience from Bali, is actually an example of the specific layer of the human mind analysed by anthropology of performance, defined as a manifestation of *Homo faber, Homo erectus, Homo ludens, Homo sapiens, Homo aestheticus,* and *Homo scaenicus* (Dissanayake, 1995; Lukić, 2013). In short, performance studies and anthropology of performance have shown that performing arts share a similar base, regardless of whether it is dance, theatre, opera, a classical music concert, performance art, or contemporary circus. Therefore, there is no doubt about the liminal zone of performance and its interdisciplinarity and interculturality (Carlson, 2004; Schechner, 2002). From another perspective, Rattle's motivational speech aims to foster a specific state of mind among orchestral musicians to achieve a convincing, coherent performance. This is covered in psychology for musicians, encompassing mental training, intrinsic motivation, and artistic purpose (Hallam, 2019; Lehman et al., 2007). The third layer is very significant—an imperative for success—specifically discussed in performance psychology as the pressure present in the entertainment industry (Coterill, 2018). Success is defined not only by high standards of musical performance but also by a (hidden) rule in the pressure to perform effectively, better known as the "perform or else" phenomenon (McKenzie, 2001).

It is unclear whether classical musicians, such as famous conductors, are informed or educated in various performative techniques, except those related to music. What is widely known, however, is that Balinese performative technique consists of four components: (1) *agem,* (2) *tandang,* (3) *tangkis,* and (4) *tangkep. Agem* is defined as "attitude" or base position. *Tandang* means "to walk, to move in space". The central component of the Balinese performative technique is *tangkis,* which means "transition, the change from one posture, direction, level to another", followed by the fourth component, *tangkep,* known as "expression" (Barba, 1995, pp. 56-57). Eugenio Barba, a researcher of performative techniques around the globe, with special emphasis on "performance universals that function across the cultures" (Kennedy, 2011, p. 43), explains that *tangkis* literally means "to escape," "to avoid". He further describes it as "a way of doing", a way in which a performer can "escape" the rhythm he or she is following and ultimately create a variation in the design of movements. When *tangkis* is performed quickly and vigorously, through micromovements, it is defined as *angsel*, the essence of which is *keras,* strong. Alternatively, it may be gentle, in which case it is called *seleyog*—soft, supple, and flowing—and *legato* (Barba, 1995, p. 56).

As previously mentioned, Simon Rattle attempted to explain the moment of transition during a long-lasting *accelerando*. He aimed to encourage players in the orchestra to take more responsibility for the performance and to make himself less necessary (functioning only as *primus inter pares*). The idea is compelling, but, as Rattle himself admitted, not entirely achievable. Therefore, the conductor decides to give cues, but he does it in a much more restrained manner, risking that the performance may fall apart. Deeper and profound knowledge of performative techniques leads one to the phenomenon of *tangkis* present in other cultures, known as "energy potential" in Peking Opera, "pre-acting" used by Konstantin Sergeiewich Stanislavsky, "otkaz" developed by Vsovolod Meyerhold, and "pre-movement" by Jerzy Grotowski, to name only a few. The above-mentioned phenomena can be defined under the umbrella term *sats*, predominantly used by Eugenio Barba (1995). It originates from Norwegian and, in the literal sense, it means motion. In the academic field of performance theory, *sats* is defined as "the moment in which the action is thought/acted by the entire organism, which reacts with tensions, even in immobility. It is the point at which one decides to act. There is a muscular, nervous and mental commitment, already directed towards an objective. It is the tightening or the gathering together of oneself from which the action departs" (Barba, 1995, p. 54). It is crucial to distinguish isolated gestural movements from the rest of the performer's body, for example, a conductor's beat gestures or a pianist's finger action during piano-

playing exercises. The importance of *sats* lies in linking separate actions with the sense of the entire body. The *sats* engages the entire body: "*sats* is impulse and counterimpulse" (Barba, 1995, p. 55). It is related to both the body and mind.

Application of *sats* in classical music performance

It is well known that musicians perform demanding pieces of music, artworks, and masterpieces that are very challenging, both technically and musically. Technical superiority is a *conditio sine qua non* for professional musicians, the physical component of performance, the ability of body and mind to perform most *virtuoso* music scores (Hallam, 2019; Lehman et al., 2007). The importance of the body-mind connection for pianistic technical learning is quite thoroughly presented by pianist Miguel L. Henriques (2014). His focus is on health issues and the potential for mental work, the speed of mental processing ("reflexes" and "whips," pp. 75-101), instantaneous and coincident attack and rest commands, proprioception, and specifics of the hand and fingers. The possible role of *sats* to improve/encourage technique lies in the fact that *sats* is "the tiny keystone of every physical action. It makes it possible for the performer to be technically precise even when working according to the 'magic if' and 'emotional memory' procedures" (Barba, 1995, p. 58).

I would like to offer two simple examples from the fields of piano playing and choral conducting to illustrate the point. For a detailed presentation, the workshop format would be more appropriate. The first example (Figure 1) is Carl Czerny's *Etude* op. 849, no. 25. If students use a well-known, traditionally suggested method, namely, to practise the entire *Etude* in very slow tempo and forte first, using the individual strength of each finger, they may become bored, exhausted, and discouraged. Encouraged by the idea of making practice interesting and creative, as many psychologists of musical performance suggest, I will present an approach from the performative perspective.

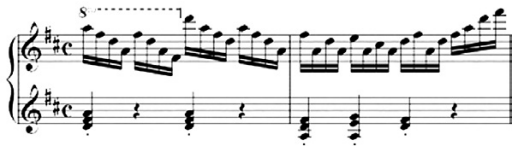

Figure 1. Carl Czerny: *Etude* op. 849, no. 25 (Fragment)

Conversely, if students apply the concept of *sats* in practice and create a "*sats*-state of mind and body"—that is, work in a "*sats*-way"—the finger-focused method is likely to be enriched by an awareness of what occurs between individual finger movements, throughout the entire body and mind. This includes an embodied sense of transition between movements, sound, touch, the vibration of an instrument, and space. Another traditional (mainstream) way of practising is to change the rhythm (Figure 2) to achieve a faster tempo.

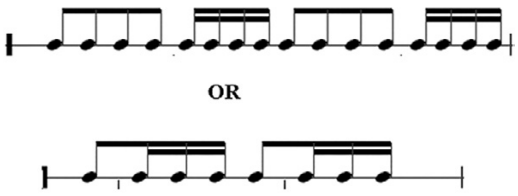

Figure 2. Example of rhythmic changes – a traditional way of practising sixteenth notes in Carl Czerny's *Etude* op. 849, no. 25

Figure 3 shows that the rhythm method should not be used for its own sake but should be enriched with ideas of transition and decision-making to produce a faster, more active movement.

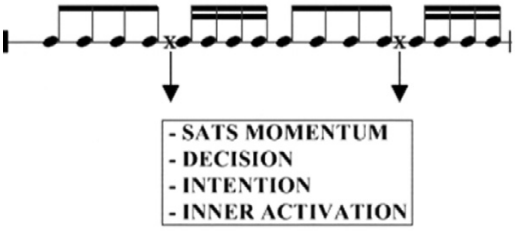

Figure 3. Example of a proposal for the application of *sats* as a body-mind technique

The same principle applies to Figure 4: awareness of the transition and of what is happening in the moment (an active body-mind system). In Figures 3 and 4, the sign X is to indicate "mental click" – a performative impulse – in which the inner activation, intention and decision to act should emerge and create *sats momentum.*

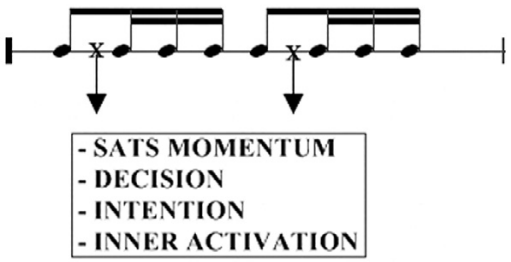

Figure 4. Example of a proposal for the application of *sats* as a body-mind technique

To conclude the discussion about practising Czerny's *Etude*, Barba's words are appropriate: "in physical behaviour the transition from intention to action is a typical example of difference in potential" (1995, p. 54).

As an introduction to the second example, the following may serve as a very appropriate metaphorical and poetical definition of *sats:* "It is the spring before it is sprung. It is the attitude of the feline ready for anything: to bounce forward, to withdraw, to return to a position of rest. An athlete, a tennis player or boxer, immobile or moving, ready to react. It is John Wayne facing an adversary. It is Buster Keaton about to take a step. It is Maria Callas on the verge of an aria" (Barba, 1995, pp. 54-55).

How can a musician practise *sats*? Let us take a choral conductor as an example. Colin Durant (2003, p. 113) writes that "basic psychology will tell us that people will respond to challenge more efficiently if they experience pleasure sensations in the activity. The creation by conductors, therefore, of a positive, encouraging atmosphere is integral to this response to musical challenges". To create such an atmosphere, I first suggest that the conductor achieve a *sats*-state. As a musician, the conductor has to be convinced of his/her musical concept, respecting musicological facts about the piece and style, as well as historically informed facts. However, the conductor is not only a musician but also a performer. If the conductor is aware that *sats* is "a minute charge with which the thought innervates the action and is experienced as thought-action, energy, rhythm in space" (Barba, 1995, p. 57), they will be able to create an effective body-mind connection when shaping music through gestures. Figure 5 presents the opening of *Ave Maria* by Ivan Zajc.

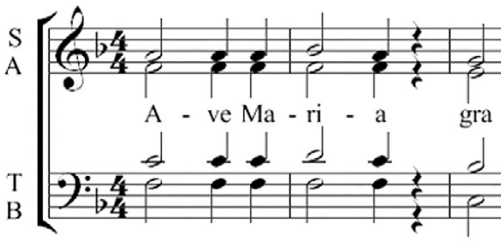

Figure 5. Ivan Zajc: *Ave Maria* (Fragment)

In a "sats-manner", during the vocal warm-up, the conductor asks the singers, as the first step, to perform a four-part vocalise legato from beginning to end (Figure 6).

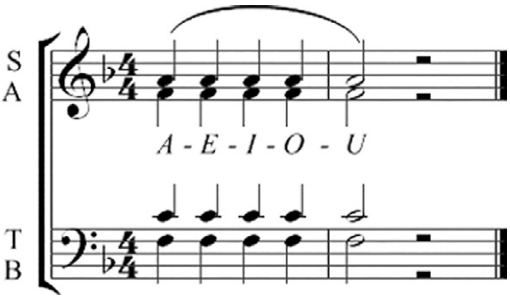

Figure 6. Example of a proposal for the application of *sats* as a body-mind technique for *Ave Maria* by Ivan Zajc

Figure 7 illustrates the next step of vocal warm-up based on the "sats-manner". As a help, I use the sign ə (half-vowel), which is an "ingredient" of every vowel and is present in the moment of transition. The conductor asks the singers to sing a four-part vocalise legato, but with a fully aware transition from one vowel to the next, focusing their thoughts and presence on the beginning and the ending of each vowel. It is a quite fast and short moment, but a highly important performative impulse.

(ə)A____əE____əI____əO____əU____(ə)

Figure 7. An illustration of a *sats* supplement for the four-part vocalise

Thirdly, and most importantly, the conductor should announce that they will stop unexpectedly at a random vowel and silently wait for some time (Figure 8). During the silence, the conductor encourages the singers to feel the moment, their body and the environment (space) to actively participate in silence, creating an active peace (*sats momentum*).

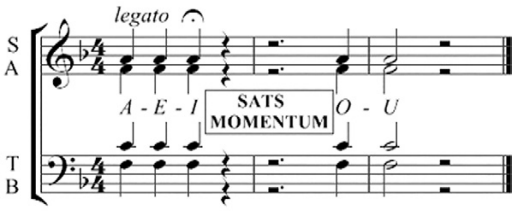

Figure 8. Example of a proposal for the application of *sats* as a body-mind technique for *Ave Maria* by Ivan Zajc

Then, with a cue that comes from the conductor's "sats-moment", they signal the choir to continue to vocalise. In the "state-of-sats", the choir is ready to sing Ave Maria in a fresh, mesmeric atmosphere.

Conclusion

Lifelong learning for musicians to continuously improve their musical skills might seem difficult, and sometimes even harsh. Having that in mind, the implication of this paper is to present both the theoretical and practical examples of sats application and its implications. The main aim is to offer the renewed methods and techniques that classical music performers use during preparation and performance. Examples offered and described (both verbally and visually) - Carl Czerny's *Etude* op. 849, no. 25 and Ivan Zajc's *Ave Maria* - serve as a general illustration of the application of sats in classical music performance. As mentioned earlier, a workshop format would be more effective, vivid, and applicable. With regular practice, the expected outcomes include stronger engagement and a more prepared presence, with more confident, stress-free, and authentic performance. Further directions for exploration focus on creativity and innovation in the field of classical music as performance.

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Music in Everyday Life

Analyzing Effects of Musical Activities on Children's Social-Emotional Well-Being and Resilience

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Abstract

The primary aim of early childhood education and care (ECEC) curricula is to foster and enhance children's social-emotional well-being. Previous research indicates that musical activities in ECEC settings can support various aspects of children's well-being, particularly social-emotional competencies. This study examined whether integrated musical activities influence the social-emotional well-being and resilience of preschool children in ECEC environments. A quasi-experimental within-subjects design without a control group was employed. Two early childhood educators from rural and urban areas in the counties of Zagreb and Međimurje assessed the social-emotional well-being and resilience of 45 children before and after a six-week program of daily musical activities centered on three animal-related themes. The sample comprised 21 boys and 24 girls aged 4.5 to 7 years. Changes in social-emotional well-being were measured using the Croatian version of the PERIK instrument. The intensive six-week music program increased children's interest in musical activities and contributed to the development of their musical competence. Paired *t*-test analyses revealed significant improvements across all six dimensions of social-emotional well-being and resilience: social skills, self-control, assertiveness, emotional stability, activity orientation, and pleasure in exploration. While these findings support the positive role of integrated musical activities in preschool settings, the absence of a control group limits the generalizability of the results. Future research should include a control group and a larger, randomized sample to determine the impact of musical interventions on children's social-emotional well-being and resilience more accurately.

Keywords: early childhood, integrated musical activities, preschool children, social-emotional well-being, resilience

Introduction

Events such as lockdowns, earthquakes, wars, economic crises, globalization, and migration profoundly impact children's social and emotional well-being and resilience. These global changes require careful attention and further research to understand their effects on young children and support their development in an increasingly complex world. The effects of the pandemic, coupled with broader political and economic issues, have impacted the achievement of the Sustainable Development Goals (SDGs) by 2030 (United Nations [UN], 2015), particularly those related to education, health, and well-being. Simultaneously, access to artistic and cultural experiences for children has been limited (Bačlija Sušić & Sambol, 2022; European Commission [EC], 2021; UN, 2015).

Given the complexity of education and the importance of local context, meaningful change in early childhood education and care (ECEC) settings requires both internal and external leadership (Eisner, 2017). The concept of educational connoisseurship illustrates how artistic principles can enrich educational practices by encouraging nuanced observation and interpretation of learning and teaching processes (Efland, 2004). Ecological developmental theories, such as Bronfenbrenner's ecological systems theory and its later "process–person–context–time" (PPCT) model, further support the relevance of contextual influences. These theories provide comprehensive frameworks for understanding child development through interactions within their environment (Eriksson et al., 2018). Bronfenbrenner's (1979) ecological theory highlights the influence of contextual systems on children's development, while Brendtro et al. (2005) emphasize that every child benefits from having at least one adult who offers them unwavering care and affection. ECEC systems are increasingly focused on fostering children's social-emotional development, resilience, and overall well-being. This approach aligns with international agendas and national curricular priorities. Education systems recognize social-emotional well-being and resilience as essential components

of holistic development. They play a pivotal role in creating emotionally supportive environments that nurture social connectedness, emotional regulation, and adaptive functioning.

Social-emotional well-being in early childhood

The concept of children's social-emotional well-being is increasingly viewed as a multidimensional, developmental construct within positive psychology. Various theoretical perspectives offer a thorough basis for examining and comprehending this concept (Tatalović Vorkapić, 2019a, 2019b, 2020, 2021, 2024). One of the most prominent theoretical models of children's well-being is the multifaceted framework developed by Ben-Arieh et al. (2014), which offers an interdisciplinary approach that comprehensively captures the complexity of well-being across multiple dimensions. Besides other contemporary aspects this model encompasses, it also perceives children's overall well-being as aligned with the developmental domains of cognitive, psychomotor, and social-emotional well-being. Even though this model provides such a significant contribution to the field of children's well-being, it still lacks some related indicators and measures. Therefore, other, more context-specific and operational models have been developed to help practitioners assess and promote well-being in educational settings.

Mayr and Ulich's (2009) model offers a framework for understanding and promoting social-emotional well-being in early childhood. The model identifies six observable dimensions that serve as practical indicators for assessment and pedagogical planning: social skills, self-control, pleasure in exploration, self-assertiveness, emotional stability, and activity orientation. These domains emphasize that children's well-being should take precedence over pedagogical trends, offering educators objective tools to guide developmentally appropriate strategies grounded in children's emotional needs and interests. As Mayr and Ulich (2009, p. 45) assert, "the well-being of children under a practitioner's care is of paramount importance, beyond all pedagogical methods and trends."

National and European educational policies increasingly prioritize child well-being as the foundation of lifelong learning and development (Ho & Funk, 2018). For example, the Croatian National Curriculum Framework for Early Childhood Education and Care [NKRPOO] (Ministarstvo znanosti, obrazovanja i sporta Republike Hrvatske [MZOS], 2015) recognizes well-being as a core value and integrates it into cognitive, psychomotor, and social-emotional developmental domains (Tatalović Vorkapić & LoCasale-Crouch, 2021). However, Ho and Funk (2018) emphasize that aligning policy goals with everyday practice requires reliable methods for assessing and supporting children's well-being in specific settings. Therefore, it is crucial to implement objective observation and documentation techniques to monitor children's development. These techniques form the basis for designing educational activities that respond to children's needs and interests.

Social-emotional well-being and music education in ECEC

The first five years of life are critical for establishing a foundation for lifelong learning and well-being (Neuman & Powers, 2021). ECEC settings play a vital role in supporting children's well-being (Sheridan & Pramling Samuelsson, 2013). Rather than relying on implicit or secondary goals, integrating music education as an explicit teaching objective can enhance the focus on children's social-emotional development. When well-being is a clear goal of music education, educators can implement strategies that promote children's overall development (Schmid, 2024). This approach aligns with the NKRPOO (MZOS, 2015), which emphasizes children's well-being across personal, emotional, physical, educational, and social domains. High-quality ECEC environments support children's healthy development and successful integration into positive social relationships (MZOS, 2015).

Research from the Study of Early Education & Development [SEED] Project Consortium (2018) studied the social-emotional well-being of five-year-old children in ECEC settings across five European countries, including Croatia. The study revealed notable variability both within and between countries. In Croatia, the relatively low percentage of children identified as a cause for concern may be linked to specific contextual factors. For example, many five-year-olds do not regularly attend ECEC programs, and mixed-age group settings are common, resulting in fewer children being assessed. These findings highlight the diversity of ECEC contexts and the need for targeted pedagogical approaches, such as music education, to support social-emotional well-being. Furthermore, the SEED Project emphasizes the importance of considering cultural context and ECEC traditions

when assessing children's psychosocial well-being, as developmental competencies are understood differently across countries (Franck et al., 2024). Therefore, universal assessment tools should be used cautiously, particularly in culturally diverse settings.

Studies based on experiential learning models (Laevers, 1997) show that children's well-being and engagement are key indicators of the quality of education during musical activities. Using tools such as the Leuven Scales for Well-Being and Involvement, researchers have found that children exhibit above-average levels of well-being and engagement during music sessions. These results are supported by responsive teaching practices that enrich musical skills and overall experiences (Bačlija Sušić et al., 2022).

Fostering social and emotional learning by providing musical activities in early childhood and care education

Building on the foundational understanding of children's social-emotional well-being, Social and Emotional Learning (SEL) and Social and Emotional Competencies (SEC) are essential components of curricular activities in ECEC. These elements support children's mental health and overall well-being (Ho & Funk, 2018; Yorke et al., 2021). Higher SEL levels are consistently linked to enhanced well-being, emotional intelligence, resilience, and positive academic and social outcomes (Arslan & Akın, 2013; Bačlija Sušić et al., 2022; Rakap et al., 2018; Tatalović Vorkapić, 2021, 2022).

According to the Collaborative for Academic, Social, and Emotional Learning (CASEL, 2020), SEL encompasses processes through which children develop skills to recognize and manage emotions, build positive relationships, demonstrate empathy, and make responsible decisions. CASEL (2013) outlines five interrelated competencies: self-awareness, self-management, social awareness, relationship skills, and responsible decision-making. These competencies are central to children's effective social engagement (Vranjican et al., 2019).

Music education is a powerful tool for fostering SEL. Activities such as improvisation, playing instruments, group singing, and identifying emotions through music provide authentic opportunities to develop collaboration, empathy, emotional regulation, and social cohesion (Bačlija Sušić & Buerger Petrović, 2023; Varner, 2020). Music stimulates emotions, fosters creativity and imagination, and promotes group interaction and self-expression (Küpana, 2015). Additionally, it offers relaxation and inspires imaginative thinking. Research indicates that music classrooms create safe, predictable learning environments characterised by emotional connection and empowerment, which are vital for SEL (Newhouse, 2020). Long-term engagement in collaborative music-making improves mood, strengthens peer relationships, and enhances self-awareness (Carter, 2011; Stewart et al., 2019). Moreover, brain research suggests that early and sustained interaction with music supports both cognitive and emotional development and can be enriched through technology (Upitis, 2001).

Empirical findings from the SEED Project Consortium (2018) and studies using tools such as the Leuven Scales for Well-Being and Involvement (Laevers, 1997) reinforce the positive impact of music on children's social-emotional well-being in diverse ECEC contexts, including Croatia (Bačlija Sušić et al., 2022). These insights underscore the importance of integrating music into SEL-focused curricula as a means of nurturing inclusive, culturally responsive, and emotionally supportive learning environments.

The aim of this research is to analyse the effects of integrated musical activities implemented in two early childhood settings of preschool children on their social-emotional well-being and resilience. It was expected that significant differences in children's socio-emotional well-being and resilience after the implementation of integrated musical activities would be found.

Method

Participants

The study included a non-random sample of 45 participants, 21 boys and 24 girls, with a mean age of 5.65 years (SD = 5.59), ranging from 4.5 to 7 years. The children were enrolled in preschool programs at two kindergartens: one in an urban area of Zagreb County and the other in a rural area of Međimurje County.

Measures and procedure

This study uses a quasi-experimental, within-subjects design to test the possible effect of integrated musical activities, without a control group, and a non-random sample with only one group of subjects. In other words, only one experimental group was used, with musical activities implemented with two-time measurement

points. The time between the first and the second measurement was six weeks. Children's social-emotional well-being and resilience were measured using the PERIK (Positive development and resilience in kindergarten; Mayr & Ulich, 2009), i.e. its adapted and validated version in Croatian language (Tatalović Vorkapić & Lončarić, 2014). The instrument contains 45 items distributed equally across six subscales: social skills, self-control, pleasure in exploration, self-assertiveness, emotional stability, and activity orientation. First subscale measures children's competencies in making social contact and socialization, the second one the ability of regulating one's own behaviour, the third one the enjoyment in exploring the environment; the fourth one evaluates fulfilling one's own needs in alignment with the environment, the fifth one the ability to cope with stressful situations, and the sixth one activity engagement. Early childhood educators rated the items on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). All subscales showed satisfactory levels of reliability (social skills α = .958; self-control α = .968; pleasure in exploration α = .946; self-assertiveness α = .956; emotional stability α = .896; and activity orientation α = .818), confirming the reliability levels reported in the national validity study.

After obtaining the necessary permission based on the informed consent, which consisted of the basic information about the study, the early childhood educators who agreed to participate were provided with the instructions for rating children's behavior and using the scales. The kindergarten management teams, early childhood educators, and parents were thoroughly informed about the aims and methods of the research. Ratings were collected before and six weeks after the musical activities were implemented.

The ratings were carried out by the early childhood educators who worked with the children in the kindergarten groups that implemented the activities. The confidentiality of the data collected on children's behavior was maintained to the greatest extent possible. However, due to the within-subjects design and the need to compare data from two measurement points, complete anonymity was not possible. Only educators who performed the assessments knew the children's identities, while the researchers had no access to any personally identifiable information. This distinction between confidentiality and anonymity is particularly important in within-subject designs, where individual data must be tracked over time. Statistical analysis was carried out using SPSS 22, i.e. descriptive analysis and testing for mean differences (*t*-test for dependent sample) between two measurement points. Musical activities based on three themes related to children's interest in animals were integrated with other areas within two-week themes, such as rabbit, spider, and bee, as part of the full-day program for children in ECEC settings. Encouraged by various prompts, the children were engaged in adopting and performing new songs (*Bunny Woes*, *Here Is the Beehive*, and *One Little Spider*), counting rhymes (*The Rabbit Is Sleeping*, *Bumblebees and Bees*, and *Spider*), and listening to classical music (Camille Saint-Saëns' *Carnival of the Animals* ("Kangaroos"); Nikolay Rimsky-Korsakov's *Flight of the Bumblebee* and Vic Mizzy's *The Addams Family* theme) within the musical play. All stimuli used were selected based on the children's interests and developmental stages. Throughout the research, the educators and the music expert planned each phase collaboratively, based on joint reflections (Bačlija Sušić et al., 2024).

Results and discussion

The descriptive statistics and *t*-tests for dependent samples are presented in Table 1. It can be observed that the mean values in the first measurement are rather similar to those reported in previous studies (Tatalović Vorkapić, 2022; Tatalović Vorkapić & Lončarić, 2014). As previously established, early childhood educators rated the emotional stability of children as the lowest, and the self-control as the highest, all within moderate to slightly elevated value levels. The mean values obtained in the second measurement were higher than those in the initial measurement. Statistically significant differences were observed across all PERIK dimensions between the first and second time-point measurements. In other words, the rated social-emotional well-being and resilience were significantly higher after the implementation of musical activities. This finding is expected and in accordance with previous findings.

Research findings from the SEED Project, which examined the social and emotional well-being of young children in ECEC settings, suggest that the lower percentage of assessments of social and emotional well-being among 5-year-olds in Croatia compared to other countries may be due to lower attendance at ECEC programmes and the presence of mixed-age groups in some Croatian settings (SEED Project Consortium, 2018).

Furthermore, previous research in the context of music education confirms that music can serve as a powerful tool for supporting children's SEL and well-being, in line with a holistic approach to learning in early childhood education (ECE) (Bačlija Sušić et al., 2022; Bačlija Sušić & Buerger Petrović, 2023). The results of an earlier study on musical activities with preschool children, viewed through the lens of children's well-being and involvement as key indicators of educational quality (Laevers, 1997), show above-average levels of well-being and involvement, while highlighting the important role of early childhood educators in this process.

Music and SEL share complementary goals of supporting children's self-awareness, social awareness, responsible decision-making, self-management, and relationship skills (Varner, 2020). Music serves as an emotional stimulus, a creative outlet, a means of relaxation, and a tool for self-expression and group interaction (Küpana, 2015), while activities such as improvisation, ensemble playing, group singing, and identifying emotions in music naturally connect general music learning to SEL (Varner, 2020).

Table 1. Descriptives at each measurement point and *t*-values with significance levels on each social-emotional dimension

PERIK dimension	**MP***	***M***	***SD***	***t***	***df***	***p***
Social skills	1	3.48	1.06	-5.86	44	< .001
	2	4.32	0.75			
Self-control	1	3.53	1.08	-6.05	44	< .001
	2	4.27	0.59			
Pleasure in exploration	1	3.70	0.90	-5.78	44	< .001
	2	4.47	0.59			
Assertiveness	1	3.42	1.10	-6.75	44	< .001
	2	4.22	0.72			
Emotional stability	1	2.93	0.78	-6.41	44	< .001
	2	3.63	0.64			
Activity orientation	1	3.29	0.80	-6.92	44	< .001
	2	4.11	0.65			

Note. *MP=measurement points (1=first measurement; 2=second measurement)

It is important to note the significance of an integrated approach to ECE's music education in the curriculum (MZOS, 2015). As a component of an integrated approach to ECE, in which all segments within the educational process are connected and integrated (MZOS, 2015), music activities are part of children's holistic way of artistic and creative expression of ideas, experiences and emotions through different media.

Instead of viewing the benefits of music for children's well-being as an implied outcome, music education can be presented as a specific goal aimed at promoting social-emotional development and enhancing well-being. When well-being is defined as a teaching objective, educators can design music activities that intentionally foster children's emotional and social development (Schmid, 2024).

However, it should be noted that only one group of children received musical activities; there was no control group in this study. This absence is a major methodological limitation because it makes it difficult to determine whether the observed changes can be attributed solely to the musical activities or to other external factors, such as maturation, group dynamics, or environmental influences. Without a comparison group, it is impossible to completely rule out alternative explanations for the results. In addition, the sample was very small and non-random, which should be addressed in future studies. Moreover, the assessments were carried out by early childhood educators who implemented the musical activities, which may have influenced their assessments at the second measurement point. Furthermore, as teachers' ratings reflect the context and traditions of ECEC, universal assessment systems may be inappropriate due to cultural differences in assessing children's psychosocial well-being (Franck et al., 2024). Thus, ensuring a larger, random sample, a control group and more objective rates - while recognizing that universal assessment systems may be inappropriate due to cultural differences in assessing children's psychosocial well-being - will improve the objectivity, reliability, validity and generalizability of future studies on the impact of musical activities on children's social-emotional well-being and resilience.

In terms of possible implications for practice, it can be concluded that ECEC music programs should be designed to support children's holistic development. Based on the belief that children have the right to receive the highest quality education from skilled, professional educators (Day & Gu, 2015), the well-being of children under

the practitioner's care takes precedence over any teaching methods or trends (Mayr & Ulich, 2009). Music can serve as a powerful tool in this context, playing a crucial role in fostering children's holistic development.

Conclusion

This study provides preliminary evidence that integrated musical activities in kindergarten may positively influence preschoolers' social skills, self-control, assertiveness, emotional stability, stress management, activity orientation, and enjoyment of exploration. While these results are encouraging, they are not conclusive. Conclusions should be drawn with caution, as the lack of a control group limits the generalizability of the findings. To better assess the impact of integrated musical activities on children's social-emotional well-being and resilience, future research should include a control group, a larger, randomly selected sample, and a more rigorous design to confirm these effects.

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The MUSIC Model of Music Preferences and Preference for Mainstream Western Balkan Regional Music Among Young Adults in Croatia

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Abstract

The aim of the study was to examine the structure of music preferences measured with music excerpts belonging to mellow, unpretentious, sophisticated, intense and contemporary music (the MUSIC model; Rentfrow et al., 2011) and additional excerpts from the regional mainstream music of the Western Balkans that is popular in Croatia. Another aim of the study was to examine the relationships between preferences, uses of music and music consumption. Participants were 192 young adults (65% female; M_{age} = 20.57, SD_{age} = 1.93), who listened to 26 music excerpts and rated how they liked them. Twenty-one music excerpts were used to measure preference for the five dimensions of the MUSIC model (Rentfrow et al., 2011) and another five music excerpts (selected in a pilot study) were used to measure preference for mainstream Western Balkan (WB) regional music. Participants also completed the Uses of Music Inventory (Chamorro-Premuzic & Furnham, 2007) and the Music Consumption Scale (Chamorro-Premuzic et al., 2012). Confirmatory factor analysis was used to examine the expected six-factor structure of music preferences when using excerpts intended to measure the five dimensions of the MUSIC model and one dimension of a mainstream WB regional music. The results confirmed the six-factor structure. Some of the dimensions of music preference were positively correlated with uses of music: preference for mellow and mainstream WB regional music correlated with emotional use of music and preference for sophisticated music correlated with cognitive use of music. Preferences for mellow, unpretentious and sophisticated music all correlated positively with music consumption. The observed results corroborate the results of previous studies examining the relationships between music preferences and music-related tendencies and behaviours. In future studies, research on music preferences from the MUSIC model can be extended by also using mainstream WB regional music.

Keywords: music preferences, Western Balkan regional music, uses of music, music consumption

Introduction

The MUSIC model by Rentfrow et al. (2011) is a standard framework for conceptualizing music preferences. It includes preferences for mellow, unpretentious, sophisticated, intense and contemporary music. Each of the five dimensions can be described by musical (e.g., tempo, rhythm, instrumentation) and psychological characteristics of music (e.g., sad, inspiring, reflective, contemplative) that are not exclusively associated with a musical genre. For example, mellow music is smooth and relaxing and can refer to songs from the pop, soft rock and soul/R&B genres. Unpretentious music is sincere, somewhat romantic, neither complicated nor aggressive, and primarily includes music found in country and singer–songwriter genres. Sophisticated music is intelligent, complex and often instrumental, combining pieces from classical, jazz and world music. Intense music can be described as distorted, loud, energetic and aggressive, with songs belonging to rock, punk, heavy metal and power pop. Finally, contemporary music is rhythmic and percussive and not sad. Songs with these characteristics can be found in rap music, Latin, electronica and Euro-pop.

When investigating music preferences using the MUSIC model, listeners are presented with several validated music excerpts (examples can be found in Rentfrow et al., 2011) belonging to each of the five dimensions and are asked to rate their liking of each excerpt they hear. This method allows for the study of music preferences in different populations, including children, regardless of their familiarity with a particular style. The classification of music underlying the MUSIC model also enables examination of music preferences across cultures, as the majority of music listened to in different countries, including the regional music of a particular country, can be assigned to the five dimensions of the MUSIC model. To date, the MUSIC model has been extensively replicated in

many countries (Greenberg et al., 2022; Nave et al., 2018; Rentfrow et al., 2012; Rossi et al., 2021) including Croatia (Greenberg et al., 2022; Žauhar & Levak, 2020).

One limitation that may arise when using this model to study music preferences in different countries is the possibility that not all music listened to in a given country can be classified according to the MUSIC model. Some music genres may be specific to a particular region and may not share their characteristics with any of the dimensions of the MUSIC model. In Croatia, for example, a group of music genres, including dance music from the 90s, folk, turbofolk, popular and patriotic music, which can be labelled as mainstream Western Balkan (WB) regional music could not be adequately assigned to any of the dimensions of the MUSIC model (Butković & Žauhar, 2025). Mainstream WB regional music consists of contemporary folk tunes and is characterised by the simplicity of the melodies and structures. Lyrics are predominantly about topics that evoke feelings especially when listened to on social occasions (emotional relationships, national identity, etc.). Thus, when preferences are measured according to the MUSIC model with validated music excerpts in Croatian samples, preferences for mainstream WB regional music, which is popular among adolescents and young adults in Croatia (Pavlović et al., 2017; Plantak, 2020; Senjan, 2021), cannot be investigated because this type of music does not have enough musical or psychological similarities with the dimensions of the MUSIC model to be categorised as one of the factors (Žauhar & Levak, 2020).

So far, preferences for mainstream WB regional music in Croatia have been measured with questionnaires (Butković & Žauhar, 2025; Dobrota et al., 2019; Pavlović et al., 2017; Račevska & Tadinac, 2019). However, when preferences were examined with validated music excerpts used in the measurement of preferences according to the MUSIC model, mainstream WB regional music was not included (e.g. Žauhar & Levak, 2020). To complement the MUSIC model and extend the measurement of music preferences in Croatia (and the WB region), in this study we investigated the structure of music preferences in a Croatian sample of young adults. We collected liking ratings for excerpts of mainstream WB regional music and for excerpts of mellow, unpretentious, sophisticated, intense and contemporary music from the MUSIC model. Additional excerpts from other music from the region, such as pop, rock, sophisticated or contemporary music, that share their characteristics with the five dimensions of the MUSIC model, were not used. Indeed, the excerpts used in the MUSIC model were selected to represent all pieces of music that share the same characteristics, regardless of the region from which they originate (Rentfrow et al., 2011).

It is documented that music preferences can partly be explained by music-related tendencies (such as music use for specific reasons) and behaviours (such as music consumption through attending music concerts; e.g., Chamorro-Premuzic et al., 2010; Schäfer, 2016; Vella & Mills, 2017). Music-related tendencies refer to a listener's inclination to listen to music in a particular way or for a particular reason (Chamorro-Premuzic & Furnham, 2007). For example, music can be used to regulate one's emotions and moods (emotional use of music), to analyse voices or solos in music performances or to analyse the structure of musical pieces (cognitive use of music), and to serve as a background for other activities unrelated to the music itself, such as studying, working, cleaning, etc. (background use of music). On the other hand, music-related behaviours refer to various aspects of music consumption such as buying or downloading music, attending music concerts, reading about musicians, etc. (Chamorro-Premuzic et al., 2012). Although the results were not always consistent, previous studies have revealed some relationships between music preferences, uses of music and music consumption. For example, preferences for conservative (Račevska & Tadinac, 2019), regional (mainstream WB) (Butković & Žauhar, 2025), and conventional music (Vella & Mills, 2017) were negatively correlated to cognitive use of music. Cognitive use of music is intellectual and related to analysing voicings, performances or structures of music pieces and can be related to preferences for more complex music such as sophisticated (Vella & Mills, 2017) or intense music (Getz et al., 2014; Žauhar & Levak, 2020). Due to its characteristics, mainstream WB regional music is not appropriate for this type of listening. Emotional use of music was positively correlated with the preference for sad music, that can be used for emotion and mood regulation. The use of music as a background for other activities was positively related to preferences for happy and social music (Chamorro-Premuzic et al., 2010). At social events and to accompany other non-musical activities, participants often choose music that is rhythmic and played at faster

tempi. Finally, positive correlations have also been observed between music consumption and liking of intense, contemporary and mellow music (Levak & Žauhar, 2021). Actual music consumption is a behavioural manifestation of music preferences and may be related to preference for music of different styles.

In this study, we examined the structure of music preferences when mainstream WB regional music excerpts were used together with the excerpts from the MUSIC model to measure music preferences. We expected that the six-factor structure would be confirmed.

In addition, we investigated the relationships between preferences, uses of music and music consumption. We hypothesized that preferences for mellow and mainstream WB regional music would be positively correlated with emotional use of music, intense and sophisticated music with cognitive use of music, and contemporary music with background use of music. We further anticipated a negative correlation between preferences for mainstream WB regional music and cognitive use of music. With regard to music consumption, we expected a positive correlation with different music preferences.

Method

Participants

A total of 192 young adults (65% female; M_{age} = 20.57, SD_{age} = 1.93) participated in the study.

Material and measures

All music excerpts had a duration of 15 seconds. Twenty-one excerpts were taken from the Rentfrow et al. (2021) study validated on a Croatian sample (Žauhar & Levak, 2020), and five were selected to represent mainstream WB regional music in a pilot study described below. After listening to each music excerpt participants indicated their liking on a 5-point scale (1 = not at all; 5 = completely). The names of the excerpts are listed in Table 1 (for mainstream WB regional music, performers and genres are given in parentheses).

Pilot study for mainstream WB regional music excerpts. The pilot study was carried out as part of the course assignment for 25 students, who were divided into five groups of five students each, and did not participate in the main study. Each group was tasked with selecting music excerpts representative of one of the five regional music genres (dance, folk, turbofolk, patriotic, popular). For each of the music genres, a designated group had to choose five music pieces that were commercially released but unknown to a wider audience and prepare 15-second excerpts that were then digitized. These excerpts were played over a computer as MP3 files to the students who had not selected them (N = 20 from the remaining four groups). For each excerpt, these students had to judge which genre the excerpt belonged, how representative it is for that genre on a scale from 1 (not at all) to 10 (completely), and answer whether they recognized the performer and/or the music piece. Based on their answers, one excerpt was selected as a music stimulus for each regional music genre. Croatian dance (M = 8.15, SD = 1.04), patriotic (M = 7.75, SD = 1.65) and turbofolk (M = 8.45, SD = 1.19) pieces had high representativeness with none of the students recognizing either the performer or the music piece. Croatian folk music piece (M = 8.30, SD = 0.98) also had high representativeness, but one student recognized the piece. Popular music piece had the lowest representativeness (M = 7.25, SD = 1.37) with one student recognizing the piece and five the performer.

Table 1. Factor loadings, descriptive data and reliabilities for the dimensions of music preference and correlations between the dimensions of music preference, uses of music and music consumption

Music excerpts	Music preferences					
	Sophisticated	Intense	Contemporary	Mellow	Unpretentious	Regional
Seltzer, Do I Drink Too Much?	.569					
Sonata A Major	.675					
Who Are You?	.624					
La Trapera	.425					
La Wally	.559					
I Was Wrong	.675					
Death Before Dishonor		.840				
Face the Failure		.821				
White Knuckles		.655				
Johnny Fly		.846				
Falling Down		.795				
Immaculate			.664			
Get the Party Started			.613			
Thankful			.386			
Sexy			.764			
She Walks				.357		
Sweet Scene				.490		
Children of Spring				.841		
That's Not Rockabilly					.792	
Carrots and Grapes					.659	
I'm Already Over You					.684	
Harmoniku kad zasviram (Narodni dar; Folk)						.801
Znam (Novi fosili; Popular)						.694
Blam, blam (Ćana; Turbofolk)						.602
Kad sklopim oči (Ivo Fabijan Mrvelj; Patriotic)						.595
Budi tu (Funky G; Dance)						.594
M	3.22	3.13	2.99	2.89	3.13	2.69
SD	0.78	1.07	0.84	0.82	0.98	0.92
α	.77	.89	.69	.62	.75	.78
Sophisticated		.24**	.21**	.40**	.33**	.00
Intense			.04	.08	.34**	-.20**
Contemporary				.02	.06	.17*
Mellow					.45**	.06
Unpretentious						.22**
Emotional use of music	.05	-.02	.12	.17**	.10	.20**
Cognitive use of music	.33**	.17*	.10	.16*	.01	-.16*
Background use of music	.06	-.06	.16*	.14*	.06	.13*
Music consumption	.35**	.12	.11	.27**	.19**	-.05

Note. The order of the excerpts is comparable to Rentfrow et al. (2011) and Žauhar &Levak (2020). Regional = Mainstream WB regional music; *$p < .05$, **$p < .01$

Uses of music. The Uses of Music Inventory (UMI; Chamorro-Premuzic & Furnham, 2007) consists of 15 items and was translated into Croatian in an earlier study (Žauhar & Levak, 2020). The subscales Emotional (e.g. *When I listen to sad songs, I feel very emotional*), Cognitive (e.g. *I often enjoy analysing complex musical compositions*) and Background use of music (e.g. *I enjoy listening to music in social events*) each comprise five items. Participants rated their agreement with each item on a 5-point scale (1= strongly disagree; 5 = strongly agree). The observed reliabilities of the subscales were α = .60 for emotional, α = .80 for cognitive, and α = .66 for background use of music. Similar reliabilities were observed in other studies (e.g., Butković & Žauhar, 2025; Chamorro-Premuzic & Furnham, 2007).

Music consumption. The original Music Consumption Scale (Chamorro-Premuzic et al., 2012) consists of ten items and has a single-factor structure. The Croatian version of the scale consists of eight items based on the results of a confirmatory factor analysis (Levak & Žauhar, 2021). Participants indicated how often they engaged in the activities described by the items (e.g. *Attend musical concerts or recitals*). In the original version of the scale, participants responded on a 5-point scale (1 = very rarely; 5 = very often). In the Croatian version of the scale participants were given the possibility to respond that they never perform some of the activities with the 5-point response scale (1 = never; 5 = very often). This change was made to ensure that participants who do not perform the listed activity (e.g. *Play a musical instrument (including vocals)*) could also give a valid answer. Furthermore, some of the activities listed in the scale are not as common within young adults today as they were when the scale was constructed and it is therefore to be expected that some participants never engage in these activities (e.g. *Visit music shops (HMV, Zaavi, etc.) with the intention of buying music.*) The reliability of the scale was α = .76, similar to that reported in other studies (Chamorro-Premuzic et al., 2012; Levak & Žauhar, 2021).

Procedure

Participants took part in the study by attending an online Zoom meeting from home. Meetings were organised for groups of about 10-15 people at a time. In the first part of the meeting, they listened to 26 music excerpts, each lasting 15 seconds. Immediately after listening to each excerpt, they rated how much they liked it on a 5-point scale (1 = not at all; 5 = completely). The music excerpts were presented in four random orders (one random order for each group of participants). In the second part of the meeting, participants provided demographic data and completed the Uses of Music Inventory (UMI; Chamorro-Premuzic & Furnham, 2007) and the Music Consumption Scale (Chamorro-Premuzic et al., 2012). The duration of the online session was approximately 30 minutes.

Results

The results are presented in two sections. The first one presents the structure of the music preferences measured by liking ratings of listened music excerpts belonging to the MUSIC model and additional excerpts of mainstream WB regional music. The second section reports the relationships between music preferences, uses of music and music consumption.

Factor structure of music preferences

In order to examine the expected six-factor structure of music preferences when using excerpts intended to measure the five dimensions of the MUSIC model and a mainstream WB regional music dimension, confirmatory factor analysis was conducted. The results showed that the six-factor structure was acceptable ($\chi2[284] = 661.10$, $p < .001$; NC = 2.33; CFI = .80; RMSEA = .08; SRMR = .09). The factor loadings are shown in Table 1. Table 1 also presents descriptive data and reliabilities for six music preferences as well as Pearson's correlations within the music preferences dimensions and uses of music and music consumption (discussed in the following section). Descriptive data indicate moderate preferences for listening to six music dimensions included in the study. The reliabilities of the MUSIC model dimensions ranged from moderate to high. The reliability for the mainstream WB regional music preference was moderate and acceptable. When observed, the correlations within the dimensions of the MUSIC model were predominantly positive and low to moderate. The correlations between mainstream WB regional music preference and contemporary and unpretentious music preferences were low and positive, while the correlation with intense music preference was low and negative.

Relationships between music preferences, uses of music and music consumption

Descriptive data of uses of music and music consumption as well as Pearson's correlations between them are presented in Table 2.

Table 2. Descriptive data and correlations between uses of music and music consumption

	Uses of music			MC
	Emotional	Cognitive	Background	
M	3.72	2.29	3.52	2.70
SD	0.67	0.87	0.78	0.83
Emotional		.05	.37**	.17**
Cognitive			.13*	.59**
Background				.37**

Note. *$p < .05$, **$p < .01$. MC = music consumption.

Within uses of music, both emotional and cognitive use of music were positively correlated with background use of music, but their mutual correlation was not significant. All uses of music were positively correlated with music consumption.

In order to examine the relationships between music preferences, uses of music and music consumption, Pearson's correlation coefficients were calculated and presented in Table 1. From Table 1 it can be observed that sophisticated music preference positively and moderately correlated with cognitive use of music and music consumption, while intense music preference was only positively correlated with cognitive use of music and the correlation was low. For contemporary music preference, only a low positive correlation was observed with background use of music, while mellow music preference had low positive correlations with all uses of music and with music consumption. A low positive correlation was also found between preference for unpretentious music and music consumption. Mainstream WB regional music preference showed low positive correlations with emotional and background uses of music and a low negative correlation with cognitive use of music.

Discussion

In this study, we investigated music preferences for the five dimensions of the MUSIC model, i.e. mellow, unpretentious, sophisticated, intense and contemporary music, and additionally for mainstream WB regional music. We examined whether mainstream WB regional music is a separate dimension of music preferences from the MUSIC model dimensions, and whether its use complements the use of the MUSIC model in understanding the music preferences among young adults in Croatia. Investigating music preferences through liking ratings of music excerpts has advantages over using questionnaires (e.g., the listener does not need to be familiar with the music style to indicate whether they like the music they hear). Furthermore, the MUSIC model provides a framework that can be used in different countries to measure music preferences with validated music excerpts (Greenberg et al., 2022). Although the MUSIC model has also been applied to Croatian samples (Greenberg et al., 2022; Levak & Žauhar, 2021; Žauhar & Levak, 2020), it has not been able to measure preference for music that is commonly listened to in Croatia and the WB region (especially among adolescents and young adults), as this music does not fit into the five dimensions of the MUSIC model in terms of its characteristics. So far, there have been no systematically selected music excerpts to reliably measure the preference for this type of music.

The results of this study confirmed the expected six-factor structure of music preferences and showed that the reliabilities of each dimension of the MUSIC model were in accordance with previous research using the same or similar excerpts in Croatian (e.g. Žauhar & Levak, 2020) and other samples (e.g. Doi et al., 2018). The reliability of the mainstream WB regional music preference was moderate and acceptable, within the range of the reliabilities observed for the dimensions of the MUSIC model. The preference for mainstream WB regional music did not correlate with preferences for sophisticated and mellow music, but it correlated positively with preferences for contemporary and unpretentious music, and negatively with the preference for intense music. The observed correlations were low, but the observed pattern of results reflected the similarities and differences between the styles included in the dimensions of the MUSIC model and mainstream WB regional music. It is worth mentioning that some of the correlations between the MUSIC model dimensions were higher than the correlations with the mainstream WB regional music dimension, further indicating that this dimension captures something different from the existing MUSIC model dimensions. The music excerpts validated in this study can be used in future research to examine a wider range of music preferences in Croatia, but also in the Western Balkan region, as similar music is listened to in other neighbouring countries.

In terms of the relationships between music preferences and uses of music, the results showed that almost all music preferences from the original five dimensions of the MUSIC model correlated positively with at least one use of music, indicating that different types of music can be used for different functions (Schäfer, 2016). As expected, sophisticated and intense, but also mellow music correlated positively with cognitive use of music, while mainstream WB regional music preference correlated negatively with cognitive use of music. The observed relationships can be explained in terms of characteristics of the music and its suitability for intellectually engaging listening. Similar results have been observed in other studies (e.g., Butković & Žauhar, 2025; Getz et al., 2014; Račevska & Tadinac, 2019; Vella & Mills, 2017).

As expected, preferences for mellow and mainstream WB regional music correlated positively not only with emotional use of music but also with background use of music. A positive correlation with background use of music was also observed for contemporary music. Mellow music is appropriate for emotion and mood regulation and the observed result corroborates previous studies (Chamorro-Premuzic et al., 2010). On the other hand, mainstream WB regional music is suitable for listening in social situations when people want to have fun and relax with friends and experience shared emotional release (Plantak, 2020). Although they have different characteristics, mellow, contemporary and mainstream WB regional music are used as a background for other activities that take place in groups of peers (more pronounced for mainstream WB regional music and contemporary music) or in solitude, as they represent music that is commonly listened to in young adulthood (Bonneville-Roussy et al., 2013).

The unpretentious music preference was the only music preference that was not related to the uses of music, but it was positively related to music consumption, along with mellow and sophisticated music. As predicted, music consumption correlated with several dimensions of music preference. However, the results of this study only partially confirmed the results observed in adolescents (Levak & Žauhar, 2021), where positive correlations were found with mellow, intense, and contemporary music. Actual music consumption varies among participants of different ages (Chamorro-Premuzic et al., 2012), but these relationships need to be further investigated, especially in relation to music preferences. The scale used in this study examines music consumption in general. However, not all items are equally applicable to different styles of music. Future studies should use a more precise measure as well as a measure of actual behaviour (Kok et al., 2024; Krause & Brown, 2021).

Conclusion

This study showed that the expected six-factor structure of music preferences is acceptable when considering mellow, unpretentious, sophisticated, intense, contemporary, and mainstream WB regional music with the purpose of measuring music preferences with music excerpts. In a sample of young Croatian adults, preferences for each of the six dimensions were moderate. In this study, the results also showed that the correlations between music preferences, uses of music and music consumption corroborated previous research. Specifically, the newly examined preferences for mainstream WB regional music correlated positively with the emotional and background uses of music, and negatively with the cognitive use of music. This result can be explained by the characteristics of regional music and its suitability for social situations in which people listen to music to experience shared emotional release. In conclusion, mainstream WB regional music excerpts can be used together with the music excerpts validated by Rentfrow et al. (2011) within the MUSIC model to extend audio-based research on music preferences.

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Musical Preferences for Different Music Genres: Relation to Gender and Music Education

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Abstract

Musical preferences reflect individual differences shaped by various factors such as gender, age, personality, cognitive and emotional responses to music, musical processing, and social and cultural contexts (Fricke et al., 2019; Greasley & Lamont, 2016; Hargreaves et al., 2005). Furthermore, musical training has been identified as a significant factor influencing the evaluation and acceptance or rejection of a musical piece (Dobrota & Raić Ercegovac, 2017). This study aimed to investigate gender differences as well as the relationship between music education background and musical preferences. A total of 1012 participants (76.6% female) aged 16 to 65 was surveyed to examine musical preferences linked to gender and music education. Participants completed an online questionnaire regarding their gender, music education background, favourite music genres (classical, pop, rock/alternative, rap, hip-hop, trap, old and new Serbian folk music, metal, electro, house and techno music, other), music choices in social settings, and the music they most frequently listened to during childhood. Results showed that males were more frequently fans of metal, rap/hip-hop, electro/house, techno, and rock/alternative music, while females were more frequently fans of pop music. A similar pattern was detected in the music they listened to while growing up. Classical music preferences steadily grew with higher levels of music education, while the number of rock/alternative music fans remained consistent across different levels of music education. Gender differences were most noticeable in preferred music types and genres during upbringing, with less variation observed in social music settings. Similarly, individuals with higher music education qualifications exhibited distinct music preferences compared to those with lower education levels, though these differences were less apparent in social music contexts.

Keywords: music preference, gender differences, music education

Introduction

Listening to music is widely regarded as one of the most ubiquitous activities among individuals, with its appeal extending across diverse contexts and purposes. Some studies have shown that people spend, on average, between 15% and 20% of their daily time listening to music (Rentfrow, 2012). This number of spent hours even increases in the case of adolescents who listen to music up to three hours a day (Roberts et al., 2009; Tarrant et al., 2000; Zillmann & Gan, 1997). Music preferences, as a complex phenomenon (Palmquist, 1990), "refer to a person's liking for one piece of music as compared with another at a given point in time" (Hargreaves et al., 2016, p. 303). This phenomenon, as "the simplest form of affective response to music" (Dobrota & Reić Ercegovac, 2014b, p. 234), is the display of distinct psychological characteristics, potentially influenced by unique situational demands, experiences, or restrictions (Rentfrow et al., 2011). However, a variety of individual traits, situational factors, and musical characteristics that shape the likelihood of developing a positive attitude toward a specific kind of music will emerge.

Various internal and external factors act as filters that shape perception, musical experiences, and the interpretation of music (Brownell, 2024), as proposed by the Reciprocal Feedback Model (RFM) of music processing (Hargreaves et al., 2005; North & Hargreaves, 2008; Schubert et al., 2014). The RFM processing proposes that music perception and experience are shaped by three interrelated components: the music itself, the listener, and the listening context (Hargreaves, 2012; Hargreaves et al., 2005, 2016; Schubert et al., 2014). These components influence each other bidirectionally, with musical elements (such as genre and complexity), listener characteristics (including age and gender), and contextual factors (both immediate and broader cultural settings) all

playing vital roles. Building on this framework, the Music Preferences in Adulthood Model (MPAM), emphasizes how both intrinsic musical factors (such as melody and rhythm) and extrinsic elements (such as individual traits and social contexts) shape musical preferences throughout adulthood (Bonneville-Roussy et al., 2017).

Gender, as an individual difference variable, is one of the factors that shape how and why certain musical styles are more preferred over others in daily life (Boer et al., 2012). A general view of musical preferences in men and women reveals that women tend to have a greater appreciation for "softer" musical styles such as classical, mainstream pop, soft/non-rebellious rock music, contemporary R&B, soul, Black gospel, religious music, soundtracks, and disco, whereas men typically favour more dynamic and rather "aggressive", intense rebellious musical styles such as various rock genres, alternative, heavy metal, blues, and rap music (Abeles & Chung, 1996; Christenson & Peterson, 1988; Colley, 2008; Cremades-Andreu et al., 2024; Dobrota & Reić Ercegovac, 2009; Habe et al., 2018; Hargreaves & North, 2010; North & Hargreaves, 2007, 2008; O'Neill, 1997; Reić Ercegovac & Dobrota, 2011; Rentfrow & Gosling, 2003; Robinson et al., 1996; Szabó et al., 2024), which suggests a tendency toward music devoid of romantic themes (Christenson & Peterson, 1988). The gender differences are present in early and middle adolescence, where girls show preferences for a wide range of musical styles, including reggae, chart pop, jazz, classical, folk, and opera, whereas boys exhibit narrower range of favoured styles (Hargreaves et al., 1995). Similar trends are present at the university, where female students show a stronger preference for the Reflective and Complex style, and popular national folk music, while male students prefer Intense & Rebellious musical style (Habe et al., 2018). However, Colley (2008) revealed that women expressed similarly high ratings for rock music as men, despite showing a strong preference for chart pop, which contradicts earlier findings suggesting that women prefer "softer" styles. Findings from the Netherlands challenge previous research by revealing that a milder form of heavy metal gained significant popularity among female adolescents. Girls have developed a preference for popular heavy metal subgenres like gothic metal, while boys tend to favour more aggressive forms of this genre (Selfhout et al., 2008; ter Bogt, 2000), which can precede later externalizing problem behaviour (Lacourse et al., 2001; Miranda & Claes, 2004). In general, girls exhibit liking for a wider range of styles than boys (Crowther & Durkin, 1982; Dobrota & Reić Ercegovac, 2014b; Habe et al., 2018; Hargreaves et al., 1995).

Musical knowledge and training function as personal filters, shaping how listeners perceive and experience music, ultimately influencing individual musical preferences. Research consistently shows differences in music preferences between individuals with and without musical education (Dobrota & Reić Ercegovac, 2009, 2014a, 2017; Gregory, 1994; Habe et al., 2018). Musical training has been found to enhance openness to a broader range of musical genres, both within and across styles (Gregory, 1994). Dobrota and Reić Ercegovac (2014) further confirmed that music education and overall musical experience result in higher preferences for diverse music excerpts among music students compared to students from other academic disciplines. Similarly, arts-related students, particularly those in music and the arts, demonstrated significantly stronger preferences for the Reflective and Complex style, Traditional and Contemporary Ethno, and Intense and Rebellious genres, in contrast to students in social or technical fields (Habe et al., 2018). These findings align with research by Hargreaves et al. (1995), which highlights that individuals with higher levels of musical education exhibit stronger preferences for "serious" musical styles, such as reggae, chart pop, jazz, classical, folk, and opera.

This research investigates the association between musical preferences, gender, and music education. Considering that musical preferences are "based upon the interaction of input information consisting of the musical stimulus and the listener's cultural environment" (LeBlanc, 1982, p. 29), we decided to investigate the relationship between musical preferences and gender within developmental and social context.

Method

Measures

An online survey containing a total of eight questions was constructed using Google Forms. The questions asked about (1) participant's age, (2) gender, (3) music education, (4) music genres they are a fan of, (5) whether they consider themselves passionate fans of a certain genre, and if so, (6) which one, (7) what genres of music they most often choose to listen to when in the company of others, and (8) what kinds of music they most

often listened to while growing up. Participants could select multiple genres from a list and could add their own genres to questions 4, 7, and 8. In question 6, participants had the option to choose one genre from the predetermined list or add their own genres in which case they were allowed to add only one.

The survey, conducted in February 2024, was administered in the Serbian language using the Serbian Cyrillic script. The survey link was disseminated online with the help of the authors' friends and colleagues.

Sample

A total of 1009 Serbian native speakers participated in the survey, including 236 (23.4%) males, 772 (76.5%) females, and 1 (0.1%) participant of unstated gender. The structure of the sample with regards to age and music education is presented in Tables 1 and 2.

Table 1. Participants' age

Age	*n*	%
16-20 years old	198	19.6
21-25 years old	422	41.8
26-30 years old	124	12.3
31-35 years old	69	6.8
36-40 years old	41	4.1
41-45 years old	39	3.9
46-50 years old	35	3.5
51-55 years old	39	3.9
56-60 years old	28	2.8
61-65 years old	14	1.4
Total	1009	100.0

Table 2. Participants' music education

Music education	*n*	%
none	513	50.8
self-taught	127	12.6
primary music school	119	11.8
secondary music school	62	6.1
graduate music studies	128	12.7
post-graduate music studies	59	5.8
not stated	1	0.1
Total	1009	100.0

Data analysis

All open response answers that participants provided for questions 4, 6, 7, and 8 were categorised into music genres by going through each entry and first checking whether it could be classified to genres that were already listed in the survey, and if not, creating a new genre that best described it and adding it to the list. A new genre category was created only when the entry could not be properly classified under an existing category. When all entries have been categorised, the authors reviewed the resulting genre categories, examined whether some should be changed or restructured, and made changes deemed more suitable for making music categories distinctive and coherent.

The Chi-squared test was used for examining gender and music education differences with regards to music genre, and, whenever possible, the exact significance, rather than an asymptotic one, was computed. Cramer's V was used as a measure of effect size.

Results

Only 2 (0.2%) participants indicated they were not a fan of any kind of music, meaning that they did not listen to any particular music genre more than four times a week for at least an hour. Most participants identified as fans of pop (77.4%), followed by rock/alternative (56.1%), older Serbian folk music (46.2%), classical music (40.5%), new Serbian folk (33.2%), rap/hip-hop (29.8%), electro/house (22%), trap (17.3%), metal (16.6%), techno (13.1%), and jazz music (7.7%), while the other music genres each had less than 5% of fans.

The greatest gender differences in musical preferences (Table 1 in the Appendix) were found for pop music, with 82.8% of women being fans as opposed to 59.7% of men, and metal, which had 12.2% of fans among women and 30.9% among men. Smaller gender differences were found for rap/hip-hop (25.8% of women, 43.2% of men), electro/house (18.5% of women, 33.5% of men), techno (10.9% of women, 20.3% of men), rock/alternative (53.1% of women, 65.7% of men), and reggae music (0.4% of women, 2.1% of men).

Music education was also related to musical preferences (Table 2 in the Appendix). The strongest association was found for classical music (Cramer's $V = 0.525$), where the number of fans grew relatively steadily from around 20% among those with no music education, to 40% among those who finished primary music school, and then rose sharply to 75%

among those who finished secondary music school, and exceeding 90% among those who finished post-graduate music studies. A similar trend but a weaker relation was found for jazz music where the number of fans grew from about 3% for those with no music education, to about 7% for those with secondary music school, and then rose sharply to over 20% for those who have completed graduate or post-graduate music studies. The opposite trend was found for new Serbian folk music: from 44% among those with no music education, to 10% among those who completed graduate or post-graduate music studies, with a sharp drop between those with primary and those with secondary music school. Rap/hip-hop showed a similar trend: from over 30% among those with no music education, to around 15% among those who completed graduate or post-graduate music studies, and a sharp drop between secondary music school and graduate studies. Around 26% of self-taught musicians were fans of trap music, as opposed to 10% or less among those who completed at least graduate-level studies, and about 18% for all other music education levels. Only 12% of those with no music education were fans of metal as opposed to 25-30% of the self-taught or those who completed secondary music school, with the rest being at about 17%. Around 82% of people who completed primary music school and those with no music education were fans of pop music, while the self-taught accounted for 64%, and about 72% for the rest. When it comes to rock/alternative music, around 64% of the self-taught or those who completed at least graduate-level music studies were fans, as opposed to 50% of people with no music education. For older Serbian music, the number of fans declined relatively steadily as the level of music education increased, from 52% among those with no music education to 34% among those who completed post-graduate music studies. The trend was reversed for blues, rising from about 1% among those with no music education to about 6% among those with graduate or post-graduate-level of music education.Although the Chi-squared test yielded a significant association between music education and being a fan of incidental music, only 12 participants stated they were fans of such music, so it is best not to draw any conclusions regarding this relation.

When asked whether they considered themselves passionate fans of a music genre, 40.4% of participants stated that they did. Around 38% of women identified as passionate fans as opposed to 50% of men (Cramer's V = .107; $\chi^2 = 11.503$; $df = 1$; $p = .001$). Genres that had the most passionate fans were rock/alternative (10% of total participants), pop (6.1%), classical (4.3%), new Serbian folk (4.2%), metal (3.5%), older Serbian folk (3.4%), rap/hip-hop (2.7%), unspecified Serbian folk (2.2%), electro/house (1.8%), jazz (1.4%), and trap music (1.1%), while all the other genres had less than 1% of passionate fans. When each particular genre was examined for gender differences (Table 3 in the Appendix), the greatest gender differences were found for metal – 2.1% of women and 8.1% of men were passionate fans of that kind of music. This was followed by differences in rap / hip-hop (1.8% of women, 5.5% of men), punk (0.3% of women, 2.1% of men), and electro / house music (1.2% of women, 3.8% of men).

When among other people, participants most often chose to listen to pop (48.1%), unspecified Serbian folk (29.5%), new Serbian folk (28.7%), rock / alternative (26.1%), older Serbian folk (18.3%), rap / hip-hop (7.9%), electro / house (6%), trap (5.1%), metal (3.4%), jazz (3.3%), techno (2.3%), and classical music (2.2%), while other genres were chosen by less than 2% of participants each. Men and women differed with regard to the kinds of music they most often chose to listen to when in a social setting (Table 4 in the Appendix). The greatest difference was found in pop music (54.7% of women, 26.7% of men), followed by rap/hip/hop (6% of women, 14.4% of men), electro/house (4.5% of women, 10.6% of men), and metal (2.5% of women, 6.4% of men).

Most participants often listened to pop music while growing up (49%), followed by rock/alternative (44%), unspecified Serbian folk (28.3%), new Serbian folk (24.8%), older Serbian folk (24.5%), classical music (10.5%), metal (8.5%), rap/hip-hop (7.1%), electro/house (4.8%), and children's music (2.3%), while every other genre was listened to by less than 2% of participants while growing up. Gender differences were found for several music genres (Table 5 in the Appendix). Pop music was listened to by 55.2% of women as opposed to 28.4% of men. The differences were smaller for metal (6.2% of women, 16.1% of men), rap/hip-hop (5.2% of women, 13.6% of men), electro/house (3.2% of women, 9.7% of men), and rock/alternative music (42.4% of women, 51.3% of men), and the smallest for children's music (2.8% of women, 0.4% of men).

Discussion

The survey results reveal a strong interest in a wide variety of musical genres among respondents, with pop music being the most preferred, followed by rock/alternative, rap/hip-hop, trap, metal, electro/house, and techno. Notably, classical music ranked unexpectedly high as the fourth most favoured genre.

An analysis of the relationship between musical preferences and gender revealed distinct differences for stylistically contrasting genres, with women showing a strong preference for pop music and men favouring genres such as metal, rock/alternative, rap/hip-hop, trap, and electro/house. However, both genders, expressed similar interest in older and new Serbian folk music, reflecting the genre's popularity in the Western Balkans. These findings underscore the significant role of gender in shaping musical preferences, aligning with existing literature. Women are more likely to prefer "soft" musical styles and are generally associated with the Reflective and Complex dimension of musical preferences, while men show a stronger inclination toward "aggressive" genres, corresponding to the intense and rebellious as well as energetic and rhythmic dimensions identified by Rentfrow and Gosling (2003). This pattern is consistent with the idea that women are more inclined toward mainstream and melodic genres, whereas men gravitate toward rhythmically and lyrically intense styles (Abeles & Chung, 1996; Colley, 2008; Cremades-Andreu et al., 2024; Habe et al., 2018; North & Hargreaves, 2008; Robinson et al., 1996). In addition, men's preferences appear to span a narrower range of musical styles compared to women (Hargreaves et al., 1995).

The study's results reveal a strong correlation between the level of musical education and musical preferences. As musical education advances, preferences for classical music notably increase. A significant shift toward classical music was observed among respondents transitioning from primary to secondary music education, with the highest preference expressed by professional musicians with postgraduate music training. A similar trend was evident for jazz music, where the strongest preferences were reported by professional musicians who attended music academies or faculties of music arts, as well as those with postgraduate education. These results align with previous research linking an appreciation for classical and jazz music to higher levels of musical education (Dobrota & Reić Ercegovac, 2014a; Dobrota & Reić Ercegovac, 2017; Habe et al., 2018; Hargreaves et al., 1995). Conversely, music perceived as lower in quality was most favoured by individuals with minimal or no formal musical training. This trend was particularly pronounced for new Serbian folk music, where preferences were highest among respondents with no formal music education or only basic musical training, while professional musicians showed the least interest in this genre. However, old Serbian folk music maintained a strong following across all educational levels, though its popularity declined as musical education increased. This suggests that social conventions and the contexts in which Serbian folk music is traditionally promoted may have a stronger impact than formal education. Pop music emerged as the most favoured genre among individuals without formal musical training and those with basic education, while self-taught participants exhibited a notably lower preference for this genre. Despite variations, pop music demonstrated high levels of preference across all groups. However, these results indicate that pop music is predominantly associated with the absence of formal musical training, diverging from Hargreaves' findings, which linked pop music to higher levels of musical education (Hargreaves et al., 1995).

The study identified distinct patterns in musical preferences across various education levels, particularly in the categories of rap/hip-hop, trap, metal, and rock music. Non-professional musicians showed the strongest preference for rap/hip-hop, with a notable affinity observed among secondary music education students. This suggests that adolescents exposed to diverse theoretical musical subjects develop enhanced receptivity to varied styles and greater aesthetic flexibility. Their advanced training fosters a more experimental approach to musical exploration, transcending conventional limitations. Trap and metal music attracted the most enthusiasts among the self-taught participants and secondary music students, while professional musicians showed the least interest. Similarly, self-taught participants exhibited the highest interest in rock music, a trend also noted among those with graduate-level music education. These findings indicate that music education significantly shapes musical preferences. However, a higher level of education is not a definitive predictor of preferences for specific genres, contrary to the conclusions of Habe et al. (2018). While the results partially confirm the idea that music education enhances appreciation for genres perceived as more

complex or sophisticated, while reducing affinity for mainstream genres, they do not support Gregory's (1994) assertion that advanced music education broadens musical preferences both across and within genres. This finding is particularly relevant for individuals with no formal training, self-taught participants, and those with basic music education.

The present study sought to explore whether respondents self-classify themselves as passionate fans of a specific music genre. In contrast to women, men identified as dedicated enthusiasts of particular genres more frequently. Consistent with the patterns observed in the section examining the relationship between musical preferences and gender, women demonstrated a stronger affinity for softer music styles,such as classical and pop,while men expressed a distinct passion for more aggressive genres, including trap, electro, techno, rap/hip-hop, punk, and, notably, metal music. Both genders exhibited a comparable level of preference for rock/alternative music. This suggests potential differences in the way men and women engage with music, with men perhaps exhibiting a deeper commitment to specific genres. The finding that men are more passionate music fans contrasts with previous research indicating gender differences in attitudes toward music. Specifically, earlier studies suggest that girls typically exhibit a more positive attitude toward music and listening compared to boys (North & Hargreaves, 2008).

The study examined the relationship between gender and musical preferences within a social and developmental context. Results revealed that during childhood and adolescence, pop and rock/alternative music were the most frequently listened-to genres, followed by Serbian folk music (encompassing older, newer, and unspecified styles). A clear gender divide emerged: women predominantly favoured pop music and, to a lesser extent, Serbian folk music, while men were more frequently exposed to aggressive genres, with rock/alternative music being the most prominent, followed by rap/hip-hop, metal, and electro/house music. In addition, children's music was listened more often by female participants during childhood. The comparison of participants' current musical preferences with their childhood preferences highlights the significant role of early music exposure in shaping adult tastes. This finding confirms that childhood and adolescence are critical periods for developing musical preferences, with early interactions establishing a foundation for enduring tastes. Furthermore, the results suggest that close family relationships play an important role, as shared musical experiences and positive family memories encourage acceptance of diverse musical styles and contribute to long-lasting preferences (Greasley & Lamont, 2006; Hargreaves et al., 2006; Lamont & Crich, 2022; North et al., 2000).

The analysis of social listening patterns reveals that popular music and new/unspecified Serbian folk genres dominate in communal settings. Gender-based distinctions are evident, with women showing a stronger preference for popular music, while men favour rap and hip-hop genres. However, both genders exhibit similar preferences for rock and new/unspecified Serbian folk music. A key question arises regarding the alignment between musical preferences in social contexts and personal tastes. While social music selections often partially reflect individual preferences, they are heavily influenced by prevailing social norms and group dynamics. Empirical evidence highlights that music serves as a medium for expressing social identity, values, and attitudes, with individuals selecting music that aligns with their self-perception and group affiliation (Rentfrow & Gosling, 2003). Social gatherings and shared musical experiences further facilitate the adoption and reinforcement of popular or culturally valued music styles (Greasley & Lamont, 2006; Rentfrow & Gosling, 2003). In addition, social influence significantly impacts individual music ratings, with perceived popularity leading to higher evaluations when others have expressed positive feedback (Prišuta et al., 2023).

While this investigation yielded valuable insights, several limitations warrant consideration. The study relied on self-report measures, which carries the usual risk of the results being skewed by subjectivity (in this case mainly non-objective memory, subjective impressions, and idealised self-image). In addition, the sample predominantly consisted of individuals aged 16-30, which could make our findings less representative of other age ranges. A primary constraint emerged in the classification of musical genres, as the data collection instrument allowed participants to supplement predetermined genre categories with their own preferences. This resulted in the emergence of approximately 100 distinct subgenres and stylistic variations, presenting substantial taxonomic challenges in the categorization process. Consequently, future research would benefit from focused investigations of specific genres and their constituent subgenres. Additional limitations manifest in the study's social

and developmental dimensions. Longitudinal research designs could provide more comprehensive insights into the trajectory of musical preferences across developmental stages, from childhood through adulthood. Moreover, the incorporation of broader demographic variables, including cultural background and socioeconomic status, would deepen our understanding of preference formation. The interplay between social pressure, conformity, and musical choices within social and cultural contexts also merits further investigation. The role of musical education in shaping genre preferences, particularly for classical and jazz music, emerges as a complex factor requiring deeper examination. The development of appreciation for these genres necessitates a sophisticated level of musical knowledge that typically extends beyond elementary music education. Therefore, future research should investigate the relative influence of various factors that shape musical preferences during primary education, extending beyond formal musical training to encompass broader developmental and environmental influences.

Conclusion

This research contributes to our understanding of factors that shape musical preferences. The findings suggest that musical taste develops through a complex interplay of individual characteristics (particularly gender), educational background, and social influences. While several traditional patterns of music preference were confirmed, others challenged existing research, highlighting the dynamic nature of how people engage with and develop preferences for different musical genres. These insights deepen our understanding of music's role in personal development and social contexts, while suggesting the need for further investigation into the complex mechanisms underlying musical preference formation.

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Appendix

Table 1. Gender differences in musical preferences

Select music genres you are a fan of (that you listen to more than 4 times a week for over an hour)		male $n = 236$	female $n = 772$	Cramer's V	χ^2	df	p^a
classical music	not a fan	57.2%	60.1%	.025	.631	1	.449
	is a fan	42.8%	39.9%				
pop music	not a fan	40.3%	17.2%	.233	54.753	1	< .001
	is a fan	59.7%	82.8%				
rock / alternative music	not a fan	34.3%	46.9%	.107	11.592	1	.001
	is a fan	65.7%	53.1%				
rap / hip-hop music	not a fan	56.8%	74.2%	.161	26.257	1	< .001
	is a fan	43.2%	25.8%				
trap music	not a fan	79.2%	83.8%	.051	2.644	1	.115
	is a fan	20.8%	16.2%				
older Serbian folk music	not a fan	54.2%	53.8%	.004	.017	1	.941
	is a fan	45.8%	46.2%				
new Serbian folk music	not a fan	68.2%	66.5%	.016	.255	1	.636
	is a fan	31.8%	33.5%				
unspecified Serbian folk music	not a fan	96.6%	98.1%	.041	1.697	1	.213
	is a fan	3.4%	1.9%				
metal music	not a fan	69.1%	87.8%	.214	46.000	1	< .001
	is a fan	30.9%	12.2%				
electro / house music	not a fan	66.5%	81.5%	.153	23.527	1	< .001
	is a fan	33.5%	18.5%				
techno music	not a fan	79.7%	89.1%	.119	14.208	1	< .001
	is a fan	20.3%	10.9%				
video game music	not a fan	99.2%	100.0%	.081	6.555	1	.055
	is a fan	0.8%	0.0%				
jazz music	not a fan	89.8%	93.0%	.050	2.552	1	.125
	is a fan	10.2%	7.0%				
latino music	not a fan	99.6%	99.1%	.023	.536	1	.689
	is a fan	0.4%	0.9%				
afro music	not a fan	100.0%	99.9%	.017	.306	1	1.000
	is a fan	0.0%	0.1%				
blues music	not a fan	97.9%	96.9%	.025	.634	1	.511
	is a fan	2.1%	3.1%				
indie music	not a fan	98.7%	98.1%	.021	.465	1	.589
	is a fan	1.3%	1.9%				
punk music	not a fan	97.5%	99.1%	.061	3.798	1	.090
	is a fan	2.5%	0.9%				
reggae	not a fan	97.9%	99.6%	.083	6.871	1	.020
	is a fan	2.1%	0.4%				
R&B music	not a fan	95.8%	96.5%	.017	.280	1	.692
	is a fan	4.2%	3.5%				
spiritual / religious music	not a fan	99.6%	98.8%	.032	1.013	1	.468
	is a fan	0.4%	1.2%				
country music	not a fan	98.7%	99.7%	.061	3.751	1	.087
	is a fan	1.3%	0.3%				
children's music	not a fan	100.0%	99.6%	.030	.920	1	.587
	is a fan	0.0%	0.4%				
world music	not a fan	99.6%	99.4%	.012	.153	1	1.000
	is a fan	0.4%	0.6%				
incidental music	not a fan	98.3%	99.0%	.026	.667	1	.491
	is a fan	1.7%	1.0%				
avant-garde / experimental music	not a fan	99.2%	99.9%	.056	3.139	1	.138
	is a fan	0.8%	0.1%				

[a] exact 2-sided significance

Table 2. Music education and musical preferences

Select music genres you are a fan of (that you listen to more than 4 times a week for over an hour)		no music education $n = 513$	self-taught $n = 127$	primary music school $n = 119$	secondary music school $n = 62$	graduate music studies $n = 128$	post-grad. music studies $n = 59$	Cramer's V	χ^2	df	p^a
classical music	not a fan	78.6%	66.1%	60.5%	24.2%	16.4%	6.8%	.525	278.291	5	< .001
	is a fan	21.4%	33.9%	39.5%	75.8%	83.6%	93.2%				
pop music	not a fan	18.3%	36.2%	15.1%	25.8%	28.9%	27.1%	.163	26.659	5	< .001
	is a fan	81.7%	63.8%	84.9%	74.2%	71.1%	72.9%				
rock / alternative music	not a fan	50.1%	35.4%	42.9%	43.5%	32.0%	37.3%	.141	20.116	5	.001
	is a fan	49.9%	64.6%	57.1%	56.5%	68.0%	62.7%				
rap / hip-hop music	not a fan	67.4%	59.8%	66.4%	71.0%	88.3%	83.1%	.183	33.837	5	< .001
	is a fan	32.6%	40.2%	33.6%	29.0%	11.7%	16.9%				
trap music	not a fan	81.1%	73.2%	80.7%	82.3%	96.9%	89.8%	.170	29.231	5	< .001
	is a fan	18.9%	26.8%	19.3%	17.7%	3.1%	10.2%				
older Serbian folk music	not a fan	48.3%	52.8%	61.3%	58.1%	61.7%	66.1%	.127	16.200	5	.006
	is a fan	51.7%	47.2%	38.7%	41.9%	38.3%	33.9%				
new Serbian folk music	not a fan	55.6%	70.1%	67.2%	82.3%	89.8%	89.8%	.284	81.268	5	< .001
	is a fan	44.4%	29.9%	32.8%	17.7%	10.2%	10.2%				
unspecified Serbian folk music	not a fan	98.8%	97.6%	95.0%	95.2%	98.4%	94.9%	.105	11.110	5	.052
	is a fan	1.2%	2.4%	5.0%	4.8%	1.6%	5.1%				
metal music	not a fan	88.1%	70.9%	84.0%	74.2%	82.8%	79.7%	.164	27.128	5	< .001
	is a fan	11.9%	29.1%	16.0%	25.8%	17.2%	20.3%				
electro / house music	not a fan	80.5%	71.7%	76.5%	79.0%	77.3%	72.9%	.077	5.988	5	.308
	is a fan	19.5%	28.3%	23.5%	21.0%	22.7%	27.1%				
techno music	not a fan	88.1%	83.5%	84.0%	83.9%	89.1%	88.1%	.063	3.940	5	.560
	is a fan	11.9%	16.5%	16.0%	16.1%	10.9%	11.9%				
video game music	not a fan	99.8%	100.0%	100.0%	98.4%	100.0%	100.0%	.084	7.126	5	.271
	is a fan	0.2%	0.0%	0.0%	1.6%	0.0%	0.0%				
jazz music	not a fan	97.3%	92.1%	93.3%	93.5%	77.3%	78.0%	.273	75.138	5	< .001
	is a fan	2.7%	7.9%	6.7%	6.5%	22.7%	22.0%				
latino music	not a fan	99.0%	99.2%	99.2%	100.0%	99.2%	100.0%	.034	1.185	5	.974
	is a fan	1.0%	0.8%	0.8%	0.0%	0.8%	0.0%				
afro music	not a fan	100.0%	100.0%	99.2%	100.0%	100.0%	100.0%	.086	7.478	5	.238
	is a fan	0.0%	0.0%	0.8%	0.0%	0.0%	0.0%				
blues music	not a fan	98.6%	98.4%	96.6%	95.2%	92.2%	94.9%	.134	18.112	5	.005
	is a fan	1.4%	1.6%	3.4%	4.8%	7.8%	5.1%				
indie music	not a fan	98.4%	96.9%	97.5%	96.8%	100.0%	98.3%	.070	4.927	5	.412
	is a fan	1.6%	3.1%	2.5%	3.2%	0.0%	1.7%				

Table 2. Music education and musical preferences (Cont.)

Select music genres you are a fan of (that you listen to more than 4 times a week for over an hour)		no music education $n = 513$	self-taught $n = 127$	primary music school $n = 119$	secondary music school $n = 62$	graduate music studies $n = 128$	post-grad. music studies $n = 59$	Cramer's V	χ^2	df	p^a
punk music	not a fan	98.8%	97.6%	99.2%	95.2%	100.0%	100.0%	.099	9.972	5	.077
	is a fan	1.2%	2.4%	0.8%	4.8%	0.0%	0.0%				
reggae	not a fan	99.4%	97.6%	99.2%	98.4%	100.0%	100.0%	.079	6.281	5	.273
	is a fan	0.6%	2.4%	0.8%	1.6%	0.0%	0.0%				
R&B music	not a fan	97.5%	94.5%	94.1%	98.4%	94.5%	96.6%	.081	.6.664	5	.237
	is a fan	2.5%	5.5%	5.9%	1.6%	5.5%	3.4%				
spiritual / religious music	not a fan	99.6%	96.9%	98.3%	100.0%	99.2%	98.3%	.097	9.463	5	.081
	is a fan	0.4%	3.1%	1.7%	0.0%	0.8%	1.7%				
country music	not a fan	99.8%	97.6%	99.2%	100.0%	100.0%	100.0%	.106	11.430	5	.081
	is a fan	0.2%	2.4%	0.8%	0.0%	0.0%	0.0%				
children's music	not a fan	99.8%	99.2%	100.0%	100.0%	99.2%	100.0%	.054	2.934	5	.580
	is a fan	0.2%	0.8%	0.0%	0.0%	0.8%	0.0%				
world music	not a fan	99.8%	98.4%	100.0%	100.0%	98.4%	98.3%	.088	7.762	5	.181
	is a fan	0.2%	1.6%	0.0%	0.0%	1.6%	1.7%				
incidental music	not a fan	99.2%	100.0%	99.2%	93.5%	97.7%	100.0%	.138	19.137	5	.005
	is a fan	0.8%	0.0%	0.8%	6.5%	2.3%	0.0%				
avant-garde / experimental music	not a fan	99.8%	99.2%	99.2%	100.0%	100.0%	100.0%	.056	3.133	5	.485
	is a fan	0.2%	0.8%	0.8%	0.0%	0.0%	0.0%				

[a] exact 2-sided significance

Table 3. Gender differences in being a passionate fan of different music genres

If you consider yourself a passionate fan of some music genre, what genre is that?		male $n = 236$	female $n = 772$	Cramer's V	χ^2	df	p^a
classical music	not a pass. fan	96.6%	95.5%	.024	.579	1	.473
	is a pass. fan	3.4%	4.5%				
pop music	not a pass. fan	95.8%	93.4%	.042	1.784	1	.213
	is a pass. fan	4.2%	6.6%				
rock / alternative music	not a pass. fan	90.3%	89.9%	.005	.026	1	.902
	is a pass. fan	9.7%	10.1%				
rap / hip-hop music	not a pass. fan	94.5%	98.2%	.097	9.466	1	.004
	is a pass. fan	5.5%	1.8%				
trap music	not a pass. fan	98.3%	99.1%	.032	1.040	1	.474
	is a pass. fan	1.7%	0.9%				
older Serbian folk music	not a pass. fan	97.0%	96.5%	.012	.157	1	.838
	is a pass. fan	3.0%	3.5%				
new Serbian folk music	not a pass. fan	95.3%	96.0%	.014	.189	1	.710
	is a pass. fan	4.7%	4.0%				
unspecified Serbian folk music	not a pass. fan	97.9%	97.8%	.002	.006	1	1.000
	is a pass. fan	2.1%	2.2%				
metal music	not a pass. fan	91.9%	97.9%	.138	19.274	1	< .001
	is a pass. fan	8.1%	2.1%				
electro / house music	not a pass. fan	96.2%	98.8%	.085	7.225	1	.012
	is a pass. fan	3.8%	1.2%				
techno music	not a pass. fan	98.7%	99.4%	.030	.892	1	.399
	is a pass. fan	1.3%	0.6%				
jazz music	not a pass. fan	98.7%	98.6%	.006	.031	1	1.000
	is a pass. fan	1.3%	1.4%				
latino music	not a pass. fan	99.6%	99.9%	.028	.790	1	.414
	is a pass. fan	0.4%	0.1%				
afro music	not a pass. fan	100.0%	99.9%	.017	.306	1	1.000
	is a pass. fan	0.0%	0.1%				
blues music	not a pass. fan	99.6%	99.9%	.028	.790	1	.414
	is a pass. fan	0.4%	0.1%				
indie music	not a pass. fan	99.2%	99.2%	.003	.011	1	1.000
	is a pass. fan	0.8%	0.8%				
punk music	not a pass. fan	97.9%	99.7%	.095	9.063	1	.009
	is a pass. fan	2.1%	0.3%				
reggae	not a pass. fan	100.0%	100.0%	/	/	/	/
	is a pass. fan	0.0%	0.0%				
R&B music	not a pass. fan	100.0%	99.6%	.030	.920	1	.587
	is a pass. fan	0.0%	0.4%				
spiritual / religious music	not a pass. fan	100.0%	99.7%	.025	.613	1	1.000
	is a pass. fan	0.0%	0.3%				
country music	not a pass. fan	100.0%	100.0%	/	/	/	/
	is a pass. fan	0.0%	0.0%				
children's music	not a pass. fan	100.0%	100.0%	/	/	/	/
	is a pass. fan	0.0%	0.0%				
world music	not a pass. fan	100.0%	100.0%	/	/	/	/
	is a pass. fan	0.0%	0.0%				
unspecified folk music	not a pass. fan	98.7%	99.2%	.022	.498	1	.694
	is a pass. fan	1.3%	0.8%				
incidental music	not a pass. fan	99.2%	99.9%	.056	3.139	1	.138
	is a pass. fan	0.8%	0.1%				
avant-garde / experimental music	not a pass. fan	100.0%	100.0%	/	/	/	/
	is a pass. fan	0.0%	0.0%				

[a] exact 2-sided significance

Table 4. Gender differences in music listened to when in a social setting

What kinds of music do you most often choose to listen to when you're in the company of other people?		male $n = 236$	female $n = 772$	Cramer's V	χ^2	df	p^a
classical music	doesn't choose to listen to	97.0%	98.1%	.030	.886	1	.443
	chooses to listen to	3.0%	1.9%				
pop music	doesn't choose to listen to	73.3%	45.3%	.237	56.634	1	< .001
	chooses to listen to	26.7%	54.7%				
rock / alternative music	doesn't choose to listen to	73.3%	74.1%	.008	.058	1	.866
	chooses to listen to	26.7%	25.9%				
rap / hip-hop music	doesn't choose to listen to	85.6%	94.0%	.132	17.656	1	< .001
	chooses to listen to	14.4%	6.0%				
trap music	doesn't choose to listen to	92.8%	95.6%	.054	2.948	1	.091
	chooses to listen to	7.2%	4.4%				
older Serbian folk music	doesn't choose to listen to	83.1%	81.2%	.020	.405	1	.565
	chooses to listen to	16.9%	18.8%				
new Serbian folk music	doesn't choose to listen to	69.9%	71.8%	.017	.301	1	.622
	chooses to listen to	30.1%	28.2%				
unspecified Serbian folk music	doesn't choose to listen to	70.3%	70.5%	.001	.001	1	1.000
	chooses to listen to	29.7%	29.5%				
metal music	doesn't choose to listen to	93.6%	97.5%	.091	8.412	1	.006
	chooses to listen to	6.4%	2.5%				
electro / house music	doesn't choose to listen to	89.4%	95.5%	.108	11.855	1	.001
	chooses to listen to	10.6%	4.5%				
techno music	doesn't choose to listen to	98.3%	97.5%	.022	.476	1	.623
	chooses to listen to	1.7%	2.5%				
jazz music	doesn't choose to listen to	96.2%	96.9%	.017	.283	1	.676
	chooses to listen to	3.8%	3.1%				
latino music	doesn't choose to listen to	99.6%	99.6%	.002	.006	1	1.000
	chooses to listen to	0.4%	0.4%				
blues music	doesn't choose to listen to	99.2%	99.6%	.028	.771	1	.596
	chooses to listen to	0.8%	0.4%				
indie music	doesn't choose to listen to	98.7%	99.7%	.061	3.751	1	.087
	chooses to listen to	1.3%	0.3%				
punk music	doesn't choose to listen to	98.3%	99.1%	.032	1.040	1	.474
	chooses to listen to	1.7%	0.9%				
reggae	doesn't choose to listen to	100.0%	100.0%	/	/	/	/
	chooses to listen to	0.0%	0.0%				
R&B music	doesn't choose to listen to	98.3%	98.7%	.014	.211	1	.750
	chooses to listen to	1.7%	1.3%				
spiritual / religious music	doesn't choose to listen to	99.6%	99.9%	.028	.790	1	.414
	chooses to listen to	0.4%	0.1%				
country music	doesn't choose to listen to	100.0%	100.0%	/	/	/	/
	chooses to listen to	0.0%	0.0%				
children's music	doesn't choose to listen to	100.0%	100.0%	/	/	/	/
	chooses to listen to	0.0%	0.0%				
world music	doesn't choose to listen to	99.6%	99.9%	.028	.790	1	.414
	chooses to listen to	0.4%	0.1%				
unspecified folk music	doesn't choose to listen to	99.2%	97.9%	.039	1.547	1	.272
	chooses to listen to	0.8%	2.1%				
incidental music	doesn't choose to listen to	100.0%	99.9%	.017	.306	1	1.000
	chooses to listen to	0.0%	0.1%				
avant-garde / experimental music	doesn't choose to listen to	100.0%	99.7%	.025	.613	1	1.000
	chooses to listen to	0.0%	0.3%				

[a] exact 2-sided significance

Table 5. Gender differences in music listened to while growing up

What kinds of music did you most often listen to while growing up?		male $n = 236$	female $n = 772$	Cramer's V	χ^2	df	p^a
classical music	didn't listen to often	91.1%	89.0%	.029	.857	1	.397
	listened to often	8.9%	11.0%				
pop music	didn't listen to often	71.6%	44.8%	.227	51.919	1	< .001
	listened to often	28.4%	55.2%				
rock / alternative music	didn't listen to often	48.7%	57.6%	.076	5.816	1	.017
	listened to often	51.3%	42.4%				
rap / hip-hop music	didn't listen to often	86.4%	94.8%	.138	19.128	1	< .001
	listened to often	13.6%	5.2%				
trap music	didn't listen to often	98.7%	99.2%	.022	498	1	.694
	listened to often	1.3%	0.8%				
older Serbian folk music	didn't listen to often	82.2%	77.3%	.050	2.539	1	124
	listened to often	17.8%	22.7%				
new Serbian folk music	didn't listen to often	78.4%	74.4%	.040	1.584	1	.228
	listened to often	21.6%	25.6%				
unspecified Serbian folk music	didn't listen to often	76.3%	70.5%	.055	3.010	1	.098
	listened to often	23.7%	29.5%				
metal music	didn't listen to often	83.9%	93.8%	.150	22.627	1	< .001
	listened to often	16.1%	6.2%				
electro / house music	didn't listen to often	90.3%	96.8%	.129	16.877	1	< .001
	listened to often	9.7%	3.2%				
techno music	didn't listen to often	97.9%	98.7%	.029	.836	1	.541
	listened to often	2.1%	1.3%				
jazz music	didn't listen to often	98.3%	98.3%	< .001	< .001	1	1.000
	listened to often	1.7%	1.7%				
latino music	didn't listen to often	99.6%	99.9%	.028	.790	1	.414
	listened to often	0.4%	0.1%				
blues music	didn't listen to often	98.7%	99.1%	.016	.244	1	.707
	listened to often	1.3%	0.9%				
indie music	didn't listen to often	100.0%	99.7%	.025	.613	1	1.000
	listened to often	0.0%	0.3%				
punk music	didn't listen to often	97.9%	98.6%	.024	.557	1	.550
	listened to often	2.1%	1.4%				
reggae	didn't listen to often	99.6%	99.9%	.028	.790	1	.414
	listened to often	0.4%	0.1%				
R&B music	didn't listen to often	99.6%	99.2%	.018	.327	1	.696
	listened to often	0.4%	0.8%				
spiritual / religious music	didn't listen to often	100.0%	99.7%	.025	.613	1	1.000
	listened to often	0.0%	0.3%				
country music	didn't listen to often	100.0%	99.9%	.017	.306	1	1.000
	listened to often	0.0%	0.1%				
children's music	didn't listen to often	99.6%	97.2%	.069	4.771	1	.042
	listened to often	0.4%	2.8%				
world music	didn't listen to often	99.6%	100.0%	.057	3.274	1	.234
	listened to often	0.4%	0.0%				
unspecified folk music	didn't listen to often	97.5%	98.4%	.032	1.006	1	.397
	listened to often	2.5%	1.6%				
incidental music	didn't listen to often	99.6%	99.5%	.006	.033	1	1.000
	listened to often	0.4%	0.5%				
avant-garde / experimental music	didn't listen to often	99.6%	99.9%	.028	.790	1	.414
	listened to often	0.4%	0.1%				

[a] exact 2-sided significance

Tuning in to the Individual: Customizing Individualized Music Listening for Diverse Needs in People with Dementia

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Abstract

Individualized Music Listening (IML) is a promising non-pharmacological intervention that uses personally meaningful music to improve the emotional well-being of Persons with Dementia (PwD). Given the complexity of behavioural and psychological symptoms of dementia (BPSD), such as agitation, depression, and apathy, tailored interventions are essential to improve health outcomes and reduce caregiver burden. This paper presents three behavioural sequence examples illustrating different responses to IML, each categorized into one of ten behavioural types based on a typology of reactions of PwD to IML. Each example highlights the importance of adapting the music listening experience to the individual's spatial and social environment, as well as their unique musical preferences. Data were collected from a research project conducted in five nursing homes in Thuringia, Germany, to assess the impact of IML on the quality of life and social participation of PwD. Our findings indicate that the interplay between environmental factors and music selection is crucial for optimizing IML outcomes. We also provide recommendations for caregivers to improve the effectiveness of IML interventions and to demonstrate how our research observations can be translated from theory to practice.

Keywords: cognitive impairment, non-pharmacological intervention, behavioral analysis

Introduction

Dementia affects more than 55 million people worldwide, with nearly 10 million new cases reported each year (World Health Organization, 2021). While cognitive decline is a characteristic feature of dementia, the way it manifests and progresses is significantly influenced by behavioural and psychological symptoms of dementia (BPSD), such as agitation, depression, and apathy (Kales et al., 2015). These symptoms are associated with worse health outcomes for Persons with Dementia (PwD), increased caregiver stress, and higher care costs. As "one size fits all" solutions are not appropriate due to the unique nature and complexity of BPSD, non-pharmacological interventions tailored to the individual with dementia are recommended as a first-line strategy (Kales et al., 2015), with music interventions being one of the most promising approaches. While the influence of music on emotions and well-being is already significant in non-pathological ageing (Laukka, 2007), it becomes crucial in pathological ageing. Anxiety, depression, and agitation often become major challenges for PwD (Ferreri et al., 2019) and music is increasingly being used to enhance their well-being. One particularly effective intervention is individualized music listening (IML), which refers to personally meaningful pieces of music that were an important part of the person's life before the illness, and are associated with positive experiences and feelings (Jakob et al., 2021).

Recognizing familiar music is considered emotionally significant for PwD, even in the later stages of the disease. Their musical identity is influenced by psychosocial factors such as life events and personality traits, but also by the severity of the dementia (McDermott et al., 2014). It has been shown that IML has a positive impact on anxiety, agitation and depression and promotes relaxation (Särkämö et al., 2012; Sittler et al., 2021; Sung & Chang, 2005). Despite studies highlighting benefits and other positive changes of IML (Hillebrand et al., 2024; Weise et al., 2020), it is often neglected how people with different psychological symptoms of dementia respond to music differently. For example, PwD with increased depressive symptoms or a history of depression are more likely to recall negative memories, which can also be triggered by listening to music. IML should therefore be based not only on favourite or personally meaningful music, but also on the specific symptoms of a PwD and their psychiatric history (Garrido et al., 2018).

Furthermore, participants' responses to IML can be marginal and vary widely, yet most PwD derive pleasure from listening to music (Ragneskog et al., 2001). This leads to the question of how to meet the individual needs of PwD and how to tailor IML to their needs in terms of both the music listening situation and the music selection itself.

Research objective

In this article, we present three examples of behaviours that show different responses of PwD to IML. We assign each example to one of ten behavioural types we defined in a typology of reactions of PwD to IML (Töpfer et al., 2024), explain what characterizes the respective type, and provide recommendations on how the individualized music listening situation can be best adapted to the needs of this type in this particular situation. We consider both the spatial and social environment as well as the individualized music selection. Using these examples, we demonstrate how our research observations and analyses can be translated from theory to practice.

Method

The data for the present investigation were collected as part of the research project *Individualized Music for People with Dementia - Improving Quality of Life and Social Participation for People with Dementia in Institutional Care*. The project was conducted from January 2018 to April 2021. Its objective was to investigate the impact of an IML intervention on the quality of life, problem behaviour, and social participation of PwD recruited from five nursing homes in Thuringia, Germany (Weise et al., 2018).

Study design

The study followed a pre-post design, with all participants being randomly assigned to either the intervention (IG) or control group (CG). IG participants listened to individualized music, while CG participants received standard care. We recruited 130 nursing home residents in Thuringia, Germany. Twelve individuals were excluded prior to randomization due to death, ineligibility, or withdrawal, leaving 118 PwD who were randomized to the IG (n = 61) or the CG (n = 57). The present study focuses solely on IG participants.

Based on Gerdner (2021), a questionnaire was used to assess the music preferences of PwD and to create the individualized playlists. The questionnaire was completed by caregivers or family members. Where possible, PwD were asked about their music preferences. Three playlists, each lasting 20 minutes, were created for each person in the IG. The IG participants listened to their music via headphones and MP3 players for 20 minutes every other day for six weeks. The music interventions were carried out by the project team, employees of the nursing home, volunteers and relatives.

For both study groups, 60-minute behavioural observations were conducted at three points in time during the intervention period. For the IG, these included listening to the individualized music, so that 20 minutes before, 20 minutes during and 20 minutes after the music intervention were observed. Behavioural observations were conducted using the Dementia Coding System (DeCS), an observation scale developed by the project team to systematically assess the effects of nonpharmacological interventions, such as IML, in PwD. The DeCS was designed following a systematic time-sampling approach, i.e. observing PwD in prescribed time intervals. Over a 60-minute period, the behaviour of PwD is assessed at four-minute intervals in three categories: positive, challenging, and music-related behaviours of PwD (Hillebrand et al., 2022). Where consent was given, behavioural observations were filmed by the project team.

Individual needs of people with dementia

Based on the collected data we conducted two extensive studies examining aspects of individualization in relation to the spatial and social setting of music listening (Töpfer et al., 2024) and the individually chosen music (Schön, 2025). Both studies were based on analyses of 108 video recordings of 60-min behavioural observations of 45 PwD in the IG.

Focusing on the spatial and social setting of the music listening situation, we have conducted an ideal-type analysis (Stapley et al., 2022) which yielded 10 types of reactions ("expressing and sharing joy," "self-disclosure stimulated by music," "concentrated, absorbed listening," "blissful enjoyment," "experiencing the music as bittersweet," "sharing memories," "releasing tension," "tensing up and rejecting," "predominant search for social exchange," "no interpretable reaction") and 3 dimensions ("valence" from negative to positive, "arousal" from calm to activated, "communicative activity" from defensive/resistant to proactive), providing a holistic representation of reaction types to IML (Töpfer et al., 2024).

Focusing on music related influencing factors on the reaction of PwD on IML, ten case studies were conducted, which showed distinctive music-related reactions during IML. Five fields of impact addressing music-related influencing factors of IML on PwD were identified ("individual adaptation of music selection and listening situation", "synchronization and orientation through rhythm", "music-related memory and nostalgia", "the influence of own music-making", "sadness and farewell"). The three behavioral sequence examples presented in this article can be found in the first, second and sixth of these ten case studies (Schön, 2025).

Results

Behavioural sequence example 1:

On the third visit, the PwD's most striking reaction is to the song *The Rain in Spain!* from the musical *My Fair Lady*. Right at the beginning of the song, the lyrics "Enough, Professor Higgins!" are sung emphatically, and the PwD joins in laughing. She seems completely consumed by her emotion and infects the project team with it. When the musical character Eliza repeats the words: "The green gets greener when Spain's blossoms bloom" after the professor, the PwD laughs and repeats: "The green gets greener" and looks at the project team, who then ask, "Do you know this song?" She replies, "Yes, yes." When the same line of lyrics is sung by the musical characters Higgins, Eliza and Pickering together, the PwD takes turns tapping out the basic beat with her hands on her lap. She laughs at the lyrics and smiles at the project team [case study 1, behavioural sequence 3].

Characterization of reactions and recommendations for tailoring the intervention: Based on our typology, the behaviour of the person with dementia can be classified along the following three dimensions:

- Valence: Positive / high (6–9)
- Arousal Activated / medium (3–6)
- Communicative activity: Proactive / medium (3–6).

According to the ranking on the dimensions and the observed behaviour in this particular example, the PwD showed the highest agreement with the "expressing and sharing joy" type, which is characterized by behaviours such as seeking and initiating contact and social interactions to express (in this case, laughing and tapping to the beat) and to share joy (seeking eye contact with the project team and initiating conversation through the lyrics of the song). The PwD was also pleased when the project staff responded to her offer of contact. At the same time, the conversational comments were solely about the music, as the music gave impulses for communication. The PwD also alternated between initiation of communication and listening to music by herself (Töpfer et al., 2024).

The following factors can be considered in relation to the spatial and social setting of the music listening situation and the individually chosen music: Instead of listening through headphones, it can be helpful to listen to the music together, e.g. through loudspeakers, to get more involved with the PwD and to be able to mirror their reactions of joy in order to make them feel comfortable. Depending on the reactions of the PwD, in this case tapping and repeating text passages of the lyrics, one should take up and show resonance to the impulses of the PwD by moving along and also referring to certain text passages (Töpfer et al., 2024). Considering the choice of music, it is of striking importance to be familiar with the music the person is currently listening to be able to join into the lyrics and for example sing along together. In this case, it may be helpful for the caregiver to bring the lyrics with them for reference. Titles that elicit such a clear positive reaction can be used to guide the selection of alternative titles. In this case, these would be songs from musicals during the PwD's youth, with descriptive, uplifting lyrical content that they can relate to (Schön, 2025).

Behavioural sequence example 2:

During the first part of the song *I Love Life* (*'Ich liebe das Leben'*) by Vicky Leandros, the PwD sits quietly; when the banjo and rhythm section join in, she moves her legs and head rhythmically. During the quieter interludes, she also becomes calmer outwardly, and when the music gets livelier, she moves her legs right along with it. The swaying of her legs is transferred to her upper body. As she moves, she keeps to herself and makes no contact with the project team. To the following song, *Two Guitars by the Sea* (*'Zwei Gitarren am Meer'*) by Fred Bertelmann, she slowly rocks her upper body back and forth, then moves her legs to the beat throughout the song, as if she were dancing while sitting. After the music, she turns to the project team and thanks them for the music, in contrast to the music listening period when she was socially withdrawn [case study 2, behavioural sequence 24].

Characterization of reactions and recommendations for tailoring the intervention: Based on our typology, the behaviour of the PwD can be classified along the following three dimensions:

- Valence: Positive / high (6–9)
- Arousal Activated / high (6–9)
- Communicative activity: Proactive / low (0–3).

According to the ranking on the dimensions and the observed behaviour in this example, the PwD showed the highest agreement with the blissful enjoyment type, which is characterized by behaviours such as being excited and enthusiastic, shown by physical reactions (in this case, dancing while sitting, rocking her upper body back and forth) that are not directed at another person. The PwD was also focused on and absorbed by the music and did not interact with the project team while listening (Töpfer et al., 2024).

The following factors can be considered in relation to the spatial and social setting of the music listening situation and the individually chosen music: If possible, the PwD should be able to listen to their music by themselves through headphones in an undisturbed environment. If they cannot be in a room without another person present, the caregiver should get out of sight and engage in other activities. For some PwD, it may be helpful to look into the distance, for example by sitting outside or by a window overlooking a garden (Töpfer et al., 2024).

As for the choice of music, this example shows a specific, rhythmic response, as the PwD responded to the music exclusively motorically. Synchronization to music becomes easier the more clearly the pulse structure can be perceived. PwD, who often have difficulty orienting themselves in time and space, can be helped to synchronize to music by a clear pulse structure. The sense of orientation provided by rhythm provides a contrast to the everyday life of many PwD and can lead to a sense of security and well-being. It is advisable to choose songs that have a clear rhythmic pulse structure and a tempo that is appropriate for the person, so that they can synchronize their movements with the music (Schön, 2025).

Behavioural sequence example 3:

As she listens to the quiet opening section of *I've never been to New York* (*'Ich war noch niemals in New York'*) by Udo Jürgens, the PwD looks around in her room, listens attentively and does not comment or sing, but whispers parts of the lyrics. Sadness is now clearly visible in her expression; her head and eyes are lowered. At a point in the lyrics where it says, "To be full of dreams once more", she nods and tells the story of a friend who had invited her to her house but who died the next day. She comments: "A beautiful death. That's what I always want. To go to sleep and not wake up". She rests her head in her hands. The project team listens attentively. The following song is the love song *Plaisir d'amour* by Peter Alexander. At the part of the lyrics "Come to me, love is here for you too", she says: "Yes, love, that was beautiful. My husband died a long time ago." She tells the story of the day he died. Then she nods, turns to the project team and looks at them for a long time. Soon after, the music changes to the next song, and as she hears the new melody, she starts to sing along [case study 6, behavioural sequence 41].

Characterization of reactions and recommendations for tailoring the intervention: Based on our typology, the behaviour of this PwD can be classified along the following three dimensions:

- Valence: Negative / low (-3 to 0)
- Arousal: Activated / medium (3–6)
- Communicative activity: Proactive / medium (3–6).

According to the ranking on the dimensions and the observed behaviour in this example, the PwD showed the highest agreement with the type called self-disclosure stimulated by music, which is characterized by a music-stimulated self-disclosure about painful issues (in this case, the death of a beloved one). The music helped to contain the accompanying feelings and provided a time frame within which to act. In comparison to the joy expressing and sharing type, biographical accounts are based on themes from the lyrics of the song. In this example, the love song brought back memories of the beloved husband (Töpfer et al., 2024).

In this situation, the following factors can be considered in relation to the spatial and social setting of the music listening situation and the individually chosen music: The emotional experiences that are shared are of existential value to the PwD. Sharing these emotions can help them to cope with the upcoming feelings, so it is important for the caregiver to normalize and validate the emotional experiences. Since the music itself is leading the person to open up about a personal experience, the caregiver does not necessarily have to participate in the conversation, but should actively listen to make the PwD feel heard (Töpfer et al., 2024).

Music can be a distraction when PwD are in a sad mood. At the same time, it can intensify sadness if elements of the music reiterate sadness, for example if lyrics echo the mood of PwD through words such as "alone" or "sad". These songs should be chosen with caution. When mixed emotions occur, as in this case, music can help by providing a framework for expressing sadness. In a playlist that uses different types of music to evoke different emotions, a song can be used to evoke a more challenging emotion such as worry or grief. If this is followed by an uplifting, activating song, this may help the PwD to get into a different mood to prevent the sadness from becoming overwhelming. When creating the playlist, songs that PwD react to with sadness do not have to be omitted completely, but can be placed between relaxing, distracting or generally positive songs (Schön, 2025).

Discussion

The aim of this investigation was to demonstrate how our research observations and analyses can be translated from theory to practice using three examples from our study project. The three examples were chosen to show the complex nature of individual responses to IML. They stress the importance of addressing the PwD's needs based on their current condition. The examples also illustrate the diverse nature of the positive effects that IML can have on PwD. The different, enriching experiences that PwD have when listening to their favourite music clearly show the benefits of this personalized intervention that can respond to individual needs.

While the first step in IML is the appropriate selection of individually meaningful music, the environment and social support systems are equally important for the outcomes of such interventions (Garrido et al., 2018). The benefits of the intervention can be enhanced by having another person present who engages with the PwD through singing, clapping, or dancing, thereby expressing and sharing joy, as shown in the first example. This person also normalizes and validates emotional experiences, shows interest in the individual's memories, and initiates conversations for social exchange. However, there are cases, where listening to music by oneself is key to improving the wellbeing of PwD through IML, as shown in the second example, and flexibility in the music listening situation is one of the most important skills that caregivers should develop.

The combination of spatial, social, and music-related factors in the application of IML in this paper also shows that the spatial and social environment of the PwD as well as the choice of music are closely linked and cannot be considered separately. The lyrics of certain songs in particular can trigger activating, joyful reactions in PwD (example 1), as well as feelings of sadness or grief (example 3). This can then be responded to by either selecting more songs that have similar characteristics to the song that caused the positive reaction. Similarly, songs that evoke mixed feelings or sadness can be embedded in a context of stimulating and relaxing songs. If, in the context of listening to music, it becomes clear that feelings of sadness, grief or worry are overwhelming for the PwD, the respective songs can be removed from the playlist. However, it is important to note that the expression of sadness in PwD, which may appear burdensome from the outside, can be a valuable experience. There are often few opportunities in everyday care, especially for PwD in care homes, to deal emotionally with issues that trigger sadness. Music that provides access to emotions such as grief can be helpful for PwD, and listening to music can provide a safe environment for these emotions. Feelings of sadness are just as relevant to the individual and their well-being as feelings of activation or joy, as they are part of their own life experience and therefore inextricably linked to their own identity. Particularly in later life and in the context of a care home, issues such as saying goodbye to one's own home and coping with death are important and should be given space (Schön, 2025). This space can be created through music, which again underlines the relevance of this form of intervention.

The excerpts presented here provide only a brief insight into the numerous visits and music listening sessions that were conducted with PwD in the IG as part of the study project. The selection of these three short excerpts as examples is intended to provide practical insight into the behaviour of PwD. These observations should not be taken as generalizations, but they illustrate the great potential of IML for PwD, who can experience joy, be physically activated, or access burdensome memories through listening to music. It can be seen from the examples that their mood can change abruptly when they listen to music. On the one hand, this may be due to their condition, for example, if a PwD has been generally exhausted that day. However, as shown in example 3, mood can also change significantly based on individual pieces of music. The types of music

presented and the associated recommendations for tailoring the intervention are intended to raise general awareness of the situation of listening to music. In all cases, it is clear that PwD require increased attention during IML.

Our study shows positive immediate effects of using IML with PwD (Hillebrand et al., 2023), as illustrated by the behavioural sequences. For this reason, we recommend incorporating IML into the everyday care setting to ensure the continued benefits of its positive effects. The success of IML can be further enhanced by taking into account the recommendations we give regarding the listening environment, the social situation and the musical factors. From our experience, we see that considering the individual needs of PwD contributes to their well-being and that caregivers can be sensitized to the needs of PwD in order to provide a valuable experience through music listening, not only for PwD, but also for themselves.

Conclusions

This investigation highlights the importance of IML as an effective non-pharmacological intervention for PwD. By recognizing the diverse behavioural responses to IML and tailoring the listening experience to each individual's needs, taking into account both their personal history with music and their current emotional state, caregivers can significantly improve the quality of life for PwD. The integration of spatial and social factors in addition to personalized music selection is essential to maximize the benefits of IML. Our findings support a flexible approach to implementing IML that prioritizes individual differences, ultimately fostering a more supportive environment for PwD.

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Exploring Musical Addiction: Interdisciplinary Perspectives

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Abstract

Musical pleasure triggers dopamine release in the brain's reward circuit, and some listeners compare music listening to a drug that provides substantial relief. Based on an awareness of interdisciplinary literature, we explored the concept of musical addiction through the lens of emotional regulation and behavioural addiction. We analysed the evolution of the concept of addiction, highlighting the transition from substance dependence to behavioural addiction, and identified how excessive music listening may exhibit addictive patterns. Drawing on perspectives from psychology, neuroscience, and sociology, our point of view suggests parallels between musical addiction and behavioural addictions, particularly in terms of salience, loss of control, and negative consequences. It proposes a framework for analysing listening practices by distinguishing factors controllable by the listener, such as context and listening mode, from less controllable aspects like immediate emotional reactions and awareness of individual musical responses. This framework introduces the hedonic management competence model, identifying three levels of mastery over the listening experience (low, intuitive, significant). Our work shows how effective management can transform potential addiction into a positive tool for emotional regulation. Our conclusions open up avenues for raising awareness among listeners about their listening practices, optimizing their musical experiences while using music as a tool for emotional well-being. Future research should explore this model and define its putative applications for emotional regulation strategies.

Keywords: musical addiction, emotion regulation, musical reward

Introduction

YouTuber Jak Piggott (2024) introduces a personal experiment, seven days without music, with a confession: "I've been a chronic music addict since my birthday." Surprisingly, he finds the experience liberating, gaining a sense of mental clarity and emotional calm. His testimony reflects growing awareness of the potential downsides of music as an omnipresent part of daily life, not only as an enjoyment, but also as an emotional reliance.

Music is a powerful emotional stimulus, shaping mood, identity, and social cohesion. (Boer & Abubakar, 2014; Hird & North, 2021; Laiho, 2004; Saarikallio & Erkkilä, 2007) While its benefits are well-known, excessive or compulsive use may sometimes exhibit patterns similar to behavioural addiction. These two faces of the same coin raise key questions about the psychological mechanisms and social contexts underpinning engagement to musical listening.

The present work proposes a conceptual reflection on "musical addiction", drawing on psychological, neuroscientific, and sociological insights. It seeks to identify the boundaries between intense engagement and potentially problematic use of musical listening. Can music's immersive and emotionally charged nature foster patterns of use that impair daily functioning, and if so, under what conditions? These questions echo testimonies on social media and forums, where listeners report several hours of daily exposure and refer to themselves as "addicted" (Open_Town, 2024). Common features of these reports include:

- Prolonged voluntary exposure (salience of the activity);
- Loss of control, listening duration being too long or feeling discomfort without music (compulsive activity);
- Discomfort, anxiety, or frustration relieved by listening to music, which thus becomes a strategy for emotional regulation (emotions before and after listening: pleasure, relief).

When poorly managed, such practices can reinforce anxiety, rumination, or isolation (McFerran & Saarikallio, 2014; Singh et al., 2023). Listeners may recognize these effects but lack tools to manage them, turning to online forums

under headings like "I'm addicted to music." In this context, listening control becomes central.

Recent studies address these practices but rarely frame them explicitly as musical addiction (Massemin, 2022). Some authors link repeated listening to the attraction to specific artists or to thematic coherence within listening sessions (Tsukuda & Goto, 2017), but often reduce such potentially addictive patterns to frequency of exposure. Others suggest that compulsive listening may result from uncontrollable cravings, measurable with adapted tools like the Desires for Alcohol Questionnaire (Starcke et al., 2024). Although these dimensions are explored, a coherent framework remains poorly developed. We thus aim to contribute to this field by examining the central issue of control over music listening.

This article hence seeks:

- to explain why the behavioural addiction framework is relevant for these practices;
- to introduce a methodological framework centred on the listener's control, what we call "hedonic management competence" through music.

Rather than relying on empirical data, this work explores conceptual and theoretical dimensions of the so-called musical addiction, proposing several directions for future research. It investigates how excessive listening may interact with addiction mechanisms through the lens of the behavioural addiction theory. Our goal is finally to distinguish intense but non-pathological engagement from genuinely addictive use. We hypothesize that some forms of excessive music listening operate as high-risk emotional regulation strategies, similar to other non-substance behavioural addictions, a statement that leads us to ask: Can intense musical engagement become addictive, and under what psychological or social conditions?

Different approaches to addiction

Addiction is a biological, psychological, and social pathology, ranging from a precisely diagnosed condition to a simple excessive and impulsive behaviour. Several approaches to understanding addiction exist, mainly from the fields of psychiatry and sociology.

Substance-related disorders according to the DSM-5

The reference manual named the Diagnostic and Statistical Manual of Mental Disorders (version 5 of the DSM, from the American Psychiatric Association, 2015) describes substance-related disorders such as alcoholism, cocaine, and methamphetamine addiction. These disorders are diagnosed using specific criteria along a continuum of severity (mild, moderate, severe) based on the number of diagnostic criteria met. Only one disorder considered in the DSM-5 is not associated with a substance: pathological gambling.

Behavioural addiction

The concept of behavioural addiction first appeared with the book Love and Addiction by Peele & Brodsky (1975), which addressed love dependency and positioned addiction at the intersection of psychological, biological, social, and cultural dimensions.

American psychiatrist Aviel Goodman (1990) expanded the concept of addiction by focusing on behaviour and introduced the term behavioural addiction. Individuals may respond differently to the same addictive substance or situation: some develop addiction, others do not, and some manage to control their consumption. This description minimizes the role of the substance alone and considers the notion of user control. Research has since focused on the links between addictive behaviours, their underlying processes, and individual vulnerabilities.

Alavi et al. (2012) have identified several characteristics for behavioural addiction:

- Conditions for emergence: preexisting trait anxiety, depression, substance dependency or withdrawal, social anxiety, or lack of social support.
- Active or passive nature: addictive behaviours may manifest actively or passively.
- Functional impairments: at work, in social relationships or in other social contexts.

Common mechanisms between substance and behavioural addictions have been indeed highlighted: tolerance, withdrawal symptoms, and persistence of maladaptive behaviours despite negative consequences (Starcke et al., 2018).

Positive addiction

Positive addictions have been defined by the psychiatrist William Glasser (1997), an approach which remains controversial. Addictions to activities such as sports or work might fall into this category, with a perspective that gives rise to a personal development movement focused on adopting beneficial behaviours. Although the benefits of music on the body and mind suggest that it could be

examined under this lens, such a perspective would exclude the negative consequences of prolonged listening.

The continuum between normal and pathological behaviour

Addictive behaviours can also be seen as normal but dysregulated behaviours in search of pleasure. The distinction between normal and pathological behaviour lies on a continuum rather than a clear boundary. In Iain Brown's model of hedonic management of addictions, addictions are understood as an extreme form of managing psychological and emotional states (Loonis, 1999). The goal of addictive behaviour is thus to maintain or restore positive hedonic tones (pleasure, well-being) or to avoid negative ones (dysphoria, discomfort). Addiction operates on the syndrome model (Shaffer et al., 2004), meaning that a set of signs and symptoms (physical and cognitive characteristics) appear in parallel and successively. This syndrome depends on individual vulnerability, exposure to the object of addiction, and interaction with this object. The addiction syndrome can hence emerge with the object of interaction, transforming progressively a goal-directed behaviour into a habit that persists despite its negative consequences (Everitt & Robbins, 2016).

This model may depict an anxious or depressed listener who turns to music for relief, which temporarily alleviates pain or suffering, driving them to repeat the relieving behaviour. Over time, the relief diminishes, yet the person feels compelled to continue listening for extended periods to avoid the discomfort of withdrawal. This view raises key questions: can listening to music cause addiction and can this reveal underlying personal vulnerabilities of the listener?

Behavioural addiction and music listening

Towards a definition of musical addiction

Considering the concept of behavioural addiction, musical addiction may be understood as a progressive dysregulation of listening behaviour, unfolding along a continuum from emotionally regulated use to compulsive engagement. Initially aimed at the conscious modulation of affective states, listening to music may gradually shift into an automatic response to dysphoria, marked by loss of control, increasing emotional preoccupation, and persistence of behaviour despite negative consequences on social, personal, or professional life. Framed within a syndromic approach to behavioural addiction, musical addiction might thus result from the interaction between individual vulnerabilities, emotional needs, and repeated exposure to music as a hedonic regulation tool. Core symptoms of musical addiction could include a compulsive craving to listen, an inability to reduce or control listening despite efforts, the use of music to escape negative emotional states, the subsequent neglect of personal or social responsibilities, and the emotional distress when music is unavailable.

Massive and impulsive music consumption

The duration of exposure to music is one of the dimensions measured in sociological studies, enabling the creation of listener typologies. Adorno (2009, Kindle location 394) presented seven categories of listeners, including the "entertainment listeners," who immerse themselves in music for hours to escape discomfort, similar to smoking, describing this as a dependency on music: "The structure of this type of listening resembles the act of smoking. It is defined more by the discomfort experienced when turning off the radio than by the pleasure, however modest, while it is on". From the 2000s onwards (DeNora, 2000), interviews and observations have been used to refine these listener portraits, challenging the rigid pre-established typologies (Lilliestam, 2013). Since 2018, the International Federation of the Phonographic Industry (IFPI) has produced annual reports on recorded music listening, surveying thousands of people in 26 countries (Childs-Young, 2023). The average listening time per day has continued to increase since 2018, reaching up to three hours per day (Childs-Young, 2023).

In France, HADOPI (2021) conducted studies on online music listening practices. Interviews with 34 participants aged 15 to 41 identified two distinct profiles, including the "musicholics" profile (similar to alcoholics) to describe listeners who feel a compulsive drive for music consumption, experiencing a constant need for music and listening all day long. Higher level of music consumption before the age of 25 was observed, often leading to a sense of fatigue.

Music listening as a highly hedonic activity

Since 2001, a series of studies demonstrated and examined the activation of the brain's reward circuit, the same circuit activated during hedonic activities such as sex or eating and addictive activities such as drug use (Blood & Zatorre, 2001). Subsequent

studies highlighted the endogenous release of dopamine in two distinct brain areas: during the anticipation of a musical reward and during peak emotional arousal (Salimpoor et al., 2011). The caudate nucleus was more involved during anticipation, while the nucleus accumbens was more active during the emotional peak. Dopamine modulation via the neuroleptic risperidone enhances the pleasure experienced when listening to music and strengthens the motivation associated with musical experiences (Ferreri et al., 2019). When a musical piece is heard for the first time, activity in the mesolimbic striatum, particularly the nucleus accumbens, strongly predicts the amount an individual might be willing to pay to acquire it. This highlights the connection between brain areas associated with reward and the subjective value assigned to new music (Salimpoor et al., 2013).

The brain areas activated during listening to very pleasant music are those activated in the context of addiction (Reybrouck & Van Dyck, 2024). This suggests that dimensions involved in music listening may contribute to addictive processes (Starcke et al., 2018) and could explain why some listeners feel an intense craving to listen to music (Starcke et al., 2024). The intense pleasure that music can provoke makes it indeed an extremely powerful tool for emotional regulation, which is one of the primary motivations for listening to music.

Negative consequences of music listening

Listening to music can be a powerful and beneficial tool for regulating emotions (Baltazar & Saarikallio, 2016, 2019; Garrido et al., 2022; Kahn et al., 2024). However, it can also be considered an "unhealthy music use" (Silverman, 2020, p. 940), which manifests in inappropriate musical choices leading to poor emotional regulation (Silverman, 2020; Singh et al., 2023). Such misuse of music is more commonly observed among individuals who are depressed, anxious, and prone to neuroticism (Vella & Mills, 2017). These individuals often seek musical rewards as an escape from their reality (Alluri et al., 2022), and certain emotional regulation strategies, such as suppression of listening, can exacerbate long-term distress (Randall et al., 2014; Randall & Rickard, 2016). Conversely, unhealthy music use can lead to increased symptoms of depression and anxiety (Tan et al., 2024). While the potential usefulness of such mechanisms for future resilience remains an open question, it highlights the awareness of music's effects on a person's emotional state and the importance of situational factors.

Controlling the parameters of the listening experience

Challenges for the listener

Parameters that influence the outcomes of the listening experience are considered to be interconnected with the functions of listening and divided into situational factors (activity, choice of music, level of attention given to music, listening alone or in a group) and individual factors (intensity of musical preferences, personal tastes, personality traits) (Greb et al., 2018). Affective regulation models for music listening incorporate these dimensions by defining musical mechanisms that depend on the individual (memory, identification, lyrics) and others that rely on the characteristics of the music itself (rhythm, genre, acoustics) (Baltazar & Saarikallio, 2019). Descriptive models of the listening experience encompass all individual and contextual dimensions, such as listening modes, agency, and functional contexts (Eerola et al., 2024). For example, it has been shown that solitary listening amplifies the perceived emotional valence of the music (Zhang et al., 2017) or allows for more intense musical chills than group listening (Egermann et al., 2011). In all cases, authors emphasize the importance of self-awareness for listeners to move toward beneficial emotional regulation and the development of appropriate strategies (McFerran & Saarikallio, 2014; Silverman, 2020; Tan et al., 2024).

The control of music listening thus plays a key role in emotional regulation, particularly for individuals for whom music is an important part of their daily life. Krause et al. (2020) suggested that this control is particularly relevant for those with a strong external locus of control, as these individuals may use music to compensate for a lack of control over other aspects of their lives. By offering increased control, devices like smartphones or streaming platforms allow listeners to control not only their choice of music, but also the location and timing of their listening. This ability to control the musical environment enhances the sense of dominance, a perception of power or control over one's activity, which is generally viewed as positive and contributes to a favourable musical experience (Krause & North, 2017).

However, it is important to note that controlling one's listening does not always result in beneficial exposure to music (Alluri et al., 2022; Garrido et al., 2017; Miranda, 2019). Poor management of listening, especially among young listeners, can lead to consequences that may not be immediately perceived. There is therefore a dual challenge:

- On the one hand, it involves mastering the factors of the listening experience to ensure that it is beneficial in the long term.
- On the other hand, it is crucial to be aware of risks associated with inadequate exposure, in order to prevent negative effects on listeners' emotional well-being.

Controllable and uncontrollable factors

In the context of a preceding dysphoric state, a listener can be unable to alter any initial emotional state. The only option may thus be to adjust contextual factors to achieve a rewarding listening experience.

It can be challenging for the listener to become aware of the role of these factors and to distinguish which can be controlled. However, this awareness can be developed with external intervention (Stewart et al., 2019). To address this point, we propose a comprehensive list of factors during the listening experience: self-awareness, controllable factors, and uncontrollable factors, presented in Table 1.

The hedonic management competence model for music

The hedonic management competence model for music we recently developed (Massemin, 2022) refers to the ability to optimize the pleasure derived from listening to music by understanding and mastering the parameters of the listening process, combined with self-awareness. It is the skill to identify the purpose of one's listening and adjust the parameters to achieve it, thereby maximizing satisfaction. Interviews conducted during this recent work identified three levels of hedonic management competence among listeners (shown in Table 2):

- The first level corresponds to an absence or low level of mastery of the listening process. A good listening experience cannot be repeated, the experience is often disappointing, and the listener may lose interest in music.
- The second level corresponds to intuitive mastery: listening is satisfying because the parameters of listening are controlled, but in an instinctive manner.
- The third level corresponds to mastery of the process based on one's own expectations. At this level, the effects of each listening parameter are known and consciously adjustable by the listener, making the listening experience a source of long-term pleasure and well-being, which can be consistently repeated.

Table 1. Factors related to self-awareness, controllable and uncontrollable parameters for the listener

Self-awareness	• Purpose and motivation for listening • Consequences of listening and evaluation relative to the goal (short, medium, and long term) • Identification of the role of each listening parameter
Uncontrollable	• Initial emotional state • Immediate physical and emotional reactions • Characteristics of the music if unknown (expectations)
Controllable	• Social context (alone, in a group) • Parallel activity • Duration of listening • Method of selecting the music • Listening medium • Characteristics of the music if known (preferences, degree of familiarity) • Manner of listening (number of repetitions, shuffle mode) • Level of attention given to the music

The purpose of the hedonic management competence model is to consider listeners as being more or less aware of their own emotional regulation mechanisms and their effectiveness, allowing them to either replicate or modify these mechanisms as needed to achieve a higher degree of mastery. It can be provided to listeners during music therapy sessions and developed further during these sessions. The creation of new listening strategies can be considered and practiced, relying on the mechanism of evaluative conditioning for emotional induction (Juslin et al., 2015).

Unlike diagnostic frameworks for behavioural addiction, which aim to identify pathological patterns such as loss of control, craving, and persistence despite negative consequences, the hedonic management competence model focuses on adaptive skills. It conceptualizes musical engagement not in terms of pathology, but as a continuum of mastery from low to advanced, centred on emotional self-regulation. Rather than diagnosing dysfunction, the model reconceptualizes musical engagement as a skill-based continuum, shifting the focus from identifying symptoms of addiction to empowering listeners to consciously regulate their musical experiences and promote emotional well-being.

Conclusion

Research on listening practices and emotional regulation shows that some listeners experience an irresistible craving to listen to music and derive significant pleasure from it. However, for individuals with pre-existing dysphoria (such as depression or anxiety), improper use of music can unconsciously worsen their emotional state. This highlights the importance of aligning listening motivations with actual outcomes of musical experiences. Listeners' behaviours can be analysed within the framework of behavioural addiction: pre-existing dysphoria, craving, intensified negative effects, and repetitive behaviour. Becoming aware of these behaviours can be a way to address them, provided that factors dependent on the listener are distinguished from those that are not. On the other hand, the degree of mastery a listener has over listening experience can be identified using the hedonic management competence model, which is structured across three levels of mastery of the listening (low, intuitive, advanced). By bringing the listener's attention to specific ways of modifying their listening experiences, it becomes possible to guide them toward better emotional regulation. In a context where access to music is facilitated by streaming platforms, raising public awareness about the implications of their listening practices has become crucial. Far from condemning intensive music use, we thus aimed to promote a balanced and thoughtful approach, where music, instead of serving as a compulsive refuge, can become a mastered tool for well-being and emotional fulfilment.

Table 2. The Hedonic Management Competence Model for Music

Level of mastery	1st level Absence/low mastery	2nd level Intuitive mastery	3rd level Mastery based on expectations
Context	Unable to determine initial emotional state Cannot vary listening contexts	Intuitive understanding of the appropriate listening situation	Conscious mastery of parameters
Goal-directed	Undefined	Defined more or less clearly	Clearly defined in advance
Music listened to	Limited musical diversity	Broad musical palette aligned with the purpose	Extensive musical database tailored to each purpose
Physical and emotional reactions	Unable to identify the effect of music on oneself	Aware of the effect of music on oneself	Knows what effect to expect from music
Experience evaluation and memory	Neutral, disinterest, or negative experience Does not recall the parameters of the experience	Considers experience parameters without necessarily linking them to the listening outcome	Compares emotional response to the expected effect Associates the effect of music with all parameters

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Loving and Owning: Psychological Aspects of Buying Music NFTs

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Abstract

The main objective of this paper is to outline the psychological aspects of trading in the music NFT (non-fungible tokens) ecosystem, with special emphasis on the psychological background of buying NFTs. Since the most important feature of NFTs is the acquisition of ownership enabled by technological solutions, we assume that each purchase of a token does not only imply an economic exchange of ownership, but also the activation of psychological ownership. Having in mind that psychological ownership is a relative category that depends, among other factors, on the nature of the target to which it is attached, our investigation is conceptual rather than empirical. By connecting the already identified cores of psychological ownership to the characteristics of some of the most prominent music NFT drops, we aim to theoretically define general dimensions of psychological ownership through which emotional and social connections to music NFTs as objects of ownership emerge. We conclude that the NFT market reinforces psychological ownership by providing consumers valuable outcomes. In terms of music NFTs, the concept of psychological ownership can be explained by several intertwined dimensions that create emotional and social connections and motivate users to purchase these digital goods. These include a sense of unique possession, identity and self-expression, a sense of belonging to a community, and investment opportunities. The NFT drops discussed illustrate how leveraging different aspects of psychological ownership can transform a music release into a special experience that reshapes the relationship between fans and musicians. Examining fans' purchases of music NFTs from a psychological perspective can help musicians better understand blockchain users' behaviour towards music, which is essential for developing NFTs into a sustainable digital format for music revenue.

Keywords: music, NFT, psychological ownership theory, buying artworks

Background

The continuous advancement of technology is transforming the ways in which music is distributed, sold, and owned. One of the latest technological innovations in the digital music market is the emergence of non-fungible tokens (NFTs). Due to their novelty, this section first explains NFTs from both technological and economic perspectives and then introduces the psychological aspects that influence NFT purchases.

What is an NFT?

As a unique data record deployed on blockchain platforms, NFT guarantees the authenticity of the origin and ownership of a particular tangible or intangible asset. Each NFT is created through minting, with multiple nodes (users) maintaining and validating the data on their hardware, so there is no control by a single entity (Fortnow & Terry, 2022). NFTs can be used for "images, videos, GIFs, audio, 3D models, codes, books and prose, collectibles, digital real estate, in-game items, etc." (Fortnow & Terry, 2022, p. 18), ensuring that the payment process only occurs when predefined conditions are met, eliminating the need for intermediaries. Building on the idea of NFTs as more than just digital assets, they "can be theorized as a form of medium which represents many other media while augmenting them with many new properties" (Popov, 2022, p. 57), such as ownership, rarity, exclusivity, and scarcity. In this sense, the NFT ecosystem combines collecting, art, marketing and economic opportunities. However, an NFT is also described as a mechanism for sale, rather than a medium, diminishing public understanding of what digital art actually is (Paul, 2022). In other words, an NFT acts as a proof of ownership of a digital artwork, an "original copy", but not representing the artwork itself (Nascimento, 2022). Although the NFT market saw a significant decline in 2023, there are people who believe that NFTs still have

the potential to revolutionize the way digital assets are owned and interacted with (Kumar, 2024).

A brief history of NFTs

The first NFTs emerged in 2014 with the idea of monetizing visual digital creations in the cryptocurrency market (Creighton, 2022; Leonidas & Exmundo, 2023; Park et al., 2022), but they reached their expansion with the foundation of the Ethereum blockchain in 2017 and again after the COVID-19 pandemic. The so-called "NFT's spring" in 2021 (Nascimento, 2022, p. 27) was heralded after the auction house Christie's announced its first NFTs sale—a digital artwork by the artist Beeple titled *Everydays: The First 5000 Days*, which sold for $69.3 million. This was a milestone, as the NFT mechanism was integrated into the mainstream art market as a solution for selling digital artworks. Today, it is possible to create an NFT from almost anything—from media files to tattoo designers and sneakers. However, within this plethora of possibilities, three categories can be identified: "a single, unique item (one-of-one)"; an open edition, "in which an unlimited number of tokens can be minted [...] for set periods"; and a limited edition, with "a finite number of NFTs available for minting. [...] Editions have less scarcity, but they are generally better for community building and increasing fan loyalty" (Thomas, 2022b, Types of music NFTs). In addition, there is a growing interest for fractionalized NFTs, where "the cost of an asset is split up into fractions and is shared between individual investors as fractional ownership" (Thomas, 2022a, para. 1) or where an NFT is broken down into small pieces and sold individually (An, 2023). Subsequently, the NFT ecosystem involves a wide range of participants, such as artists, owners, investors, developers, auction houses, and corporations (Baytaş et al., 2022). As the space continues to evolve, NFT is moving towards its full development within the metaverse, leveraging Web 3.0 blockchain technology that enables online ownership of assets and decentralized identities, interactions and transactions without a central authority (Chen et al., 2023).

Music NFTs

In terms of music, NFTs generally include various types of recorded multimedia performances, fragments of musical pieces, limited-edition tracks, generative music, exclusive behind-the-scenes content or virtual experiences, and music-related products (events, special content, or features associated with the NFT) (Thomas, 2022b). The types of music NFTs are described as "audio (full songs, albums, or unique song clips), visual (album artwork, music video clips, or digital concert posters), experience (VIP access, meet-and-greets, or exclusive online events), royalty (tokens representing a share in a song's royalties), and collectible NFTs (limited edition digital or physical merchandise)" (#Blockchain Pop, 2024, What are music NFTs?).

There are clear economic reasons for the appropriation of NFTs in music distribution. After an "evident transition from physical to digital consumption and from legal ownership (both physical and digital) to streaming [...] and the 'post-ownership' economy" (Sinclair & Tinson, 2017, p. 3), NFTs have reintroduced the concept of digital ownership into the music industry. Paradoxically, NFTs are restoring a sense of ownership and material value to music that was diminished with the rise of digital media and widespread access to streamed content. One could then raise the question of whether the NFT threatens other forms of music ownership, such as CDs, vinyl records, and even cassettes, which have regained significant recognition in the market in recent years. It could be said that these are different categories, with different modes and benefits of ownership, and that an NFT collector can at the same time be a collector of physical sound carriers as well, suggesting that these categories are not competitive, but rather complementary (Fritze et al., 2020; Magaudda, 2011; Sinclair & Tinson, 2017). Notable examples include DJ 3LAU's tokenized music album *Ultraviolet*, which was sold in 33 NFTs for over $11.7 million via an online auction in 2021 (Casey, 2023). Similarly, Kings of Leon released an album with three types of NFTs, making them the first band to offer this type of content (Hissong, 2021). Archival material relating to the Beatles' work received its NFT variants, which were distributed via an auction (Blistein, 2022). A$AP Rocky released seven different NFTs in April 2021, which included various content such as unreleased song snippets (Fortnow & Terry, 2022). Through this type of distribution, fans were given various privileges, including exclusive content, but also the opportunity to co-create unique versions of songs with the artist. In addition, there are cases where copyrights are treated as an NFT. For example, musicians Taylore Bennet and Big Zuu sold partial rights to their works through

the copyright exchange (Fortnow & Terry, 2022), resulting in fractional music royalties as the rights to a song are shaped by multiple people (Martinez Jr, 2024). These examples have highlighted the importance of uniqueness, rarity, and authorship in the plenitude of digital music distribution, all of which are important components of musical works and art in general.

The monetization of music within the cryptocurrency economy is often described as "assetizing music" (Krasikov 2022, p. 39). In this context, a song can be tokenized in various ways: it may be linked to an unlimited number of tokens (a many-of-one model) or divided into fractions, allowing multiple individuals to share ownership of a unique asset (Waters, 2023). Some musicians are using these opportunities to develop a business model that allows them to profit by bypassing record labels and streaming platforms, positioning themselves as "productive laborers in the post-streaming music industry" (Krasikov, 2022, p. 39). However, NFTs have in practice benefited mostly those who already have celebrity status (Krasikov, 2022). Record labels have already adapted their business models to NFTs. For example, Universal Music has created the digital band The Kingship, consisting of four 3D monkeys performing in the metaverse and releasing music on streaming platforms, while Spotify has followed suit by allowing artists to integrate their own NFT collections to music, including those from musicians Steve Aoki and The Wombats (Roth, 2022). The best-known music NFTs are those that have achieved great success in the market, providing innovative examples of music tokenization and introducing new models for audience engagement. In addition to fractionalized ownership, other upcoming trends in music NFTs include granting access to virtual concerts, combining AI with NFTs to create unique digital music tracks, and cross-platform integration of NFTs to work across different music platforms and metaverses (#Blockchain Pop, 2024).

Psychological background of NFTs purchase

We begin this section with the question: Why would anyone want to buy an NFT? If the value of NFTs is variable and unpredictable (Fortnow & Terry, 2022), what motivates buyers to invest in this market in the first place? Are the criteria associated with the valuation of traditional art objects, such as historical significance, sentimental or collector value (Fortnow & Terry, 2022) also applicable in this case? Previous research has identified multiple dimensions that contribute to the perceived value of NFTs. Xie et al. (2023) emphasize rarity and exclusivity, originality, creative design, and the psychological significance of the product as high investment values of NFTs. Social influence, technical criteria, market regulations, and impact have also been identified as important determinants of NFT users' behaviour (Albayati et al., 2023). Furthermore, Belk et al. (2022) point to both economic and cultural considerations in assessing NFT value, suggesting that purchases may be motivated by either financial incentives or aesthetic appreciation. All these raise the complex question of the value of NFTs that can be interpreted from different angles.

Since the most important feature of NFTs is the acquisition of property enabled by technological progress, we assume that each purchase of a token implies not only an economic exchange of ownership, but also the activation of psychological ownership. Indeed, the traditional concept of ownership implies not only possession, but "a legally enforceable right to exclusive control of a thing" (Alessandro, 2023, p. 185), which also gives the owner a certain degree of power. These mechanisms and outcomes are similar to those involved in the acquisition of traditional art, such as music. However, the particular characteristics of owning an NFT must also be considered. Both the traditional art and NFT markets are areas of high aesthetic value and exclusivity reserved for ownership by professionals and enthusiasts. However, the concept of digital ownership, i.e. the ability to "create, store and sell unique digital assets in a purely digital manner" (Alesandro, 2023, p. 171), is still full of practical uncertainties as there is no legal framework "governing the ownership, sale and classification of digital assets" (Alesandro, 2023, p. 171). This means that digital ownership without legal protection is primarily self-motivated and technologically enabled. While legal ownership is publicly regulated, psychological ownership is "a self-derived perception, recognized primarily by the individual" (Dawkins et al., 2017, p. 164) when the "feeling of ownership becomes part of an individual's psychological state" (Pierce & Jussila, 2011, p. 87). Thus, in addition to the popularity of musicians, the psychological background of fans is also an important factor contributing to the flow of music NFTs exchange, especially when "digital purchases are entirely self-directed, without the involvement of a sales agent" (Griffiths et al., 2024, p. 2).

Aims

Having in mind the complexity of music NFTs distribution and acquisition, the main aim of this paper is to shed light on the psychological aspects that drive fans' purchase of tokenized music through the lens of psychological ownership theory. This is particularly important in the context of the ongoing digital dematerialization of music embodied by platforms and the emergence of digital ownership.

The conceptualization and measurement of psychological ownership need further refinement (Dawkins et al., 2017). This theory has already been explored in organizational contexts (Dawkins et al., 2017), marketing research (Jussila et al., 2015), social media use (Karahanna et al., 2015), and music streaming consumption (Sinclair & Tinson, 2017), but its application to NFTs is still a young area of interest.

As the academic literature addressing the psychological aspect of the NFT market is limited (Albayati et al., 2023; Griffiths et al., 2024; Sestino et al., 2022; Xie et al., 2023) and that on music is almost non-existent, this paper relies on psychological ownership theory to identify the underlying psychological aspects of music NFT purchases. Psychological ownership is a state in which one develops feelings of ownership over tangible and intangible items, including objects, ideas, jobs, and organizations (Pierce et al., 2003). In other words, "Pierce et al. (2003) argue that we can cultivate strong feelings of ownership for both material and immaterial possessions and that ownership is not necessarily tantamount to legality" (Sinclair & Tinson, 2017, p. 2). Psychological ownership involves building different types of relationships and "achieving desired outcomes through possession" (Pierce et al., 2003, p. 299). As Pierce et al. (2003, p. 299) note, at "the core of psychological ownership is the feeling of possessiveness and of being psychologically tied to an object". This is an inherent feature of human existence (Burk, 1900) that grants an individual a sense of power and drives the need for effectance (Pierce et al., 2003). The roots of psychological ownership include self-efficacy, self-identity, and a sense of belonging (Pierce et al., 2003). Psychological ownership encompasses several core features that significantly influence consumer behaviour and perceptions of ownership. It develops through experiences that enhance control, knowledge, and investment in the goal (Dawkins et al., 2017). Psychological ownership is therefore related to self-investment (of time, money, and effort), as well as to the acquisition of intimate knowledge—when individuals, through their relationship with an object, gain specific insights or understanding of the object (Morewedge, 2020). Given that psychological ownership is a relative category contingent upon various factors, including the nature to which it is affixed, this research adopts a conceptual rather than empirical approach. Consequently, the principal contribution of this theoretical paper is the introduction of the concept of psychological ownership in relation to music-related NFTs. The present paper delineates four potential mechanisms through which psychological ownership of NFTs may function and establish a foundation for future empirical inquiries into these phenomena. This research objective is pursued by correlating the previously identified core elements of psychological ownership with the attributes of some of the most notable music NFT releases, thereby theoretically defining general dimensions of psychological ownership that facilitate the emergence of emotional and social connections to music NFTs as objects of ownership.

Main contribution

The four aforementioned dimensions are: (a) a sense of unique possession, (b) identity formation and self-expression, (c) a feeling of belonging to a community, and (d) the potential for financial investment. Collectively, these dimensions illustrate how the allure of music NFTs transcends their technological and aesthetic attributes, engaging deeper psychological drivers of purchasing and ownership.

a) A sense of unique possession

It is important to remember that NFTs were not introduced into the professional art world to prove ownership of a physical art object. Instead, they were conceived as a technologically mediated solution to monetize digital artworks, which are inherently immaterial (Stanković, 2024). Consequently, the emergence of NFTs does not seem to have a significant impact on the traditional concept of ownership of physical art objects. Nevertheless, in the field of digital culture, NFTs introduce a new type of digital ownership of digital creations. This technology enables the operationalization of ownership in digital culture and thus the application of traditional values associated with material art in the context of digital culture.

There are numerous instances where unique music items are represented as NFTs, drawing a clear

parallel to the logic of the traditional art market. For example, the winner of auction for *Acephalous,* the Weeknd's collaborative NFT collection of audio-visual works and unreleased music received the only copy of a previously unreleased song, making this ownership one-of-a-kind (The Weeknd, 2021). Dutch DJ and producer Don Diablo gained attention with the NFT *Destination Hexagonia*, which gave the buyer exclusive ownership of the unique concert film: "The owner received a unique hand-crafted box, which includes a hard drive that contains the only copy of the high-quality file of the film, making it a truly unique art piece" (Don Diablo, 2021, Details). This unique item, both physical and digital, enhances the value of the NFT and creates an exclusive experience for the fan. There are no strong barriers between the analogue and digital worlds as the former becomes increasingly aware of the business potential of the latter, especially in relation to blockchain technology.

Owning an NFT of a unique song, album, or copyright conveys a sense of exclusivity and authenticity, which can reinforce the psychological attachment to the target of ownership. Speaking of vinyl records in this context, one can observe that NFTs can serve as digital representations of vinyl, providing "a more transparent and efficient means to manage ownership and transactions, while also creating new avenues for artist royalties and community engagement" (Amau, 2024, Introduction). It could be argued that a vinyl record, despite its different serial number, is similar to other sound carriers in that each record is a replication of a unique master recording. In this sense, each release can be considered a copy. However, unlike NFTs, a vinyl record as a physical sound carrier does not convey ownership information, which is the main difference between these two music formats. The so-called "vinyl analogy" within the NFT music market means that vinyl has emerged as the most popular type of physical music item that can be digitally simulated, owned and resold (Rosenblatt, 2022). Warner Music Group and blockchain platform Polygon have collaborated on a campaign of music NFTs "virtual vinyl" to honour the 50th anniversary of hip-hop as a groundbreaking genre. This collection of NFTs comes with exclusive sound quality in FLAC format with no compression of digital audio data, representing identical original sounds (Paine, 2022). From the record label's side, these collectibles are described as "the best-in-class blockchain experience" (Paine, 2022, para. 5) and "an innovative initiative that will elevate music ownership and bring more music lovers and artists to Web3" (Paine, 2022, para. 7). In addition to merchandise content, physical vinyl, and access to upcoming events celebrating legendary hip-hop records from Warner Music's catalogue, the NFT is functionalized here to restore the unique aesthetic value of original vinyl audio quality and its high collectability potential as two key characteristics of this type of music media (Paine, 2022). Even though others can listen to the music represented by the NFT, fans have the feeling of owning something unique as the token is not fungible. This feeling is further enhanced when exclusive and additional content and perks (unreleased tracks, virtual art, VIP access, etc.) are offered as one-of-one or a limited number of tokens in NFT drop. This goes far beyond traditional forms of music distribution as fans have the feeling of being part of something special that goes beyond simply owning a piece of music.

These examples show that the appeal of music ownership is multifaceted. Interest in owning traditional physical music formats, such as records and CDs, can exist alongside that of NFTs, highlighting the different motivations for owning physical and digital music. It is worth investigating whether these formats reflect completely different consumer preferences and whether the sound quality of analogue and digital media is a determining factor in the choice between owning physical and digital music. Future research should investigate the extent to which ownership of physical and NFT-based media satisfies similar or divergent motivations and psychological needs that influence perceived value.

b) Identity formation and self-expression

By owning certain NFTs, fans communicate their musical preferences and taste to others, reflecting their personal identity, values, and experiences. Since "we always express ourselves by articulating to some person or group" and "our articulations are directed toward others" (Negus, 1996, p. 134), music NFTs can be considered not only as digital assets, but as integral components in the processes of articulation, expression, and representation of personal identity. A collector identity can also be said to exist as NFT owners shape their profile as collectors by selecting specific categories and strategizing their reputation (Fortnow & Terry, 2022, p. 209). As a selling mechanism that connects the physical and digital worlds, the NFT has been interpreted as a feature of fan culture "revolutionizing how audiences experience and

collect memorabilia" (Das, 2024, para. 1), such as posters, instruments, or other items signed by musicians. However, it is important to emphasise that a good reputation as a collector in the analogue world is no guarantee of success in the NFT market. On the contrary, here collectors have to build their positions from the ground up, because the competition is fierce and there are no algorithms to help (Fortnow & Terry, 2022). As a result, the NFT landscape presents unique challenges and differs significantly from other digital spheres for the presentation, distribution and collection of music, especially when considering the aspect of digital literacy and familiarity with blockchain technology.

As part of the release of the first NFT album that can be purchased on a blockchain on the same day it is released on the streaming platforms, Kings of Leon have offered a limited number of lifetime concert tickets through their blockchain partner Yellow Heart (Cirisano, 2021). Owning one of these NFTs is an important status symbol among fans, as they not only grant exclusive lifetime access to VIP seating at concerts and other benefits, such as socializing with the band, but also because the rarity of these NFTs makes them highly coveted among fan communities. Buying these tokens and showing ownership on social media or digital wallets signals a particular taste in music, a deep connection to the band, and a high level of fan engagement. While some journalists and critics argue that all of this is merely a "trendy way to offer band merchandise" (Chandler, 2024, para. 6), it can also be seen as an innovative means of engaging with fans and generating additional revenue. Furthermore, the use of smart contracts offers more control over this process. However, some inconveniences can also be observed here. Firstly, many musicians are unable to create and sell NFTs. Additionally, many do not have a large enough fan base to make selling NFTs profitable for them (Chandler, 2024). The second problem is the fact that musicians almost always share a percentage of their revenue with their publisher, which raises the question of how profitable this would be for the musicians themselves (Chandler, 2024). However, ownership of rare NFTs demonstrates an exclusive cultural status when presented within music fan communities as a form of exclusive social capital related to music. Investing in NFTs can also mean personal pleasure and prestige beyond material gain, as NFTs are designed for public display, for example, on the platform Lazy.com (Fortnow & Terry, 2022). As a medium for displaying and communicating musical preferences and values to others, music NFTs promote self-identity as one of the roots of psychological ownership.

c) Community and belonging

The NFT ecosystem has several distinctive features. One of them is the need to build a community of people who share the same values: "The bottom line is that everyone's NFT marketing strategy should revolve around building a community of collectors. This can be 3 people or 3,000 people. But the end goal here is to create superfans of your digitized assets—people who will take pride in saying that they were an early collector of your work" (Fortnow & Terry, 2022, p. 184). The results of the study on one of the most influential online communities for NFT projects—Bored Ape Yacht Club (BAYC)—showed positive community experiences, such as "personal expression and identity, mutual support among holders, and exclusive access to online and offline events" which is interpreted as "a possible causation factor of the initial rise in popularity of NFTs" (Sinnott & Zhixuan Zhou, 2023, p. 1). Other findings show that network communities—such as Twitter and Discord—are the most important determinants of the pricing of NFTs (Alon et al., 2023). Many music NFT projects foster specific communities around genres, artists or themes, reinforcing a sense of belonging. The first collection from one of the largest music NFT producers Grimes—*WarNymph* vol. 1—was sold in 2021 for a total of over 6 million dollars (Kastrenakes, 2021). The collection consists of 10 digital music videos offered as both one-of-one and many-of-one tokens. While the one-of-one music video was sold for almost 389,000 dollars, the majority of the 700 copies sold came from the two short video pieces, which sold for 7,500 each in 20 minutes and brought in a total of 5.18 million dollars (Kastrenakes, 2021). Even though the highest price was achieved for the one-of-one token, the majority of sales were made by a group of several hundred fans who were willing to confirm their fandom identity by purchasing ownership of many-of-one tokenized copies. The fans feel part of a larger movement of others who share similar interests. There are creative music NFT communities such as Arpeggi Labs, Catalog Works, and Mint Songs that are organized on platforms to "empower holders to become creators, and creators to become holders" (eminabec, 2021, Arpeggi Labs), providing the technology for minting and archiving music NFTs. By the time its collections closed, "Mint

Songs onboarded almost 2,000 artists who minted 100,000 music NFTs" (eminabec, 2021, Mint Songs). Some projects encourage participation through collaboration, such as remixing tracks or contributing to creative decisions, further empowering fans and increasing their engagement in the community. In terms of digital culture and context, "fans today do not operate in a media vacuum; rather, they embrace a multitude of mediations and technologies to augment their fan practices, and if anything, such interactions reveal the ubiquity of technology and the ease with which fans embrace digital interactions, supplementing their offline lives" (Booth, 2017, p. 171).

Artists often use platforms to engage with NFT owners and create spaces for discussion, feedback and announcements. This direct communication helps to build a vibrant community around the music. For example, in August 2021, the rapper Tory Lanez released 1 million copies of his album *When It's Dark* as NFTs, each costing just $1 and selling out in just 57 seconds (NFTevening, 2024). Fans who bought the NFTs owned a copy of the album and built a community around the musician. Some of them received special perks such as "exclusive virtual meet and greet, an unreleased track, and signed merchandise from the artist" (NFTevening, 2024, What does the Tory Lanez NFT include?). In addition to the album, certain versions of the NFT included exclusive digital artwork, making each NFT different and reinforcing the aspect of unique possession (Kairos Music, 2022). Thanks to this success, the rapper also achieved streaming success on Spotify and YouTube—he has over 18 million monthly Spotify listeners and 1.6 billion YouTube views (NFTevening, 2024). Similarly, Mike Shinoda's project *Ziggurats*—the first generative NFT mixtape collection with 5,000 unique, algorithmically created audiovisual tracks—also offered NFT owners exclusive access to his Discord server (Shinoda, 2021). By purchasing the NFT, listeners gain access to different layers and versions of the piece. This creates a personalized experience that deepens the connection to the music, reinforces a sense of ownership, and fosters a sense of belonging to a community of superfans with exclusive privileges.

d) Investment opportunities

Fans can view music tokens as investments with the potential for future appreciation. A three-point system for analysing the value of NFTs based on rarity, return on investment, and reputation shows that "a well-distributed rarity score of NFTs enhances their demand and profit" (Pham & Trinh, 2023, p. 157) and that the price value of NFTs is proportional to their scarcity. The investment potential of music NFTs lies in their rarity, the popularity of musicians, and market dynamics as factors that can potentially increase the value of NFTs over time.

The revenue opportunity in the case of music NFTs comes from sharing the copyrights of songs circulating on streaming platforms, enabling economic growth for both musicians and fans bypassing the traditional role of record labels as third-party intermediaries. For example, electronic music producer Gramatik launched his cryptocurrency token GRMTK on the Ethereum blockchain in 2017 (Castillo, 2017), becoming the first musician to convert his intellectual property into tokens to allow his fans to share in the income from his works. Similarly, musicians such as Lil Nas X and Diplo offer their fans the opportunity to receive a percentage of the streaming revenue generated by the songs by purchasing NFTs (Tan, 2022). These ownerships and profit-sharing of NFTs have transformed music publishing into a mutually beneficial relationship that allows fans to directly benefit from supporting their favourite artists. Fans no longer see themselves as just listeners but feel like shareholders and investors in a musician's career, as they receive a percentage of the revenue from each resale or stream. Anotherblock (https://anotherblock.com/) is a platform that specialises in the acquisition of shares in music copyrights via NFTs, thereby bridging the gap between intellectual property rights, digital assets and music by positioning musicians and investors as rights holders of music as an 'asset class' and demonstrating the future of alternative investments.

The investment potential of music NFTs and the sense of unique ownership are two dimensions that traditional music formats do not offer their fans. Consequently, self-efficacy—as one of the roots of psychological ownership—stems from a sense of technologically mediated control over the ownership and economics of music and the knowledge to engage appropriately as a stakeholder and investor in music on blockchain platforms.

Implications

Given the relative newness of NFTs in the music industry, the academic literature specifically addressing music NFTs is still at an early stage

(Casey, 2023; Esmaeili, 2023; Krasikov, 2022). Therefore, this paper aims to theoretically enhance the understanding of NFTs as a phenomenon that combines blockchain technology and the economic logic of cryptocurrencies with traditional artistic values, distribution mechanisms and the psychological dimensions of fan behaviour.

By clearly articulating the four core dimensions of psychological ownership and linking them to the specific examples, it is possible to understand how music NFTs embody the characteristics that reinforce the sense of ownership, while at the same time prompting a re-examination of music's role in the digital media environment. These dimensions include a sense of unique possession, identity formation and self-expression, a feeling of belonging to a community, and the potential for financial investment. The discussed NFT drops illustrate how leveraging different dimensions of psychological ownership can transform a music release, reshaping both the relationship between fans and musicians and the personal experience of music consumption.

Thus, owning an NFT of a unique song or album conveys a sense of exclusivity and authenticity, reinforcing the psychological attachment to the target of ownership. This exclusivity is further enhanced when NFTs offer additional content and perks, such as unreleased tracks or VIP access, creating a unique experience for the owner.

In addition, NFTs serve as a digital representation of personal identity and values. By owning certain NFTs, fans communicate their musical preferences and values to others, shaping their profile as collectors. This process of identity formation and self-expression is an essential part of the concept of psychological ownership.

NFTs also foster a sense of community and belonging. Many NFT projects in the music sector build specific communities around genres, artists or themes, strengthening fans' sense of belonging. This participatory approach empowers fans and increases their engagement in the community.

Finally, NFTs provide investment opportunities that allow fans to view music tokens as investments with the potential for future appreciation. This sense of technologically mediated control over the ownership and economics of music enhances a feeling of self-efficacy, another root of psychological ownership.

Studying fans' purchases of music NFTs from a psychological perspective can help musicians better understand blockchain users' behaviour towards music, which is essential for the development of NFTs into a sustainable digital format for music revenue.

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Kylie's Unheimlich Maneuver: The Uncanny Materiality of "Padam Padam"

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Abstract

This paper explores the concept of the uncanny in contemporary pop music through the lens of Kylie Minogue's 2023 track "Padam Padam". Drawing on Freud's notion of the uncanny, which suggests a discomforting familiarity in the simultaneous presence of the known and unknown, the paper argues that digital production tools in contemporary pop music facilitate a novel exploration of sonic materiality that can invoke uncanny effects. Discussing depth, surface, minimalist sculpture, materiality, and signification, the paper situates the song and its meta-elements within music development since the 2010s. This includes the rise of the so-called condensed chorus—a new formal unit that gains its climax and focal effect through absence and starkness rather than richness and fullness. Analysing the track's intro, the paper examines how the use of reverberation, side-chain compression, and synthetic textures creates an oneiric, almost ghostly atmosphere. Using the term breaks-in-presence from Gestalt-derived theory, it further discusses how the chorus marks a substantial shift as reverberation is abruptly cut off, creating an uncanny break in the mix's spatial continuity. This break contributes to the unsettling yet compelling impact of the track, enhancing its affectual power. The paper positions "Padam Padam" as an artistic example of how contemporary pop music's engagement with digital tools reshapes aesthetic expectations, particularly in relation to sonic materiality. The study extends our understanding of pop music by emphasizing how uncanny elements in sonic texture and form contribute to its evolving creativity and aesthetics.

Keywords: pop music, music production, timbre, sonic materiality, uncanny

Introduction

The concept of the uncanny is indeed somewhat contentious. Since Freud's 1919 essay *Das Unheimliche* suggested a relationship between psychoanalysis and aesthetics, it has rightfully been criticized for being vague, crude, male-centred, and colonialist. Additionally, as Anneleen Masschelein writes, "the Freudian uncanny is a late-twentieth-century theoretical concept" (Masschelein, 2011, p. 4). However, the term "uncanny" is still commonly used both inside and outside academia, sometimes referring to Freud's ideas and sometimes not, making it even more undefined. It often simply refers to something unsettling, evoking a feeling of unease or eeriness when something is simultaneously familiar and unfamiliar. There is also surprisingly little research that applies the concept of the uncanny to contemporary popular music[1].

So why revisit this well-worn, Freud-derived term once again? Because there is a facet of pop music that seems to increasingly excel in a material lack of depth. It challenges traditional notions of meaning and signification through its programmed insubordination to performance gesture and lyrical content (Reuter, 2022). We simply lack adequate vocabulary to fully articulate how and why this music holds such a distinctly compelling power. The potential for understanding contemporary pop music aesthetics—at least in part—seems to lie in examining how digital production tools facilitate new negotiations of sonic materiality. While we cannot truly escape the vagueness of the uncanny, it may offer an avenue for understanding not only a particular part of pop music, but also a particular dominant development within the genre.

[1] It has, however, been explored in relation to a variety of other types of music, from Late-Romantic music (Cohn, 2004), noise music (Hegarty, 2007), and gothic music (Van Elferen, 2012), to drum n' bass (Christodoulou, 2013), popular music harmony (Forrest, 2017), and AI-based music production (Avdeeff, 2019). Another example is philosopher Mark Fisher's (2014) analysis of the electronic musician Burial, whose blurring of past and present Fisher finds both uncanny and, more specifically, eerie (Fisher, 2014; see also Fisher, 2016).

This paper will therefore use the concept of the uncanny to offer new perspectives on explicitly digitally programmed contemporary pop music. Using Kylie Minogue's 2023 song "Padam Padam" as an example, I will explore how the uncanny can be used to understand the song and how it negotiates sonic materiality in distinctive and novel ways, drawing on perspectives from minimalism, formal music theory, and music production analysis. While the song may not represent all evolving trends, it does exemplify some of the key characteristics of contemporary pop. The goal is to investigate how the song's staging of technology and depth holds significant artistic potential, thereby contributing to a broader understanding of contemporary pop music aesthetics.

Metapop, depth and minimalism

"Padam Padam" can be interpreted as a meta-commentary on the nature of pop music itself. The "padam padam" phrase references both the Edith Piaf's 1951 song and the sound of a heartbeat, thereby evoking physical attraction and corporeal reaction, as suggested by the blatantly prosaic lyrics. Furthermore, it can be perceived as an exposé of the most basic pop template, with its intro-verse-chorus-verse-chorus-outro structure. In other words, instead of narrative depth, "Padam Padam" wears its own formula on the outside.

From this perspective, the song repeats an ironic/non-ironic feat previously perfected in Kylie's semi-comeback 22 years earlier. Her track "Can't Get You Out of My Head" (2001) took this meta-approach to pop to a new level, blurring the lines between a love-interest narrative and self-referential pop song commentary. This was demonstrated by the song's title, the now-classic "La-la-la" lead melody, and the song's wallowing in stiff, programmed, synthetic repetition that lacked any apparent depth in meaning, spatial variation, or sonic opacity. Seemingly, "Padam Padam" sounds like its "sonic sister". Similarly devoid of depth, it could appear to be a metapop song signifying nothing but a mixture of blunt horniness, Kylie's diva persona, and pop music's ostensible fondness for formal templates. The term metapop here refers to pop music that reflects on its own form, function, lyrical content, or its very status as a pop song—a mode that arguably runs throughout Kylie Minogue's discography—as it excels in its own manufacture, its own "pop-ness".

However, there is more to the subtle yet powerful attraction of "Padam Padam". It arguably became the summer hit of 2023—particularly for the LGBTQ+ community—following the pandemic shutdowns, which amplified the need for club-based connection and celebration. However, there may be something significant in the apparent lack of depth in the simplest of songs.

Paul Ricoeur rightfully warns us of the tendency to engage with what he calls a "hermeneutics of suspicion" (Ricoeur, 1970; see also Felski, 2011). This is how we are taught to read texts, symbols, and ideologies with scepticism in order to expose repressed or hidden meanings. We ask what lies beneath the surface and appearances, seeking hidden meanings. According to Ricoeur, the principal figures—the three masters of suspicion—are Marx, Nietzsche, and Freud, with the latter urging us to uncover subconscious motivations and repressed desires.

We find a different approach to surface and depth in early minimalism—arguably the most vital exponent of an aesthetic based on materiality, surface, and repetition. Art theorist Rosalind E. Krauss writes about early minimalist sculpture, focusing on how materials like steel, glass, and plastic are often explicitly industrial, emphasizing their raw material qualities (Bois & Krauss, 1997; Krauss, 1998). She describes how simplicity and reductionism create a paradox regarding surface and depth: on the one hand, the works are explicitly non-referential. "What you see is what you see," as Frank Stella famously said (1968, p. 160). On the other hand, according to Krauss, their geometric, repetitive forms activate something deep and unnameable in the viewer. The heightened materiality makes objects, such as Donald Judd's famous stacks, seem forcefully present, almost threatening, as though challenging the viewer's relationship with space. For Krauss, this intensity of presence produces an uncanny quality. In the following, I will pursue this perspective as suggested by Krauss, in relation to contemporary pop music's "surface aesthetics."

Pop form and the condensed chorus

If we understand pop as what is most popular, then the cliché of pop being many things at the same time could be truer now than ever. However, 2011 can be deemed an overall turning point in contemporary pop music (Osborn, 2023). Electronic dance music—or rather, the label EDM, which has since become the umbrella term for most popular electronic subgenres—entered not only the recording industry, festivals, and charts

but also the sound of pop. The pivotal track was arguably that year's "We Found Love" by Rihanna and Calvin Harris, as the song took the dynamics of the dancefloor and the DJ and compressed it into the three-minute format of the pop song.

The key signifier of this new sound was the introduction of the drop, the undeniable climax designed for maximum impact and corporeal energy driven mainly by bass and beat. Contrary to the chorus's traditional role as the focal centre, the drop suspended harmonics, melody, and the lead singer's vocal presence. Additionally, the formal dynamic of building up energy towards the climactic drop also emphasized a novel focus on textural design (Adams, 2019; James, 2019; Reuter, 2021, 2022).

However, trends with major impact often have short lifespans, and it did not take long before the drop and its derived pop form began taking new shapes. The drop was renegotiated, subverted, shifted, and blended into new formal constellations throughout the 2010s. A growing body of music-theoretical research has examined this development, highlighting how formal negotiations of texture introduce formal ambiguity and create a deliberate tension between expectations and dynamics (Adams, 2019; Barna, 2020; de Clercq, 2017; Nobile, 2022; Osborn, 2023).

A particular result of this expectation-defying development was what I have elsewhere termed the condensed chorus[2]. This is mainly characterized by its subversion of the otherwise well-established trope of a chorus gaining its focal role—the "larger-than-life chorus" (Everett, 2009, p. 145)—by being louder, bigger, denser, and wider (Clercq & Margulis, 2018, p. 160; Zagorski-Thomas, 2020, p. 14). Instead, this type of chorus seemingly derives its climax from absence. In line with the drop's discoesque roots, sounds are reduced to the bare minimum, often leaving only a dry vocal against the beat, devoid of reverberation, exposing an unadorned sonic texture and the rhythmic grid that organizes it. "Padam Padam" can in many ways be heard as an example of utilizing what we could call a textural condensation as a way to create tension and dynamics.

[2] In a recent publication, I have traced in greater detail the development of the drop's incorporation into pop form toward what I term the condensed chorus, from a more historical, theoretical, and media-based perspective, including analysis of *Padam Padam* (Reuter, 2026).

Padam Padam

For this purpose, I want to focus particularly on two parts of the song: the intro and the chorus, and specifically how the use of reverberation, combined with arrangement and digital production tools, creates an uncanny effect.

An unconscious intro

The song conveniently begins with its title, but the voice that utters it is down-pitched and drenched in heavy reverb and delay. A swaying synth melody with a low-pass filter (which allows only frequencies below a set threshold to pass) fades in. However, its rhythmic feel is unsettled by the sound's unusual amplitude envelope—its volume subtly bounces up and down in an irregular manner. This effect is likely due to a side-chain compressor, a technique where one sound's signal triggers one or more compressors on other sounds, shaping their dynamic amplitude, though the triggering sound itself is inaudible here. Another synth sound is introduced, providing a wider spatial contrast to the first. However, it too is subjected to a low-pass filter and seemingly a side-chain compressor, albeit with a less pronounced effect on its amplitude. Meanwhile, the down-pitched "Padam" vocal repeats three times as the filters gradually open, leading into the first verse.

In other words, the intro is defined by low-pass filtering, side-chain compression, and down-pitching. The sounds' characters combine to produce a sensation of something submerged, ghostly, and oneiric. Acoustic phenomena apply very little to these programmed sounds, which "behave" in an unnatural, opaquely programmed manner. Overtones, that are crucial for helping us navigate acoustic environments by revealing how surfaces break faster sound waves, are taken away. This results in a muffled soundscape that arguably produces a sense of being underwater.

Continuing along the lines of the surface/depth metaphor, it gains further complexity if we engage Freud's characterization of the mind as topographical. The admittedly somewhat rudimentary idea is perhaps best exemplified by his iceberg metaphor, where the conscious is above the water but rests on a massive, submerged unconscious. Similarly, the philosopher, psychoanalyst, and semiotician Julia Kristeva (1984) describes the concept of *chora*, referring to a pre-linguistic, primal space or realm that exists before structured language and symbolic meaning. In this sense, the intro's oneiric and programmed character, devoid of clear

human presence, evokes a feeling of something pre-linguistic, maybe even unconscious.

The intro is followed by a verse with a beat centred on a four-to-the-floor kick drum and Kylie's high-pitched, autotuned legato vocal, which clearly stands out alone in the upper frequencies due to the low-pass filtering of the other sounds. More drums (hi-hat and a light snare) and subtle bass are added in the second repetition of the verse. While this soundscape remains quite distant from natural acoustic sound behaviour—the synths are still muffled and bouncing—the reverberation of the drums and Kylie's voice combine to reflect or resemble a more traditional pop instrumentation and staging of sonic space. However, this is soon challenged by the transition to the next formal unit.

The transition to the chorus is marked by a break in the drums, subtle filter sweeps, and a sound that resembles a vocal's reverb played backwards. Then, from the first downbeat in the chorus, everything suddenly becomes tight, clear, reverbless, and pumping. Its lack of natural acoustic reference is emphasized not only by the absence of reverb but by the introduction of a syncopated synth bass bouncing simultaneously on the left and right sides of the mix as well. The bass's anchoring function, once centred in mono, is in other words replaced by a programmed wide synthetic bounce that, along with just the kick drum, snare, and vocal. are the only sound sources.

However, the vocal does have reverb, but it behaves unusually. Initially, it follows the vocal, as reverbs typically do, resonating after the vocal phrases, but the tail of the reverberated sound abruptly cuts off. Reverb in music production can be understood as a technique that mimics acoustic properties defined by sound reflections. This is a crucial part of our everyday and habitual use of hearing to navigate not only space but arguably the world. In "Padam Padam", the vocal's reverberation seems to act in a fairly organic way, or at least as is common in the staging of vocal space in popular music production. However, for only a fraction of a second, it shuts off. The effect of this unusual reverb tail behaviour is most likely a programming technique related to side-chain compression, where a sound (the reverb) is only activated when another sound (the vocal) is present. Alternatively, it could also be a noise gate that shuts off all sound when the input drops below a set threshold. Regardless of the technique and the fact that this might seem like a minor detail (which indeed it is in terms of brevity), the effect is crucial.

Firstly, this subtle fingerprint of programming plants a substantial seed of doubt, a crack in the human-based performance and "real-world" sonic behaviour, or, evoking the German *unheimlich*, something distinctly unhomely. While it does not replace it with something entirely virtual, it adds a glimpse of uncertainty. Secondly, the abrupt removal of the vocal's reverb occurs in a chorus that, in its first repetition, consists only of a plugged synth bass, a four-on-the-floor kick drum, and a dry snare. The removal of the reverb exposes a mix of merely staccato sounds, devoid of release, decay, or audible reverberation.

How can we begin to understand this shift in sonic materiality? Gestalt-derived theories of presence offer a temporally based hypothesis. They suggest that the brain chooses one out of a set of presumptions about whether what we perceive belongs to a physical or virtual world. In relation to computer gaming, Brenton et al. (2008) suggest that these might be superimposed, for instance, when a sound that does not belong to a virtual world is suddenly incorporated into it and vice versa. Brogni et al. (2003) describe how, as in dreams, one might experience a sudden switch in Gestalt from the virtual to the real. Instead of a smooth mixture or transition between modes of perception, this sudden switch, termed a "break in presence" (BIP), can cause an uncanny sensation (Brenton et al., 2008; Brogni et al., 2003; Grimshaw, 2009).

Arguably, the transition from verse to chorus can be heard as such an uncanny break in presence. When the vocal reverb is shut off, the listener experiences a flicker of total silence, exposing the grid-based assemblage of sound, that switches on and off according to a purely programmed logic. This challenges notions of premedial reference and instead presents a sonic behaviour that signifies its own digitally mediatized environment. The materiality of the sound is, in other words, revealed in this dead space, leaving only the presence of their own "thingness."

The overall nature of this binary on-and-off effect of monolithic sounds is amplified by the vocal melody's shift. It moves from the long, legato phrases of the verse to the short, staccato hook of the chorus based on the onomatopoetic "Padam." While verse-Kylie is never entirely unspoiled by something posthuman, the will and subjectivity of chorus-Kylie become a staccato imperative almost defined by a mechanical drive.

Naturally, what is being described here is something that can and will undoubtedly be

heard differently by each listener. Nevertheless, the ambiguity remains, planted, even if it is not consciously registered.

Conclusion

My argument is that the chorus derives its effect, its dynamic climax, and perhaps even its spectacle, from a formal break in presence. Suddenly, all sounds are exceedingly materially present. It can function as a kick to the body, a call to dance, and maybe even a call to the sexual drive. Again, music is perceived subjectively, and I do not wish to argue for any universal interpretations. Yet, as I have tried to describe, the song produces an ambivalence, a doubt, a glimpse that can install feelings of uncanny uncertainty.

I am hesitant to draw overly mind-topographical connections between the intro's oneiric character and the subconscious. While there may be connections, it does seem somewhat simple. However, the intro's oneiric character appears to connect and combine with the uncanny shift in the chorus. It is hardly a coincidence that the song begins directly in a dream-like state and, within 48 seconds, reaches what can be heard as an unusually clear, unmuffled clarity. Arguably, the effect of this development comes not only from the contrast between the opaque indistinctness of the intro and the seemingly extreme lucidity of the chorus, but also from the seed planted by the intro, and the connection between the two types of ambivalence.

On an indeed anecdotal note, I have noticed how people often either love or profusely despise "Padam Padam", its programmed sound and simple chorus melody. Uncanniness, by nature, is not always positive. This tension of ambivalence is perhaps best described by Kristeva. While Freud conceptualizes the uncanny as the return of the repressed, Kristeva situates it in the dissolution of boundaries between self and other, subject and object. It refers to a psychological and existential reaction to something that disrupts the boundaries of the self—something that is neither fully subject nor object, neither fully inside nor outside. It is "what disturbs identity, system, order. What does not respect borders, positions, rules" (Kristeva, 1982: 4). This echoes with timbre theorist Isabelle van Elferen. She writes about timbre's paradox, having both material and immaterial components, which engenders "a sublime aesthetic experience that can be described as the aporia of being drawn into a void that appears real but—which the closer you get to it—flickers in and out of earshot and comprehension" (van Elferen, 2017, p. 616).

To that end, digital pop music's uncanny textural negotiations may produce exactly these sublimely ambiguous sensations, challenging boundaries in profound ways. While I may have fallen into the temptation of making overly clear distinctions between (levels and types of) the human and posthuman, the real and the virtual, the homely and the unhomely, it is perhaps more the unsettling slippage between these categories that is relevant to the aesthetic pull (or push) of a song like "Padam Padam".

What might seem like shallow music, excelling only in its surface character, can actually embody a heightened materiality akin to that of early minimalism. It presents an intensity of presence that challenges traditional modes of listening and analysis rooted in meaning and signification.

My intention has not been to install rigid dichotomies between the real and the unreal, the semiotic and the prelinguistic, but rather, from a music-aesthetic perspective, to demonstrate their infiltration. The previously mentioned distinction between surface and "what lies beneath" thereby not only collapses, but the collapse itself becomes a deliberate aesthetic strategy. Lacan (whom I have for many reasons otherwise deliberately abstained from including here) rejects depth-psychology. Instead, he describes the psychic space as a type of flatness, a topological Möbius strip where the unconscious and discourse coexist and fluctuate endlessly on the outside. To that end, it is perhaps these very fluctuations that a novel type of digital pop music stages.

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Music and Affect

How Does This Music Make You Feel? Exploring the Structural Dimensions of Affective Musical Experience

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Abstract

Music has a profound affective impact on individuals. This narrative review addresses the following question: is musical affect best described by categorical affective experiences (e.g., triumphant, nostalgic) or by continuous affective dimensions such as valence and arousal? This paper examines two prominent approaches to affective musical experience: categorical and dimensional. Empirical studies drawn from a variety of methodological traditions—including surveys, time-series analysis, physiological and neurological measures—are reviewed to assess their explanatory power. Participants from across cultures and historical contexts were included. Recent findings suggest that while valence and arousal capture general affective tone, they may not fully represent the complexity of music-induced affect. The categorical model demonstrates higher consistency among participants in labelling affective character of compositions, whereas continuous response methodologies show that the affective experience unfolds dynamically and resists reduction to a single discrete label. Studies increasingly support the view that categories such as triumphant, joyful, or tender provide a more precise and universally meaningful framework. As such, the categorical approach offers a more ecologically valid and nuanced taxonomy of the affective experience of music, especially when considering cross-cultural aspects.

Keywords: affective experience, music perception, discrete emotions, circumplex model

Introduction

Music plays a significant role in most people's lives, both in private and social domains, and has long been of interest to various branches of psychology. A recent study conducted on a representative sample of Serbian high school students (N = 922) showed that listening to music is one of the most common activities among young people (Pešić & Videnović, 2017). A qualitative analysis of students' responses revealed that music serves as an emotionally engaging activity. The most frequently cited effects included relaxation, mood regulation, and self-expression, illustrated by statements such as, "This song moves me" or "I listen to ballads because I haven't been feeling happy lately" (Pešić et al., 2014). These insights underscore music's role in shaping affective states and supporting reflection. Similarly, Herbert's (2012) phenomenological analysis revealed that music was most commonly used as a tool to modify one's emotional state, to create a sense of exhilaration, energy, and excitement in everyday situations, to distance oneself from certain aspects of personality or circumstances, or to foster relaxation. It also served as a means for mood expression, and a framework for exploring emotions and shaping future emotional experiences. Emotional responses to music include physiological effects such as chills, laughter, tears, or increased arousal (Cowen et al., 2020). Findings from studies employing subjective, behavioural, physiological, and neurological measures indicate that listeners predominantly respond to music affectively (Gagnon & Peretz, 2003; Mitterschiffthaler et al., 2007). Although a large body of research has explored the affective experience of music, there is still no consensus on its precise definition. The term "affect" is an umbrella term which covers various affective phenomena, including emotions, moods, and preferences (Juslin, 2019, p. 43). Some authors in the field of music psychology distinguish between emotions felt by the listener (felt emotions, e.g., "This music makes me feel happy") and emotions expressed by the music itself (perceived emotions, e.g., "The music is sad"). This paper defines it technically as the affective output arising from the encounter with musical stimuli that can be attributed to various implicit and explicit aspects of the musical input, as it refers both on listeners' responses and the affective qualities attributed to the music.

The core question addressed in this paper is: what is the taxonomic structure of the affective

experience induced by music? Is the affective musical experience, such as being moved or excited, rooted in discrete emotional states (e.g., basic, such as sadness, or domain-specific, such as triumphant), or is it more accurately described by broader affective dimensions, such as valence and arousal? The present paper provides a narrative review of two widely used approaches to musical affect: the categorical and dimensional approach. Both approaches acknowledge complexity and variation but differ in how they conceptualize affective experience. Juslin (2019) uses a metaphor comparing emotions to colours to explain the difference between categorical and dimensional approaches to emotion. In the categorical view, emotions resemble distinct colour categories: just as there are different shades of blue, there are shades of sadness. However, at some point, a clear shift to another category occurs, such as from blue to red or from sadness to anger. In contrast, the dimensional approach treats affective experience as varying along continuous scales, such as valence and arousal, similar to how colours vary in hue and intensity. These models were selected due to their prominence in the field, empirical support, and contrasting theoretical assumptions. While other models—such as BRECVEMA (Juslin, 2013) that depicts different mechanisms through which music evokes emotions in listeners, or framework proposed by Hunter et al. (2010), which addresses the complexity of mixed emotional experiences in response to music—offer valuable insights, the focus remains on models that directly engage with the question of affective structure. We aim to synthesize findings from diverse studies to better understand the nature of affective experience of music.

The categorical approach to affective musical experience

According to the categorical approach, emotional episodes are experienced as categories, which are distinct from each other (Juslin, 2019). Within this approach, the best-known is the discrete emotions model that draws on Ekman's (1992) and Izard's (1992) theories of basic emotions as universal, biologically based categories suitable for categorizing emotional reactions. These emotions are considered to have specific neurophysiological underpinnings and are accompanied by distinctive subjective experiences, as well as recognizable facial expressions (Ekman, 1992). In the context of musical experience, these categories are often used to describe the perceived emotion expressed by the music, rather than the emotion felt by the listener. Schubert et al. (2012) used a discrete model of emotions to measure emotional responses continuously through a simplified user interface that displayed schematic facial expressions (emoticons) to represent emotions. The authors aimed to test the assumption that similar emotions are placed close to each other in semantic space, while opposing emotions are positioned further apart (Figure 1). They employed a circular checklist with emoticons corresponding to the following emotions, arranged clockwise: excited (1 o'clock), happy (3 o'clock), calm (5 o'clock), sad (7 o'clock), fearful (9 o'clock), and angry (11 o'clock).

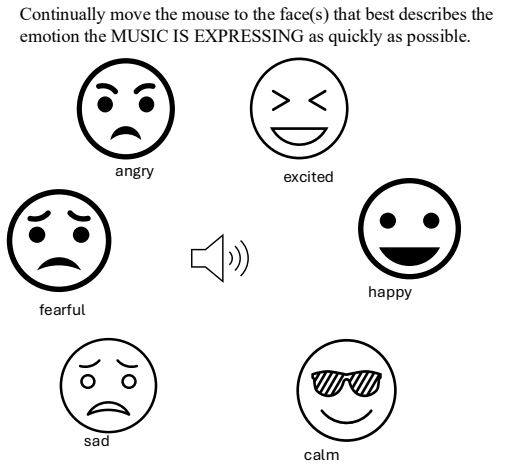

Figure 1. User interface display adapted from Schubert et al. (2012)

Participants listened to six short (max 20 seconds) musical excerpts composed for animated films, each intended to evoke one of six target emotions: angry, fearful, sad, calming, happy, or exciting. During each excerpt, participants continuously moved a cursor over an emoticon that best matched the emotion expressed (Figure 1) and then selected the dominant emotion at the end. Continuous tracking showed that the most frequently chosen emoticon often corresponded with the intended emotion, though some excerpts (e.g., angry, sad) elicited multiple dominant emotions over time. This suggests that musical emotions are often complex and cannot be reduced to a single discrete category. These emotional shifts appeared to be associated with changes in musical features, such as tempo, highlighting the dynamic nature of the music-induced affect. Final ratings

confirmed a clear pattern for each piece but also revealed individual variability. For instance, in the "angry" excerpt, 13 out of 30 participants chose "angry," while others selected "fearful," "excited," or showed indecision. These results suggest that individual differences, such as personality traits, emotional sensitivity, musical training, cultural background, or mood, may significantly influence how listeners perceive and interpret musical emotions.

Many authors note that discrete models are based on emotions that are evolutionarily adaptive and often linked to survival threat, or loss, (e.g., fear, anger, sadness, excitement). However, music rarely evokes such "raw" emotions; rather, it tends to elicit more "refined," music-specific, aesthetic, and complex emotional states that more accurately reflect the nature of musical experience (Zentner et al., 2008). Kate Hevner's (1936) pioneering study exemplifies this approach. She developed a checklist of adjectives—often reflecting mood- or evaluation-related descriptors—to assess affective experience of musical stimuli. Her instrument, depicted in Figure 2, known as the *Adjective Circle*, grouped related adjectives into clusters arranged in a circular structure. In her experiments, Hevner (1936) asked both lay listeners and trained musicians to listen to five well-known classical pieces and mark the clusters of adjectives that best described their affective experience. She found a high level of consistency in how different participants described their affective responses, suggesting a shared affective experience among listeners.

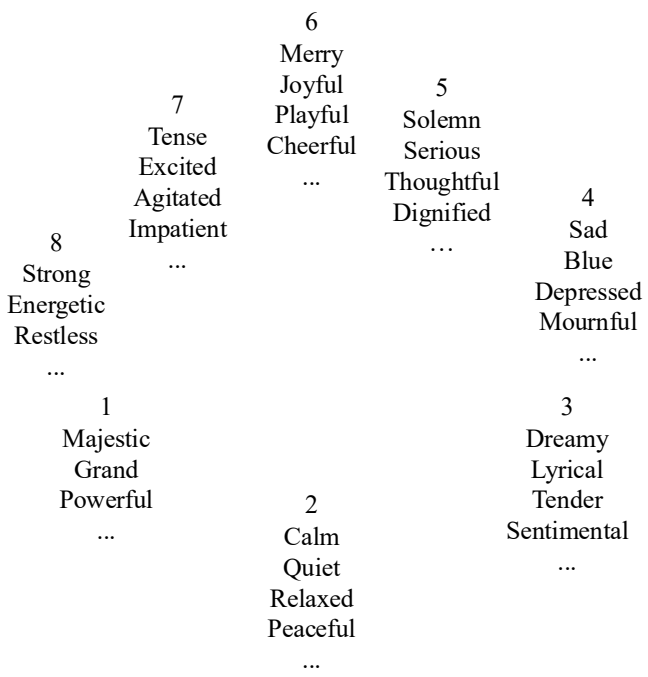

Figure 2. Adjective Circle adapted from Hevner (1936)

Schubert (2003) updated Hevner's (1936) original descriptors by adding words from Whissell's (1989) dictionary of affect and grouping them according to their position in a two-dimensional emotion space (valence and arousal). Affective descriptors were grouped into nine clusters within a two-dimensional circumplex space, which can be seen in Figure 3. Words with similar meanings were placed close together, for example, the cluster containing "bright, cheerful, joyful," was positioned adjacent to "playful, light-hearted" and further from "dark, depressive, sorrowful." That same year, Fabian and Schubert (2003) used this checklist in a study in which musically trained participants selected up to three words from the checklist that best reflected the character of each of 34 different performances of the same musical piece. Allowing the selection of three words acknowledges that the character of a performance can vary, and that multiple contrasting emotions may be expressed simultaneously. In addition, participants rated various performance features: tempo, articulation, dotting, and loudness. Using clustering techniques, five distinct and varied musical characters were evoked consistently across the performances (each cluster represented by the word bright, playful, delicate, majestic, or agitated). Each of the musical features made statistically significant contributions to distinguishing between character clusters.

For example, Cluster A (cheerful, bright) was rated as significantly faster and louder than Cluster C (graceful, gentle), which was perceived as slower and softer. Similarly, Cluster I (tense, agitated) was associated with high intensity and fast tempo, in contrast to Cluster G (majestic, sacred), which was rated as slower, contributing to its dignified character. These findings imply that the affective musical experience may be meaningfully organized around variations in basic musical features, which systematically predict membership in distinct affective categories.

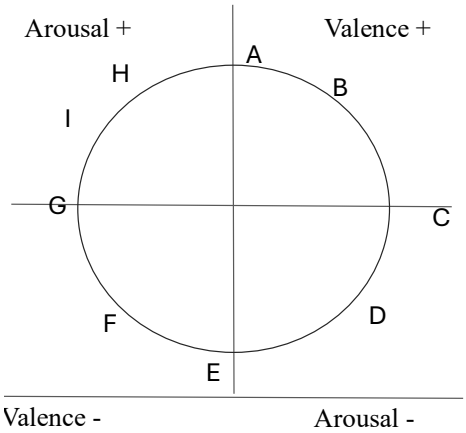

Figure 3. Adapted scheme of the revision of Hevner's checklist (Schubert, 2003)

Dimensional approach to affective musical experience

In parallel with the previous approach, there is an ongoing quest to identify a smaller number of dimensions that can optimally describe the space of affective experience. This line of research began in the 1960s with the pioneering work of Osgood et al. (1957), who established the conceptual and methodological framework for the dimensional approach through the semantic differential. This method was designed to measure people's affective (connotative) meaning of words by using pairs of opposing adjectives (e.g., pleasant–unpleasant, strong–weak). Participants rate a stimulus such as a word (e.g., snake, laugh) or a piece of music by marking a position along a 7-point scale between each pair.

Bad -3___-2___-1___0___1___2___3 Good

Figure 4. Example of a semantic differential scale (Osgood et al., 1957).

By statistically analysing these ratings utilizing factor analysis, researchers can reduce complex reactions into a smaller number of interpretable dimensions. Osgood and his colleagues identified three stable and culturally invariant dimensions: the evaluation factor (e.g., good–bad, beautiful–ugly), the potency factor (e.g., strong–weak, large–small), and the activity factor (e.g., fast–slow, young–old). These factors represented the dimensions of a hypothetical semantic space.

The model presented by Osgood et al. (1957) has demonstrated significant heuristic value in music. Subsequent studies employed the semantic differential method and factor analysis to identify the fundamental dimensions of experience. Different researchers found from three to five somewhat different dimensions of affective experience of music. Nordenstreng (1969) identified four factors, which he labelled as softness, colourfulness, relaxation, and magnitude. Wedin (1972) found three bipolar factors: tense-energetic, bright-sombre, and ceremonial-trivial. Trkulja and Janković (2012) identified the factors of affective valence, arousal, and cognitive evaluation, which collectively accounted for 60% of the variance in the affective music experience. A similar percentage of variance was explained by Živanović et al. (2018) through five factors: aesthetic experience, affective tone, tension, content-fullness, and structure. Despite differences in terminology and the number of dimensions identified, the findings reveal a recurring underlying structure in the affective experience of music. Most of the identified dimensions can be grouped into three broad and widely recognized component categories: **valence, arousal,** and **cognitive evaluation**. For instance, *softness* and *colorfulness* (Nordenstreng, 1969), *bright–sombre* and *ceremonial–trivial* (Wedin, 1972), and *affective tone* (Živanović et al., 2018) correspond to **valence**, capturing the emotional pleasantness or tone of the experience. Dimensions such as *relaxation* (Nordenstreng, 1969), *tense–energetic* (Wedin, 1972), and *tension* (Živanović et al., 2018) align with **arousal**, referring to the level of activation or intensity. Finally, *magnitude* (Nordenstreng, 1969), *ceremonial–trivial* (Wedin, 1972), *cognitive evaluation* (Trkulja&Janković, 2012), and dimensions such as *aesthetic experience*, *content-fullness*, and *structure* (Živanović et al., 2018) reflect various aspects of **cognitive or symbolic appraisal**, including the perception of complexity, meaning, and formal organization in the music. Thus, despite methodological and terminological differences, a consistent triadic framework—valence, arousal, and evaluation—emerges across studies of affective musical experience.

Another version of dimensional approach

to affective experience is the circumplex model proposed by James Russell (1980). Originally proposed to capture the general structure of affect, the model was later adapted to musical contexts. Russell (1980) employed somewhat different procedure than Osgood. Starting from adjectives commonly used to express affective experiences, he employed multidimensional scaling (MDS) of participants' ratings of affective states. This statistical technique is used to visualize the similarities or dissimilarities between items, in this case, adjectives describing affective states, by placing them in a geometric space (usually two- or three-dimensional). Participants rate the perceived similarity of emotion-related adjectives (e.g., happy vs. excited, sad vs. angry). MDS takes these ratings and plots each adjective as a point in space. The closer two points are, the more similar the affective states are perceived to be. Russel discovered that these adjectives naturally arranged themselves in a circular (circumplex) pattern in a two-dimensional space defined by: 1) valence (pleasantness-unpleasantness) and 2) arousal (activation-sleepiness). According to this model, all affective states can be mapped in this two-dimensional space. The horizontal dimension (pleasantness-unpleasantness) spans from one extreme (e.g., agony), through a neutral point (the organism's adaptation level), to the opposite extreme (e.g., ecstasy). The vertical dimension (arousal) ranges from sleepiness, through various stages of alertness, to frenetic excitement. Affective states are arranged circularly, each falling at a unique combination of valence and arousal. Russell (2003) termed the combination of these two dimensions as core affect, defined as a neurophysiological state of awareness accessible through the simplest raw (non-reflective) feelings present in moods and emotions. While core affect exists within the individual (e.g., "Ana feels anxious"), Russell (2003) refers to the perception of pleasant/unpleasant and activating/deactivating properties of a stimulus as the perception of affective quality. Consequently, a subject attributes affective quality to the stimulation (e.g., "There is a disturbing scene on the street"). It begins with a specific stimulus, and denotes its ability to alter core affect. The perception of affective quality is a "cold" process that can become "heated" if it leads to a change in core affect. These simple processes, either independently or in combination with information related to behaviour processing and planning, explain the myriad of manifestations we term as emotional.

Later researchers applied the Circumplex Model of Affect to music, adapting Russell's (2003) method to a certain extent. They used musical excerpts instead of emotion adjectives, asking participants to rate how each piece of music made them feel using affective adjectives (e.g., happy, tense, calm, sad). By applying multidimensional scaling (MDS) to these ratings, researchers mapped the emotional qualities of music in a two-dimensional affective space. The results showed that musical emotions also organize themselves around the valence–arousal dimensions, forming a circumplex structure similar to that found in verbal emotion ratings. This approach reinforces the idea that affective experiences, whether verbal or musical, share a common psychological structure.

North and Hargreaves (1997) tested the hypothesis that the emotions expressed by musical stimuli are associated with their pleasing and arousing qualities. One group of participants rated pop music tracks on valence and arousal dimensions and the other on eight different emotions. The results aligned closely with the circumplex model. Multiple regression analysis showed that ratings of liking and arousal were significant predictors of the ratings of each emotion expressed by the music. Factor analysis revealed that the dimensions of liking and arousal potential emerged from participants' emotion ratings, aligning with the circumplex model. Excerpts located in different quadrants of the circumplex (based on liking and arousal potential) were rated consistently with the emotions associated with each quadrant. For example, excerpts in Quadrant 1 (high liking, low arousal) were rated as relaxing and peaceful.

The dimensional model has also been subjected to cross-cultural investigations. Egermann et al. (2015) compared subjective and psychophysiological emotional responses to music among participants from two distinct cultures: the Mbenzele Pygmies from the Congolese rainforest, who had no exposure to Western music, and Canadians unfamiliar with Congolese music. Participants listened to 19 excerpts (8 Pygmy and 11 Western), and rated them on valence and arousal dimensions, alongside measurements of peripheral physiological activation and facial expressions. While Pygmies subjectively placed all Pygmy music in the upper right quadrant, rating it as attractive and arousing, Canadians' ratings of Western music covered the range from arousing to soothing and from positive to negative valence. Canadians perceived their music as more arousing than Pygmies did. However both groups exhibited correlated responses, with stimuli rated as highly arousing by Canadians also eliciting high

arousal and physiological responses from Pygmies. Increased tempo, spectral centroid, and pitch height raised both skin conductance and subjective arousal in both groups, indicating a universal sensitivity to these features. However, facial expressions correlated with subjective ratings of valence and arousal only among Canadians, suggesting cultural influences on expressive responses. A significant finding of this research is that there was no similarity between respondents from different cultures in the subjective assessment on the dimension of valence, nor in terms of psychophysiological reactions to Congolese music, implying that while arousal may reflect a more universal acoustic processing, subjective meaning and cultural interpretation can vary significantly.

The integrative approaches

In recent decades, authors have made efforts to capture aesthetic and music-evoked emotions beyond traditional discrete and dimensional taxonomies. One of the most famous is the Geneva Emotional Music Scale (GEMS), developed by Zentner et al. (2008). GEMS is a conceptual and instrumental framework for measuring emotions evoked by music. While majority of earlier research focused on perceived emotions—what listeners believe the music expresses—GEMS is based on emotions actually felt by the listener. Authors show that these two types of emotions often diverge, especially for negative emotions, which are more frequently perceived than truly experienced. Researchers showed that standard basic emotions (e.g., Ekman's set: happiness, sadness, anger) were not suitable enough for music. They began by compiling over 500 affective terms drawn from psychology, music theory, and everyday language. These were refined to a core list of 45 emotion descriptors, which participants used to rate their emotional responses to a wide variety of musical excerpts. Participants gave self-reports of how often they had felt given feelings in their past experiences of listening to music from their preferred genres. Data were collected from large and culturally diverse samples and across multiple genres (e.g., classical, jazz, rock, Latin, techno). Using exploratory and confirmatory factor analyses, the researchers identified nine robust and recurring emotional categories that consistently emerged in music-induced affective experience. These include wonder, transcendence, tenderness, nostalgia, peacefulness, power, joyful activation, tension, and sadness. The GEMS model was directly compared with both the discrete emotion approach (e.g., happiness, sadness, fear) and the dimensional model (valence and arousal). Participants rated musical excerpts using all three frameworks. The authors then conducted exploratory and confirmatory factor analyses, as well as intersubject correlation analyses, to evaluate which model most effectively captured the variance in emotional responses. The last analysis correlated each listener's ratings with the ratings of all of the other listeners in the sample across the excerpts. The average consensus for each of the terms from the three different checklists was computed using the ICC. The results demonstrated that the GEMS model accounted for a greater proportion of variance and yielded more differentiated, nuanced emotional profiles than the other two models. While the dimensional model often produced uniform ratings clustered around similar quadrants (e.g., high valence/high arousal), and the discrete model lacked the specificity required for aesthetic emotions, GEMS reflected the richness and complexity of emotions elicited by music. These findings support the view that affective experience of music is best captured by a domain-specific, categorical framework (Zentner et al., 2008).

A recent study by Cowen and colleagues (2020) examined the best model for describing the affective space of musical experience across cultures – discrete categories or dimensions. The 2,700 participants from the USA and China rated 2,168 musical stimuli. Participants either selected from 28 emotion categories (e.g., joyful, scary, dreamy, triumphant) derived from prior research on music and vocal emotion (e.g., Zentner et al., 2008; Juslin & Laukka, 2004; according to Cowen et al., 2020), or rated the same excerpts on 11 affective scales (e.g., valence, arousal, dominance, certainty) based on dimensional theories of emotion appraisal (e.g., Smith & Ellsworth, 1985; Barrett, 2006; according to Cowen et al., 2020). Using Principal Preserved Component Analysis (PPCA), the authors identified 13 distinct dimensions of subjective experience that were consistently preserved across cultures. These dimensions corresponded to specific emotion categories, such as amusing, calm, energizing, sad, and triumphant. The interrater agreement rates for categories varied, with an average of 42.3%, where some music samples were labelled very consistently with categories including "energizing" (up to 89% of subjects), "triumphant/heroic" (83%), "amusing" (79%), "annoying" (79%), "scary/fearful" (76%), and "joyful/cheerful" (74%). Furthermore, the cross-cultural signal correlation was calculated by correlating the

mean responses by Chinese participants with those by US participants and dividing by the explainable variance in responses from each culture. Specific categories such as "joyful," "sad," and "triumphant" were more consistently recognized across U.S. and Chinese participants than broad affective dimensions like valence and arousal. Notably, 18 out of the 28 affective categories showed higher cross-cultural signal correlation than valence, and 16 showed higher correlation than arousal. This suggests that discrete affective labels are more universally applicable in the context of music. Regression analyses showed that category judgments better predicted affective scale ratings across cultures than vice versa, suggesting that valence and arousal may be inferred from more specific emotional experiences, rather than serving as their foundational components. These findings challenge traditional dimensional models that posit valence and arousal as the core building blocks of emotional experience (e.g., Russell, 1980), and instead support a category-first approach. According to Cowen et al. (2020), music evokes rich, specific emotional states that are cross-culturally robust, and at may serve as the psychological basis from which broader affective evaluations are constructed.

Conclusion

The attempt to define the taxonomic structure of affective musical experience, whether in terms of dimensional models (valence and arousal) or categorical models, has produced important and sometimes contrasting insights. Using dimensional models in music realm, such as Russell's (1980) circumplex model, has demonstrated that musical emotions can be broadly mapped along bipolar axes of valence and arousal, with empirical support from studies like North and Hargreaves (1997). These models can be efficiently used for summarizing affective tone and intensity and have shown cross-cultural consistency in arousal responses (Egermann et al. 2015). However, evidence from more recent and methodologically diverse studies suggests that categorical models offer a more accurate and musically relevant taxonomy. Zentner et al. (2008) showed that GEMS, a music-specific categorical model, better explains emotional responses to music than basic emotions or valence–arousal models. Egermann et al. (2015) found that arousal responses are more universal, while valence ratings are culturally shaped, suggesting limitations of dimensional models in capturing the full complexity of affect. Most compellingly, Cowen et al. (2020) demonstrated that discrete affective categories such as "triumphant," "scary," or "joyful" exhibit higher cross-cultural consistency and predictive power than dimensional ratings. Nearly a century after Katherine Hevner's pioneering research, large-scale cross-cultural analysis reaffirms the categorical approach as a more nuanced, precise, ecologically valid, and universally meaningful framework for understanding the taxonomy of the affective experience of music.

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Exploring Appraisal Dimensions in Music: Toward the Development of a Standardised Appraisal Tool for Musical Emotions

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Abstract

The relationship between music and emotion is a central topic in music psychology, with cognitive appraisals—evaluations based on goal relevance, novelty, and coping potential—playing a key role. This study examines the multidimensional nature of musical appraisals and addresses gaps in both theory and empirical research. Using a diverse and ecologically valid set of musical stimuli, sixty-six participants evaluated 14 appraisal dimensions and rated their emotional responses (valence, arousal, and interest) using diverse, ecologically valid musical stimuli. Ten appraisal items proved statistically robust, and exploratory factor analysis revealed three latent dimensions—Goal-congruence, Novelty, and Complexity—that underlie appraisals during music listening. Overall, this study provides the first proof of concept for a multidimensional appraisal framework in music, advancing the field by offering a systematic method for assessing music-induced emotions and laying the groundwork for a standardised appraisal tool.

Keywords: music, emotion, appraisal, goal-directed

Introduction

The interplay between music and emotion has intrigued researchers across disciplines for a long time, prompting investigations into how musical experiences evoke emotional responses. Central to these investigations is the concept of cognitive appraisal, whereby individuals evaluate the significance of stimuli—based on factors such as goal relevance, novelty, and coping potential—thereby shaping their emotional experiences. Appraisal theory, rooted in utilitarian emotion psychology (Moors & Scherer, 2013; Scherer, 2013), is also a key component in many theories of musically induced emotions (Céspedes-Guevara, 2023; Eerola, 2017; Juslin, 2019; Lennie & Eerola, 2022; Scherer & Coutinho, 2013). Although these theories differ regarding whether appraisal processes serve as mediators or central mechanisms, they all agree that appraisals contribute to individual and contextual differences in emotional responses to music.

Musical appraisals

Empirical research on music-induced emotions underscores the importance of appraisal processes. Studies on familiarity (Bosch et al., 2013; Pereira et al., 2011) have found that familiar music elicits stronger emotional responses by enabling listeners to predict musical events, with cultural background further shaping perception. In terms of complexity, North and Hargreaves (1998) demonstrated that liking for pop music follows an inverted-U relationship with subjective complexity, in contrast to a simpler linear relationship with familiarity. Research by Cheung et al. (2019) revealed that when music meets listeners' expectations, pleasure and satisfaction increase; conversely, violation of expectations can lead to mixed responses. Moreover, goal relevance—how well music aligns with an individual's current emotional state or desired outcomes—influences both music selection and mood regulation (Greb et al., 2019; Randall & Rickard, 2017).

These studies clearly illustrate the impact of individual appraisal dimensions. However, most have examined them in isolation, leaving the dynamic interplay between multiple appraisals in emotional episodes largely unexplored.

Interaction in appraisal dimensions

Research in broader affective sciences has shown that the interaction between appraisal dimensions can shape emotional responses significantly. For example, work by Silvia (2005b) and Turner and Silvia (2006) indicates that novel stimuli appraised as manageable tend to evoke interest and curiosity, whereas unmanageable novelty may lead to anxiety or avoidance. In addition, Laukka and Elfenbein (2012) demonstrated that listeners can reliably infer multiple appraisal dimensions from vocal expressions, highlighting their role in emotional

communication—a finding that supports similar investigations in musical contexts. There are many appraisal interactions that could be noted, but a full list lies beyond the scope of this paper; for an overview of appraisal dimensions see the first meta-analysis published on the topic (Yeo & Ong, 2024). It suffices to note that exploring such ideas in a musical context is both beneficial and timely.

However, emotional responses to music generally arise from the interplay between factors such as goal relevance, familiarity, and complexity. For instance, familiarity can moderate other appraisals by shaping expectations; Gold et al. (2019) found that predictability and uncertainty influence both pleasure and engagement. When listeners' expectations are met, they experience satisfaction, while unexpected musical events can evoke surprise or tension, which can also be emotionally impactful. Recognising these interactions is essential for developing a comprehensive model of musical emotions (Lennie & Eerola, 2022), that explains why individuals may respond so differently to the same musical piece.

Aims

Further research is required to bridge both theoretical and empirical gaps in our understanding of musical appraisals, particularly given the current lack of an appropriate assessment tool in this context. This study marks the first exploratory evaluation of multiple appraisal dimensions in music and takes an initial step towards developing and validating a standardised tool. In doing so, it also extends previous work by emphasising the

Table 1. Selected appraisal terms and their relationship to the theoretical structure of appraisal categories.

Appraisal group	Sub-category	Questions format	Scale
Relevance	Novelty	How predictable is the music? How familiar is the music? How complex is the music?	Unpredictable / Predictable Unfamiliar / Familiar Simple / Complex
	Intrinsic Pleasantness	How pleasant is the music?	Unpleasant / Pleasant
	Goal-relevance	<How expressive is the music?> <Did the music have a strong effect on you?>	Unexpressive / Expressive No Effect / Strong Effect
Implications / Consequences	Expectations	Did you expect to hear music like this?	Did not expect / Expected
	Goal-congruence	Did the music produce a desirable outcome? * <How satisfying is the music? >	Undesirable / Desirable Unsatisfying / Satisfying
Coping Potential	Control	* How comprehensible is the music?	Incomprehensible / Comprehensible
Norm-compatibility	Internal standards	* Do you find the music aesthetically beautiful? * Do you find the music aesthetically challenging? Does the music represent your personal ideas of good music?	Un-beautiful / Beautiful Unchallenging / Challenging Poor / Good
	External standards	Does the music conform to socially accepted ideas of good music?	Violates / Conforms

Note:

[a] Multiple appraisal formats are suggested if there is not sufficient evidence to conclude that one may offer a better interpretation for musical appraisal.

[b] In line with other appraisal theories, this musical interpretation suggests that some appraisal formats may be representative of an appraisal group instead of a single sub-category. These appraisals are marked with an asterisk (*).

[c] Some appraisal formats are implicit measures of appraisals, less available to consciousness. These appraisals are marked with angle brackets (<>).

predictive relationships between appraisal factors and core affective states such as valence, arousal, and aesthetic interest. Specifically, the study aims to:

1. Investigate the validity and reliability of appraisal dimensions as they pertain to musical stimuli.
2. Explore the predictive power of appraisal dimensions (e.g., goal congruence, familiarity, and complexity) on core affective and aesthetic responses to music.
3. Lay the groundwork for the development of a standardised appraisal tool for music-induced emotions, informed both by empirical data and theoretical advances.

Method

Measures

Following the utilitarian appraisal framework (Moors et al., 2013), appraisals were assessed across four key categories: relevance, implications, coping potential, and norm-compatibility. This structure is true for the most popular theoretical adaption of appraisal for music, too (Scherer & Coutinho, 2013). Specific appraisal dimensions were developed from literature sources (Céspedes-Guevara, 2023; Lennie & Eerola, 2022; Robinson, 2005, 2009; Scherer, 2013; Scherer & Coutinho, 2013) and refined by the author and two music psychology experts to suit an online listening study (Table 1). For example, utilitarian appraisal dimensions such as 'adjustment' (the ability to change one's listening situation) and 'causal attribution' (identifying the source of the music) were excluded as they did not fit this study design. In addition to the appraisal dimensions, participants were asked to rate three further items. Arousal was described as "how sleepy/ awake do you feel the music to be". Valence was described as "how positive / negative do you feel the music to be". Interest was described as "how interesting / uninteresting do you feel the music to be". All scales were rated on a 7-point Likert scale.

Stimuli were sourced from the DEAM dataset (Alajanki et al., 2016), which comprises 1,800 royalty-free 45-second excerpts across 10 genres, all sampled at 44100 Hz. Sixty excerpts were selected to represent five commonly studied Western genres (classical, electric, jazz, world/international, pop/rock; Rentfrow et al., 2011). For each genre, stimuli were chosen based on valence and arousal variability: high (SD > 2.0) and low standard deviation (SD < 1.0) for both valence and arousal, with three excerpts selected per variance category. All tracks featured no lyrics, indiscernible lyrics, or lyrics in a language unlikely to be understood by UK participants. A full list of tracks is provided in Appendix A, and the collected valence and arousal scores (Appendix B) confirm a diverse affective range.

Participants and procedure

A total of 66 participants (65% female; age range 18-69, M_{age} = 34.5, SD = 11.3) were recruited using Prolific. Eligibility criteria required participants to be UK nationals that were born and are currently residing in the UK. Participants first read detailed instructions, including definitions of valence, arousal, and interest, and completed a volume check. They were asked to maintain a constant volume throughout the study. Each participant was randomly presented with 20 out of the total of 60 tracks, ensuring an even representation of high and low standard deviation tracks for both valence and arousal across the five genres. Participants could rate the appraisal terms as they listened to the 45s excerpt and could listen to the track multiple times.

Following the listening task, participants completed the G-MSI musical training questionnaire (Müllensiefen et al., 2014) and self-rated their musicality on a scale from non-musician to professional. They also indicated their music genre preferences (e.g. rock/heavy, pop/electro, classical/ethnic, other) and provided demographic information, including age and gender. The largest proportion of the participants represented music-loving non-musicians (n = 34) and amateur musicians (n = 17) with a G-MSI musical training score (M = 20.47, SD = 11), slightly lower than the British average (Müllensiefen et al., 2014). Genre preferences indicated the most popular genre was pop/electro (35%), followed by other (22%), rock/heavy (18%), and classical (3%).

Results

All data were analysed in RStudio, with G-MSI scores computed following Müllensiefen et al. (2014); the R scripts and data are available from the author.

Internal consistency

Cronbach's alpha was used to assess the internal consistency of each appraisal dimension. Nearly all terms demonstrated good reliability ($\alpha > 0.70$), except for 'Effect' (goal-relevance sub-category)

and 'Challenge' (internal-standards sub-category), which showed very low alpha values. These two dimensions were therefore excluded from further analyses. Confidence intervals indicated reasonable homogeneity across rating scales, supporting the robustness of the data for examining individual differences (e.g., age, genre preferences, and genre type) in musical appraisals. The confidence interval and Cronbach' alphas for each scale can be seen in Appendix C.

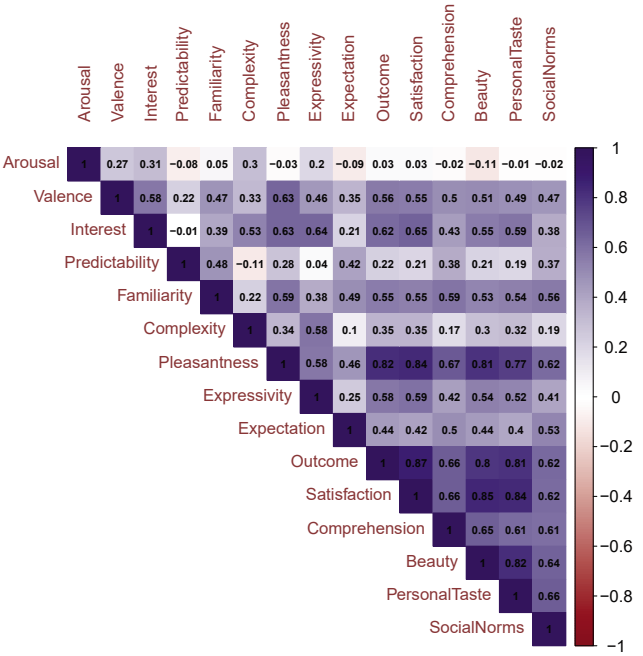

Figure 1. Correlation table for individual appraisal dimensions with arousal, valence, and interest using Pearson correlation coefficient.

Correlations

After removing the two invalid appraisal dimensions, correlations between the remaining appraisal dimensions and the dependent variables were examined. Several appraisal terms were used to represent the same dimension because it was unclear if one interpretation was theoretically superior, and there may be significant overlap in the variance they explain. Moreover, examining these correlations is informative given previous work on the overlap between core-affect and interest with appraisals.

Pearson correlation coefficients were computed to examine relationships among appraisal dimensions (Figure 1). The results revealed clear correlations between 'Valence' and 'Interest' with several appraisal dimensions. In contrast, 'Arousal' showed almost no correlation with the appraisal dimensions, aside from weak associations with 'complexity' and 'expressivity'. Individual appraisal dimensions varied in their correlations, ranging from weak to strong. Notably, very high correlations (>.80) were found between terms representing the same underlying appraisal dimension. For instance, 'Satisfaction' and 'Outcome' correlated at .87 and were theoretically representative of goal-congruence; hence, they were averaged to form a composite scale named 'Goal-congruence'. Similarly, 'Beauty' and 'Personal Taste' correlated at .82 and were averaged to form a composite scale 'Internal Standards'.

Although four scales showed similarly high correlations (> .80), they represent different theoretical levels within the appraisal model and were therefore retained separately to preserve the hierarchical structure. Much evidence supports this utilitarian structure (Davidson et al., 2009). It is possible that these high correlations partly reflect characteristics of the DEAM dataset or the selected stimuli.

Exploratory factor analysis

The new set of ten appraisal dimensions underwent parallel analysis to estimate the number of components and factors. The analysis suggested a two-component and three-factor solution (Appendix D). Subsequently, an exploratory factor analysis (EFA) was then conducted (Watkins, 2018) assuming three factors, utilising a principal factor solution with an oblimin rotation, which allows for correlated latent factors.

The three-factor solution showed that all items had sufficient loadings (|factor loadings| > 0.30). Although Comprehension and Social Norms displayed small cross-loadings, the differences (>.12) were substantial enough not to compromise factor interpretation or independence. The Tucker Lewis Index (TLI = 0.972) indicated an acceptable fit (> 0.9; Bentler & Bonett, 1980), and the Root Mean Square Error of Approximation (RMSEA = 0.0649, 90% CI: 0.0587–0.0712) was acceptable to good (Hu & Bentler, 1999). In addition, all sums of squared loadings were greater than 1 (Kaiser's rule), confirming the meaningfulness of the factors. The

full table of factor loading coefficients is available in Appendix E.

Based on loading strength and theoretical considerations, Factor 1 was named 'Goal-congruence' (accounting for 36% of the variance), Factor 2 'Novelty' (13% of the variance), and Factor 3 'Complexity' (18% of the variance). Individual item loadings and inter-factor correlations are presented in Figure 2.

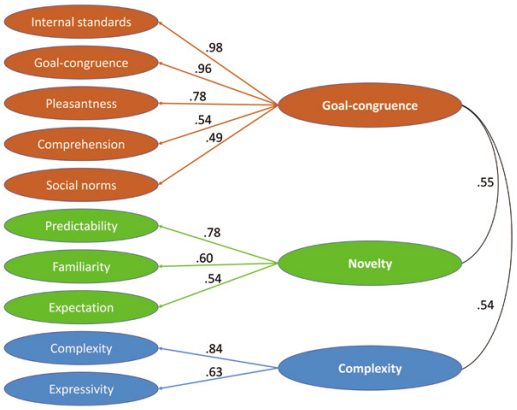

Figure 2. Factor analysis with component loadings and factor correlation coefficients.

Discussion

This discussion focuses on the validity and latent structure of the appraisal terms. For clarity, it differentiates between three levels of terminology: appraisal groups and latent factors (denoted in capitals within single quotation marks, e.g. 'Goal-congruence'), individual appraisal dimensions or sub-categories (in lowercase within single quotation marks, e.g. 'novelty'), and the terms used in the study (in double quotation marks, e.g. "predictability").

The validity of appraisal dimensions for music

The study originally proposed 14 appraisal dimensions, of which 12 showed good internal consistency across participants. In several instances, multiple terms were used to represent a single appraisal dimension—for example, both "outcome" and "satisfaction" were used to capture the appraisal dimension 'goal-congruence', and "beauty" alongside "personal taste" represented 'internal standards'. Strong correlations (>.80) between such terms justified the formation of composite measures, thereby reducing the final set to ten appraisal items representing all sub-categories and the four wider appraisal groups.

A notable finding was that some appraisal dimensions, such as 'novelty', were represented by multiple terms (e.g. "predictability", "familiarity", and "complexity") that did not correlate strongly enough to justify merging them into a composite measure. This outcome suggests that these dimensions are multifaceted constructs, perhaps reflecting different linguistic or cognitive interpretations of the same underlying process. In addition, some terms were originally hypothesised to represent broader appraisal groups rather than isolated sub-categories. For instance, "satisfaction" was originally intended to indicate the wider 'Implications and Consequences' group, while "beauty" was considered to be a proxy for the 'Norm-compatibility' group. The present results underscore that individual appraisal dimensions can be meaningfully distinguished, and that theories treating appraisal groups as unitary constructs may benefit from a more nuanced understanding of these terms.

An additional consideration is that several appraisal terms are designed to measure processes that may be less accessible to conscious introspection. For example, "expressivity" and "effect" were used to capture aspects of the 'goal-relevance' appraisal dimension—processes that Scherer et al. (2006) have suggested are implicit in nature. While the low internal reliability of "effect" ultimately led to its exclusion, the overall pattern indicates that implicit measures can be seen as indicative of the underlying mechanisms. Thus, the final set of appraisal measures provides a valid framework for the cognitive assessment of music-induced emotions.

The structure of musical appraisal

To assess the latent structure of the appraisal dimensions, a parallel analysis was conducted, which initially indicated a two-component solution. This aligns with the valence–arousal structure inherent in the stimuli (Alajanki et al., 2016), suggesting that the cumulative variance captured by the appraisal dimensions is largely explained by two broad dimensions. However, when an exploratory factor analysis (EFA) was performed using a principal factor solution with an oblimin rotation (to allow for correlated factors, as expected in appraisal research), a three-factor solution emerged as the best representation of the data.

This three-factor solution diverges from the traditional four-factor model of appraisal—typically comprising 'Relevance', 'Implications', 'Coping

Potential', and 'Norm-compatibility' (Ellsworth & Scherer, 2003). Instead, the analysis indicates that components from multiple wider appraisal groups are integrated within the latent factors.

Factor 1 ('Goal-congruence'). This factor includes items from all four appraisal groups. Notably, the composite scales for 'internal standards' (with a loading of .98) and 'goal-congruence' (with a loading of .96) dominated this factor. In line with Smith and Lazarus (1991), this finding suggests that appraisals related to social and normative compatibility are subsumed under a broader goal-congruence construct. There is of course the possibility that the distinction between goal-congruence (in the 'Implications/Consequences' appraisal group) and 'Normative Significance' is not captured in this set of stimuli (the stimuli did not vary significantly in these dimensions from those in goal-congruence). Similarly, the study participants (British nationals) may not capture meaningful distinctions between what people see as socially and individually normative as opposed to goal-congruent without a comparison group. Regardless of the additional inclusion of 'internal standards', these results suggest that goal-congruence plays a significant role in the cognitive evaluation of music.

Factor 2 ('Novelty'). This factor comprised of items representing both the 'novelty' and the 'expectations' dimensions, predominantly reflecting utilitarian interpretations of appraisal. The strongest loadings—"predictability" (.78) and "familiarity" (.60)—support the conceptualisation of novelty as a key aspect of musical appraisal.

Factor 3 ('Complexity'). This factor is characterised by the loadings of "complexity" (.84) and "expressivity" (.63). Although "complexity" was initially associated with 'novelty' (Table 1) based on Silvia's (2005a, 2005b; 2006) work on aesthetic appraisal, its strong and distinct loading here indicates that it may capture a different aspect of musical processing. It is worth noting that Silvia used an implicit experimental manipulation of more and less complex visual images as representative of complexity; his design did not use the term "complexity" explicitly, as was done here. There is an ongoing debate in the literature over the role of "complexity"—whether as a marker of novelty, 'Norm-compatibility' (Céspedes-Guevara, 2023), or emotional complexity (Robinson, 2005)—that remains unresolved. Robinson's (2005) interpretation appears closest to the results generated here. Her philosophical account of aesthetic appraisal interprets the term "complexity" as referring to the emotional complexity of what is being expressed by music; similar to the implicit measure of goal-relevance ("expressivity") presented in this adaption of appraisal terms. While the term "Complexity" was selected to reflect the distinct nature of this factor in the present study, it should be interpreted with caution, given the many interpretations noted in previous literature. What is clear from this analysis is the apparent link with the goal-relevance of the music.

Limitations and future directions

The chosen stimuli covered a broad affective space (valence and arousal) but did not systematically manipulate all appraisal dimensions. A collection of stimuli that varies across all appraisal dimensions would be incredibly large, time-consuming for participants, and would likely require a validation task, as no such dataset currently exists. Future studies would benefit from such implicit manipulations of appraisal dimensions in experimental stimuli (e.g., musical stimuli that vary in complexity or goal-relevance). However, achieving such a mammoth task is likely to be built on incremental studies, testing single appraisal dimensions at a time.

Participants may have reported hypothetical or imagined emotional responses - an established critique in appraisal research (Robinson & Clore, 2001). In addition, the short (45-second) musical excerpts may not always induce full emotional episodes, despite prior evidence suggesting this duration is often sufficient (Eerola & Vuoskoski, 2012). However, this alone is not a sufficient criterion for an emotional episode to occur (i.e., if 45 seconds of music is heard, an emotional episode will follow). Regardless of whether a full-blown emotional episode was experienced, this research provides ample support for the conclusion that appraisal is a meaningful component of the emotional experience of music.

The study's sample size limits the robustness of conclusions about individual appraisal dimensions and their latent structure. Factor analysis requires approximately ten participants per variable for stability, and a larger sample would allow for confirmatory analysis, an important next step.

Appraisals likely fluctuate over time rather than being static judgments (Scherer, 2009). Future work could explore continuous appraisal responses, but this is best approached incrementally, by investigating individual appraisals in real-time.

The relationship between appraisal and core-

affect (valence and arousal) is a key component of utilitarian theories (Russell, 2003, 2009) and music-emotion theories (Céspedes-Guevara, 2023; Eerola, 2017; Lennie & Eerola, 2022; Scherer & Coutinho, 2013). The strong correlations between appraisal dimensions and valence highlight the potential for advanced modelling of appraisal contributions to core affect, which would offer a novel addition to the field.

The appraisal terms used were adapted from existing theoretical models. Future research could refine these through empirical analysis of commonly used descriptors to enhance validity and refine dimensions. This would provide a robust grounding for appraisal in music and improve the internal validity of (or offer alternatives to) the dimensions proposed.

Conclusions

This study demonstrated the validity of ten appraisal mechanisms in musically induced emotional episodes across an ecologically valid stimulus set. Exploratory factor analysis grouped these appraisal dimensions into three latent factors: 'Goal-congruence', 'Complexity', and 'Novelty'. This study provides the first proof of concept for applying the broader appraisal framework to music and represents the first analysis of multiple appraisals in music.

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Appendix

Appendix A

Table 1. Selected track numbers and high/low sd grouping from the DEAM dataset (Alajanki et al., 2016).

DEAM - track number	Genre	Core-affect	sd
138	Classical	Valence	High
159	Classical	Valence	High
246	Classical	Valence	High
456	Electronic	Valence	High
423	Electronic	Valence	High
454	Electronic	Valence	High
707	Jazz	Valence	High
676	Jazz	Valence	High
634	Jazz	Valence	High
35	World	Valence	High
1638	World	Valence	High
1611	World	Valence	High
952	Pop	Valence	High
797	Pop	Valence	High
781	Pop	Valence	High
158	Classical	Valence	Low
171	Classical	Valence	Low
198	Classical	Valence	Low
425	Electronic	Valence	Low
459	Electronic	Valence	Low
482	Electronic	Valence	Low
1757	Jazz	Valence	Low
1792	Jazz	Valence	Low
657	Jazz	Valence	Low
1615	World	Valence	Low
1683	World	Valence	Low
1606	World	Valence	Low
851	Pop	Valence	Low
902	Pop	Valence	Low
938	Pop	Valence	Low

(Cont.)

DEAM - track number	Genre	Core-affect	sd
207	Classical	Arousal	High
150	Classical	Arousal	High
172	Classical	Arousal	High
387	Electronic	Arousal	High
422	Electronic	Arousal	High
423	Electronic	Arousal	High
631	Jazz	Arousal	High
676	Jazz	Arousal	High
696	Jazz	Arousal	High
1684	World	Arousal	High
1673	World	Arousal	High
1675	World	Arousal	High
776	Pop	Arousal	High
858	Pop	Arousal	High
781	Pop	Arousal	High
1118	Classical	Arousal	Low
1150	Classical	Arousal	Low
1132	Classical	Arousal	Low
390	Electronic	Arousal	Low
427	Electronic	Arousal	Low
1332	Electronic	Arousal	Low
722	Jazz	Arousal	Low
1775	Jazz	Arousal	Low
649	Jazz	Arousal	Low
1654	World	Arousal	Low
1693	World	Arousal	Low
1632	World	Arousal	Low
756	Pop	Arousal	Low
767	Pop	Arousal	Low
804	Pop	Arousal	Low

Appendix B

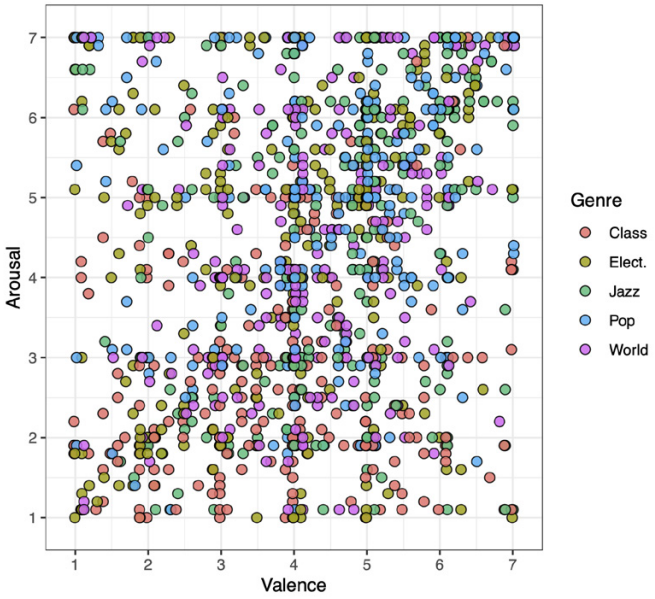

Figure 1. Valence and arousal ratings for selected stimuli as rated in the DEAM dataset (Alajanki et al., 2016) and grouped by genre. This demonstrates selected tracks have a wide distribution across the affective space.

Appendix C

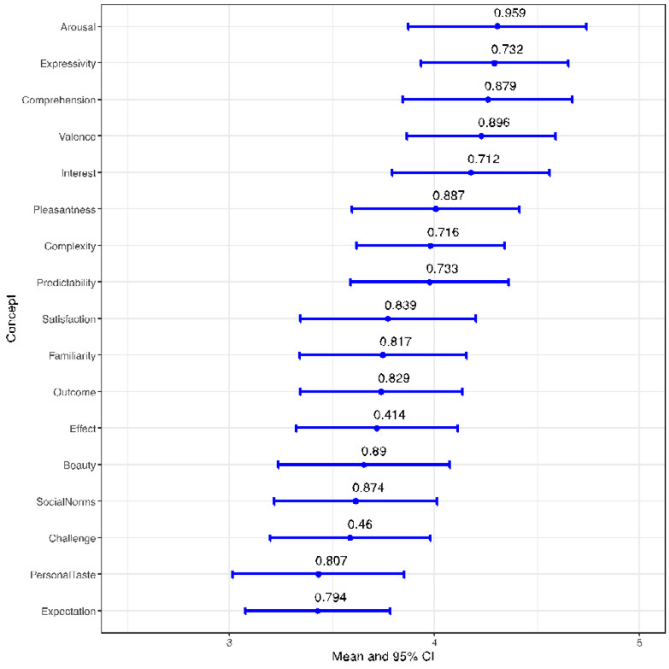

Figure 2. Confidence interval and Cronbach's alphas scores for individual for each scale of measurement.

Appendix D

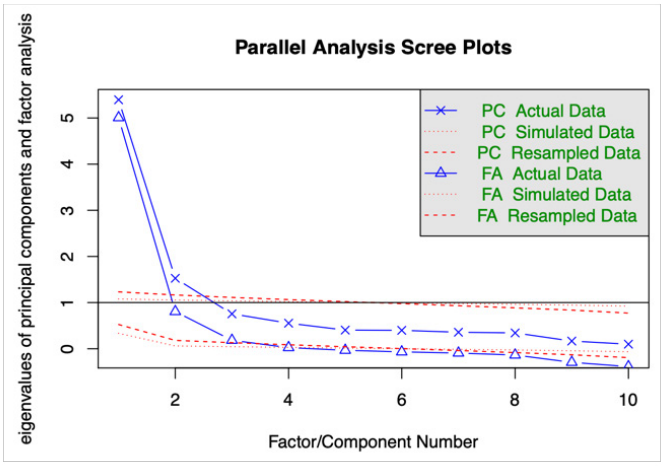

Figure 3. Parallel analysis scree plot

Appendix E

Table 2. Individual loadings for exploratory factor analysis.

	PA1	PA2	PA3
Internal Standards	0.9776101	-0.0457095	-0.0270843
Goal congruence	0.9571385	-0.0436784	0.0357015
Pleasantness	0.7811119	0.1077825	0.0866645
Comprehension	0.5383979	0.3559365	-0.0057234
Social Norms	0.4905038	0.3733337	0.0190381
Predictability	-0.1198802	0.7784378	-0.0898834
Familiarity	0.1820440	0.6048153	0.1821497
Expectation	0.1820440	0.5428005	0.0282370
Complexity	-0.0955535	-0.0219592	0.8392279
Expressivity	0.2614558	0.0225413	0.6280607

The Influence of Situational Context in the Experience of Emotions in Music: The Framework for Adaptable Musical Emotions

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Abstract

The link between music and emotion suggests that music carries expressive cues which can convey or evoke emotional experiences in listeners. Research has explored how these responses converge or diverge among individuals, social groups, and cultures. However, results often vary widely between studies, with few compelling explanations for these inconsistencies. This paper proposes that emotional responses to music are adaptable, arising from a continuous conscious and subconscious processing of the broader situational context in interaction with psychophysical, cultural, and personal factors. By integrating theory and evidence from multiple domains, this paper presents the Framework for Adaptable Musical Emotions (FAME), which explains music-evoked emotions through the mechanism of *emotion adaptability* across a spectrum of timescales ranging from evolutionary to momentary. FAME advances beyond models that mainly decode emotional signals from the music by explicitly integrating situational context and emotion adaptability. It offers testable propositions about how context modulates responses across time-scales, helping to explain previously observed variability and guiding future experimental and computational work.

Keywords: emotion, affect, arousal, adaptive processes, situational context

Introduction

Emotions play a central role in music listening and human life in general. In psychology, an emotion is a brief, coordinated response involving subjective feeling, physiological arousal, appraisal, expression, and action tendencies, typically triggered by a specific situation. Musical emotions are understood here as genuine emotional episodes that occur in aesthetic contexts but engage the same core components. They are distinct from moods, which are longer-lasting and object-diffuse. Understanding musical emotions is important not only for music psychology but also because such emotions can influence listeners' well-being and daily functioning (Juslin, 2025). Despite substantial research, how and why music elicits emotions that can differ so widely across contexts and people remains largely unclear.

In recent years, researchers have made significant strides in identifying the factors that shape our emotional responses to music. These factors are commonly categorized into three domains: psychophysical, cultural, and personal factors (Juslin, 2019). A recent synthesis explicitly formalizes these working definitions and their interactions within context (Susino et al. 2025).

Psychophysical factors (often referred to as cues or musical features) are the acoustic, structural, and expressive elements of the music itself that can convey emotional meaning largely independently of cultural or personal context. Certain musical cues are believed to encode similar emotional content across different cultures, suggesting some degree of universality (Argstatter, 2016; Egermann et al., 2015).

Cultural factors encompass the shared social norms, beliefs, and learned associations that shape emotional responses within particular groups. For example, musical preferences and interpretive tendencies differ across cultures, illustrating how cultural context influences the meaning and intensity of emotions evoked by music (Susino & Schubert, 2019, 2020).

Personal factors include the individual's unique characteristics and current state—their physiology, personality, memories, mood, and other idiosyncratic traits—which cause one person's emotional reaction to diverge from another's (Taruffi et al., 2017). Personal factors can lead to widely varying emotional responses to the same music, as when a piece evokes joy in one listener but sadness in another due to their different experiences.

Over the years, numerous theories and frameworks have emerged to explain how these psychophysical, cultural, and personal factors

contribute to musical emotions. For instance, the Cue-Redundancy Model (Balkwill & Thompson, 1999) highlighted that listeners use psychophysical cues (such as tempo or intensity) to infer emotions even in unfamiliar musical traditions, whereas the Stereotype Theory of Emotion in Music (STEM; Susino & Schubert, 2017) emphasized that we come to understand, interpret, and expect certain musical genres and our emotional response to them as learned expectations and stereotypes, especially when our understanding or fandom of the music is low. A more comprehensive account is provided by BRECVEMAC (Juslin & Västfjäll, 2008; Juslin, 2025), which delineates nine distinct mechanisms through which music induces emotion—ranging from automatic brainstem reflexes to evaluative conditioning—thereby spanning both universal psychophysical processes and learned, culture-dependent processes. Notably, BRECVEMAC acknowledged that listener characteristics and situational context can modulate these emotional responses. However, none of these influential models has explicitly modelled the dynamic adaptability of emotional responses across different situations and over time. Recent work centring around the situational function of music in everyday life converges with this emphasis on context and regulation (Eerola et al., 2024).

Main contribution

This paper builds on those foundations and introduces a new theoretical perspective. It proposes that emotional responses to music are not static, but adaptable to context. In the following, it outlines how situational context and emotion adaptability are crucial, yet previously under-specified, components in understanding musical emotion, and then presents the Framework for Adaptable Musical Emotions (FAME) as a unifying model.

Situational context

Beyond psychophysical, cultural, and personal factors, situational context plays a crucial role in shaping emotional responses to music. Situational context refers to the setting and circumstances of a musical experience, including the physical environment, the presence of other people or artifacts, the occasion and social conditions, and the listener's purposes or intentions in that moment. Different settings and listener intentions can dramatically alter the musical experience, influencing how much weight is given to the psychophysical, personal, and cultural factors, as well as how these factors are interpreted. For example, listening to the same piece at a celebratory event versus during solitary mourning can yield very different emotional reactions.

The importance of situational context is widely recognized by music scholars and psychologists alike. Previous research indicates that contextual factors are vital for understanding emotional responses to music (Barrett & Kensinger, 2010; Gabrielsson & Lindström, 2010), and numerous empirical studies have examined how aspects of context (location, activity, presence of others, etc.) influence the emotions listeners report. A comprehensive review of such evidence is provided by Susino et al. (2025). Despite these insights, there has been a lack of a theoretical framework that explicitly predicts *how* situational context interacts with other factors to influence musical emotions. FAME addresses this gap by integrating situational context into a model of emotion adaptability. Placing the situation and listener function at the center of the emotion episode provides a complementary scaffold to FAME's context-first emphasis (Eerola et al., 2024). Similarly, contextualized mapping of affect terms in music shows that interpretations shift with everyday activities and settings (Eerola & Saari, 2025).

Emotion adaptability

Adaptability is a fundamental concept in perception and cognition, referring to the capacity of systems to adjust to changes or perturbations. In sensorimotor domains, for instance, organisms flexibly recalibrate their responses to maintain performance when conditions shift (Petitet et al., 2018). A central premise of FAME is that emotional responses to music are similarly flexible. The term emotion adaptability denotes here the capacity of an emotional response to adjust based on a broad range of relevant factors in a given context. This usage is distinct from "adaptation" in the evolutionary sense, where a trait is shaped over generations for survival value. Instead, here it refers to an individual's dynamic adjustment of emotional reactions and responses in real time or across repeated exposures. Emotion adaptability means that, as the situational context and the listener's internal and external conditions change, the resulting emotion can change as well.

More formally, emotion adaptability refers to the formation of emotional responses that take

into account a comprehensive array of factors in a specific situational context. It is grounded in the understanding that emotions arise from ongoing conscious and subconscious appraisal of one's situation in conjunction with psychophysical, cultural, and personal factors (Barrett & Kensinger, 2010). In other words, music-evoked emotions are shaped by continuous feedback loops between what the music presents, who the listener is, both as an individual and a member of a culture, and the context in which the listening occurs.

Because of this adaptable mechanism, emotional responses to music are not fixed. They can vary across different circumstances and over time. For example, a listener's emotional reaction to a particular song may evolve as they grow older or encounter the song in new contexts. A piece of music that elicited exhilaration in a live performance setting might produce nostalgia or even sadness when heard years later in a different context. Indeed, emotional responses can also exhibit adaptability across cultures, as people draw on culturally specific cues and interpretations over time. In short, emotional responses shift based on changes in any of the contributing factors, allowing the emotional response to adapt to the particular context of a musical experience at any given moment. This dynamic nature of emotional experience helps explain why the same musical stimulus can induce different emotions in different people, or in the same person at different times.

Beyond acoustic cues and learned associations, higher-level goals (e.g., regulation), personal meaning, and knowledge shape perceived expression more than they guarantee a specific felt state, aligning with adaptability (Susino, 2023). These considerations introduce additional variability into how individuals feel and respond to music. Musical emotions thus follow the principle of adaptability: they unfold and change as new information and context become available to the listener (Cespedes-Guevara & Eerola, 2018).

A Framework for Adaptable Musical Emotions

Bringing together the above mentioned ideas of context and adaptability, the present paper proposes the Framework for Adaptable Musical Emotions (FAME) as a comprehensive model of emotional responses to music. FAME explicitly integrates situational context with the traditional psychophysical, cultural, and personal factors, organizing these influences according to their relative adaptability across different time scales. The framework conceptualizes a spectrum of emotion adaptability from low to high, corresponding to the degree to which each category of factors can change or be shaped by context.

Levels of adaptability

Psychophysical factors: These factors (e.g., the limits and capabilities of human auditory processing) exhibit the lowest adaptability. Psychophysical constraints, like our innate sensitivity to certain acoustics, tend to produce relatively consistent emotional effects across listeners and cultures. For instance, very sudden loud noises will startle most people, and a consonant harmony might sound pleasant broadly. However, even these basic responses are not entirely rigid; context can influence their interpretation. For example, a loud distorted solo guitar might be exhilarating in the context of a rock concert but jarring during a quiet meditation session. In general, though, psychophysical factors yield the most constrained and often cross-culturally similar emotional responses (Argstatter, 2016; Egermann et al., 2015).

Cultural factors: Cultural learning and norms have a higher adaptability compared to psychophysical factors. Culture is dynamic and continuously constructed by individuals, so its influence on musical emotions can change as culture itself evolves. Through enculturation, listeners develop expectations and associations (e.g., understanding that a slow minor-key piece might signify sadness in Western cultures). Yet these responses can adapt: for example, a Western listener might typically find a funeral march sorrowful due to cultural convention, but could also feel a sense of comfort or nostalgia if that piece is tied to personal or community memories (Schubert & Susino, 2021). Thus, cultural factors shape emotional responses in powerful but malleable ways, and people can even learn to appreciate music from other cultures by adapting to unfamiliar cues over time.

Personal factors: An individual's personal state and traits show the highest degree of adaptability in emotional responses. Personal factors include transient conditions like mood and longer-term aspects like personality or past experiences. These can lead to significant variations in response to the same music from person to person, or for the same person at different times. One listener may be moved to tears by a song that reminds them

of a loved one, while another remains unaffected without that personal association. Likewise, a piece might thrill a listener in an energetic mood but leave them cold when they are fatigued. Such idiosyncratic influences mean that personal factors often drive the unique emotional experiences that differ most widely among listeners (Taruffi et al., 2017).

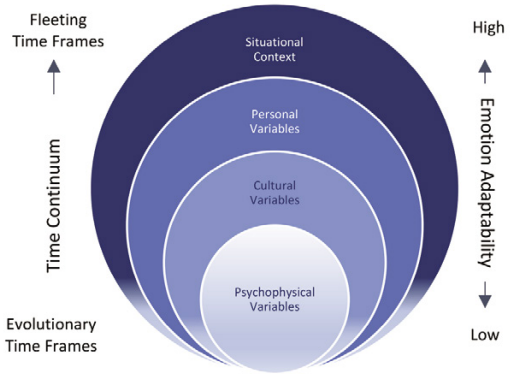

Figure 1. The Framework for Adaptable Musical Emotions (FAME) Reproduced with permission from Susino, M., Thompson, W. F., Schubert, E., & Broughton, M. (2025). Emotional responses to music: The essential inclusion of emotion adaptability and situational context. *Empirical Studies of the Arts, 43*(1), 451–483. https://doi.org/10.1177/02762374241237683.

Situational context: The situational context can modulate all of the above factors' contributions, effectively acting as a lens that magnifies or diminishes certain emotional cues. Context itself comprises many variables (physical setting, social setting, purpose of listening, etc.), that can dramatically change the emotional response to music listening. A striking example is the famous case of violinist Joshua Bell performing incognito as a street busker in a subway station. Most of the people passing by, caught in the informal commuter context, paid little attention and felt no strong emotion, at least strong enough to stop or applaud. In contrast, the very same performance in a formal concert hall context captivated the audience and evoked profound emotional responses (Weingarten, 2007). This example underscores how context can amplify emotional engagement, or dampen even the most potentially moving music. Therefore, situational context factors critically determine which psychophysical, cultural, or personal factors come to the forefront of emotional responses to music.

At the core of the Framework for Adaptable Musical Emotions (FAME) is the concept of a spectrum of emotion adaptability, illustrated in Figure 1 as expanding concentric circles. This representation conveys the increasing levels of emotion adaptability in music, ranging from low to high. Recent theory likewise centres situational function in musical-emotion episodes, offering a complementary structure to FAME's context-first emphasis (Eerola et al., 2024).

Temporal continuum

FAME spans a continuum from slow-changing (evolutionary predispositions and durable cultural conventions) to rapidly changing influences (momentary context and state). Responses dominated by slow-changing influences show lower adaptability, while responses shaped by momentary context show higher adaptability. Emotional responses shaped mostly by influences that have been stable over evolutionary or long cultural time frames (such as reflexive responses to dissonance or loud sounds) will tend to have low adaptability, meaning that they are more uniform and less affected by situational context. By contrast, emotional responses formed over shorter time frames (such as a mood induced by earlier events in the day, or the situational context of a given listening session) demonstrate high adaptability and can vary considerably.

For example, a basic startle reflex to a sudden sound is rooted in our psychophysical and evolutionary heritage and is usually automatic. However, even this can be modulated by context and personal adaptation. Levenson et al. (2012) showed that a Buddhist monk experienced a much smaller startle response to a loud noise during a meditative state than when he was not meditating. The meditation context, combined with long-term practice, allowed the individual to adapt his physiological emotional response, reducing the influence of the acoustic stimulus. This illustrates that what might be considered a "hardwired" response can be altered through situational context over time. Such modulation is consistent with constructionist accounts that treat emotion categories as populations varying with context. In general, as listeners gain experience or encounter music in new contexts, their emotional responses may shift from being driven purely by low-level acoustic features toward being shaped more by higher-level learned associations and context.

Overall, FAME integrates psychophysical, cultural, and personal factors together with

situational context to provide a more complete understanding of how musical emotions arise and change. This perspective aligns with modern constructionist views of emotion, which emphasize the continuous interaction between stimuli, the individual's knowledge, and contextual information in generating emotional experiences (Cespedes-Guevara & Eerola, 2018). In creative practice, intended expressive cues are often designed to shape perceived expression rather than to induce a specific felt emotion, which is consistent with adaptability (Susino, 2023). It is also supported by evidence that there are no invariant physiological "fingerprints" for specific emotions across all contexts. Instead, emotion responses vary, reflecting adaptation to situational context (Siegel et al., 2018). Contemporary mapping of the vocabulary of emotions that music is perceived to express also shows robust effects of everyday activities and use-contexts on interpretation. (Eerola & Saari, 2025.) By framing emotions as inherently adaptable to situational context, FAME helps explain the dynamic and often unpredictable nature of music-evoked emotions.

Conclusion

In summary, the Framework for Adaptable Musical Emotions offers a new way to understand how and why music induces emotions, as well as similar and differing emotional responses from individuals to groups, and even culture bound collectives, by highlighting the crucial role of situational context and the adaptable nature of emotional processing. The key propositions of FAME can be stated as follows:

1. **Situational context is a critical determinant of musical emotion.** Emotional responses to music are systematically influenced by the situation and context in which listening occurs. By evaluating contextual factors (physical setting, social setting, listener goals, etc.) in a structured way, we can better understand their effects on the listener's experience.
2. **Musical emotions are highly adaptable and context-dependent.** Rather than being fixed responses or fitting neatly into "universal" vs. "culture-specific" categories, emotional responses to music result from an interplay of psychophysical, cultural, personal, and situational context influences. There are no strictly invariant emotional responses to a given piece of music; instead, responses continuously adjust to the listener's traits and the situational context, blurring any clear boundaries between those factors.
3. **Focusing on adaptability and situational context opens new research directions.** Incorporating emotion adaptability and situational context into the study of music and emotion encourages innovative paradigms to examine how people respond emotionally under varying conditions. This includes experimental designs that manipulate context or require listeners to adapt (adaptation paradigms), as well as computational modelling approaches (e.g., complex systems modelling) that can capture the dynamic interactions between listener, music, and environment.

By building on previous theories of music and emotion, while explicitly modeling context and adaptability, FAME provides a more nuanced understanding of listeners' emotional processes. This perspective is echoed in a recent study (Susino, 2023), which suggested that composers and choreographers embed flexible expressive cues shaped by genre conventions and cultural factors to guide audience interpretations across diverse listening and viewing contexts. These cues increase the likelihood that certain affective meanings are inferred but do not ensure specific emotions, aligning with FAME's premise that responses remain variable and context-dependent. Framed this way, creators' strategies function as probabilistic scaffolds that shift the distribution of likely responses without fixing a single outcome, converging with context-centred models such as the Episode Model and with multi-level accounts of emotion causation (Eerola et al., 2024; Juslin, 2025). It accounts for a wide array of variables that shape musical experience, organized by their differing degrees of adaptability over time. This approach allows for better predictions of emotional outcomes, helping to explain why the same music might evoke consistent reactions in some situations and divergent reactions in others. In moving beyond classifying emotional responses as simply "universal" or "cultural," FAME suggests that all musical emotions are, to some extent, adaptable responses. Recognizing this adaptability is vital for advancing research in music cognition and emotion.

The framework also has practical implications. As our understanding of how situational factors influence musical emotions grows, it can inform real-world applications in domains such as music therapy, education, and technology. Designing

interventions with explicit attention to participants' immediate context and goals aligns with evidence from group arts interventions showing context-sensitive benefits (Watt et al., 2024). For instance, music interventions for improving mood or well-being can be tailored to consider the listener's situational context and momentary capacity for emotional adaptability. Overall, by uncovering the ways situational context and adaptability shape emotional experiences with music, we gain deeper insight into the psychological mechanisms linking music and emotion, knowledge that can ultimately help us harness music more effectively for positive human outcomes (Juslin, 2025).

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Music Makes My Soul Happy: Relationship Between Music-Related Mood Regulation Strategies and Subjective Happiness in Emerging Adulthood

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Abstract

Emerging adulthood is a life stage characterized by numerous demands and challenges that impact emotions and subjective happiness. In this context, music plays a significant role in mood regulation, engaging individuals in various strategies. This study examines the relationship between music-related mood regulation strategies and subjective happiness in emerging adulthood. The sample included 507 participants (61.3% female, M = 22.8 years, SD = 2.9), recruited via the Internet. The Music in Mood Regulation scale was used to assess seven strategies for mood regulation (Entertainment, Revival, Diversion, Solace, Discharge, Mental work, Strong sensation), while the Subjective Happiness Scale measured subjective happiness. Results revealed a weak negative correlation between overall mood regulation by music and subjective happiness (r = -.32, p < .001), primarily driven by the Discharge strategy (r = -.24, p < .001). Although Discharge strategy, which involves venting negative emotions through music, may provide short-term relief, the reactive nature of this strategy potentially reflects unresolved emotional difficulties, which raises concerns regarding its long-term adaptiveness. In contrast, other music-based regulation strategies showed no significant associations with happiness, possibly due to their temporary emotional effects or because they are predominantly employed during periods of heightened distress. These findings highlight functional differences among music-based regulation strategies and suggest that not all contribute equally to well-being during emerging adulthood.

Keywords: mood regulation, emotions, music, subjective happiness, emerging adulthood

Introduction

The period of emerging adulthood

The concept of *emerging adulthood* was first introduced by Arnett as a period spanning "from the late teens through the mid-to-late 20s (roughly ages 18–25)" or "from the late teens through the twenties" (Arnett, 2000). As the theory developed after the initial presentation of the term and its definition of age (Arnett, 2004), it became clearer that the boundaries of this period are fluid. Rather than being strictly defined by age, it is the characteristics of the period—such as prolonged time in education, delayed marriage, and later parenthood—that define it (Arnett, 2007). However, for the purposes of research, the emerging adulthood stage is most commonly defined as spanning ages 18–29 years (Arnett et al., 2014; Arnett, 2018). Arnett describes this transitional phase, characterized by numerous demands and challenges, as encompassing five key characteristics: identity exploration, instability, self-focus, feeling "in-between" and a sense of limitless possibilities. Individuals continue exploring their identities from adolescence onward, navigating various aspects of self-discovery (e.g., further exploration of values, choosing a career). This period is also marked by instability in different areas of life, such as relationships, living arrangements, and employment, often creating emotional turbulence and a heightened sense of uncertainty. Individuals in this phase tend to be self-focused, prioritizing personal growth, education and career planning. Emerging adults often feel "in-between", as though they are neither fully adolescents nor entirely adults, leading to a sense of ambiguity in their social roles and responsibilities. Furthermore, this stage offers numerous possibilities that, while promising, often provoke anxiety about life decisions, underscoring the need for effective emotion regulation to navigate societal pressures and future responsibilities (Arnett, 2000, 2004, 2007, 2018; Arnett et al., 2014).

Emotion regulation and well-being

Emotion regulation is widely recognized as a fundamental component of positive psychological well-being, both in clinical contexts and in empirical research. In contrast, poor or dysfunctional

emotion regulation has been associated with negative outcomes (Nyklíček et al., 2011). A review of research on the promotive and protective effects of emotion regulation in children and adolescents found strong evidence connecting these skills to positive psychological and behavioural outcomes. Specifically, adaptive emotion regulation was associated with reduced internalizing and externalizing difficulties, as well as improved mental health indicators, such as lower levels of depression and anxiety (Daniel et al., 2020). Expanding on these findings, a more recent systematic review emphasizes the pivotal role of emotion regulation in adolescent well-being (Serey et al., 2025). It shows that adaptive strategies, such as cognitive reappraisal and acceptance, are strongly associated with greater life satisfaction, positive emotions, happiness, and higher self-esteem. This is further supported by Verzeletti et al. (2016), who found that adolescents who frequently engage in cognitive reappraisal report better well-being across multiple domains. In addition, adaptive emotion regulation strategies serve as protective factors against depression, anxiety, and emotional distress (Serey et al., 2025). Conversely, maladaptive strategies, such as rumination and suppression, are associated with lower well-being and more psychological difficulties, including poorer psychological health, emotional loneliness, and increased negative emotions (Verzeletti et al., 2016). Longitudinal evidence from the review suggests that emotion regulation not only fosters adolescent well-being but also contributes to sustained mental health into emerging adulthood (Serey et al., 2025).

These patterns remain consistent into adulthood, where studies show similar associations between emotion regulation and well-being. Adaptive cognitive emotion regulation strategies, such as reappraisal and refocusing on planning, are associated with better subjective and psychological well-being, while rumination, catastrophizing, and self-blame are linked to poorer well-being, indicating that different cognitive emotion regulation strategies have different impacts on individuals' well-being (Balzarotti et al., 2016).

Subjective happiness represents one important aspect of psychological well-being and is often used as an indicator of overall emotional functioning. It is defined as a global assessment of one's overall happiness, incorporating absolute self-perceptions, relative comparisons to peers, and alignment with the characteristics of happy individuals (Lyubomirsky & Lepper, 1999). Research shows that individuals with higher subjective happiness tend to perceive and interpret both positive and negative life events in more favourable and adaptive ways, such as finding humour in adversity or focusing on recent improvements in their circumstances, demonstrating a strong connection to adaptive emotional functioning (Lyubomirsky & Tucker, 1998). In line with this, in studies that examined subjective happiness as an indicator of well-being, greater use of cognitive reappraisal was associated with higher levels of subjective happiness, whereas increased use of emotional suppression was linked to lower levels of happiness (Cunha et al., 2022).

Emotion regulation in emerging adulthood: Can music help?

Previously mentioned challenges in emerging adulthood highlight the important role of emotion regulation during this period. The ability to manage emotions effectively can help individuals navigate the uncertainties and demands characteristic of this transitional phase while significantly influencing their future development. This period may even be considered one of the key stages for emotion regulation, not only as a necessary skill for the present moment due to numerous emotional changes and challenges (Brewer et al., 2016), but also as a foundational skill for future adult life. Research shows that emerging adults exhibit high dysregulation of anger, suppression of fear and passivity or avoidance when feeling sad, similar to adolescents (Zimmerman & Iwanski, 2014). However, in comparison to adolescents, they seek more social support and use more adaptive emotion regulation strategies, which creates fertile ground for the continued improvement of regulatory mechanisms in later adulthood (Zimmerman & Iwanski, 2014). Therefore, understanding how emotion regulation strategies function during this critical transitional period can provide valuable insights into fostering emotional stability and overall well-being in later life, as well as supporting the future development of emerging adults. Although previous studies have examined the role of general emotion regulation strategies in relation to well-being, little is known about how music-specific emotion regulation strategies relate to subjective happiness in emerging adults.

Given the significance of emotion regulation during this phase, music emerges as a versatile tool for managing and processing emotions across various contexts, such as coping with stress or enhancing positive mood, one of its

most important functions (Schäfer et al., 2013). The literature describes strategies that differ in emotions they regulate and the way they engage people in contact with music (Saarikallio & Erkkilä, 2007). Some strategies involve simply creating a musical background atmosphere, with the aim of maintaining or enhancing already existing positive emotions (*Entertainment*). Apart from those, there are other strategies designed to promote relaxation and restore energy when one feels tired or stressed (*Revival*), as well as the ones that help listeners forget unpleasant or other troubling emotions by shifting their focus to music (*Diversion*). Similarly, some strategies allow listeners to feel as though the music understands and accepts them, offering comfort when they are sad or distressed (*Solace*) (Saarikallio & Erkkilä, 2007). In contrast, there are strategies that require listeners to be more active: for instance, to release accumulated anger or sadness, one might choose music that directly expresses these emotions, aiming for an emotional release (*Discharge*). Alternatively, music can be used to spark introspection and reflection on the listeners' personal concerns (*Mental work*). Finally, there are times when listeners simply want to experience music intensely, engaging their whole bodies and senses, for example, by feeling chills (*Strong sensation*) (Saarikallio & Erkkilä, 2007).

While general emotion regulation strategies have been widely studied in relation to well-being (e.g., Balzarotti et al., 2016; Daniel et al., 2020; Nyklíček et al., 2011; Serey et al., 2025; Verzeletti et al., 2016; Zimmerman & Iwanski, 2014), research focusing specifically on music-related mood regulation strategies remains limited. To the best of our knowledge, no studies have directly examined the relationship between these music-based strategies and subjective happiness during emerging adulthood. Given that emerging adults spend considerable time listening to music, which serves various emotional and psychological functions during this transitional period (Coyne et al., 2016), the key exploratory question guiding this study is: how are music-related mood regulation strategies associated with subjective happiness in emerging adults?

Although the research question is exploratory in nature, expectations regarding the direction of associations are grounded in prior findings on emotion regulation and well-being. Accordingly, it is anticipated that certain music-related mood regulation strategies may function as adaptive or maladaptive, depending on their association with subjective happiness. For instance, strategies such as Entertainment, Solace, Strong sensation, or Revival may be expected to positively relate to subjective happiness, given their focus on enhancing or restoring positive emotional states. In contrast, strategies such as Discharge, Mental work, or Diversion, which may involve confronting, excessively analysing or avoiding negative emotions, could have more complex or mixed associations. However, given the complexity and contextual sensitivity of music listening, along with the exploratory aim of the study, expectations regarding associations were kept tentative rather than being formalized into specific a priori hypotheses.

Table 1. Descriptive statistics and internal consistency coefficients for MMR and SHS (N = 507)

	M	*SD*	Range	*Sk*	*Ku*	*α*
Entertainment	4.43	0.68	1.00–5.00	-1.81	4.03	.71
Revival	4.08	0.75	1.43–5.00	-0.86	0.21	.84
Strong Sensation	4.18	0.72	1.43–5.00	-1.09	1.00	.83
Diversion	3.46	0.90	1.00–5.00	-0.39	-0.43	.80
Discharge	2.73	1.09	1.00–5.00	0.29	-0.88	.86
Mental Work	3.74	0.87	1.20–5.00	-0.54	-0.28	.80
Solace	3.59	0.92	1.00–5.00	-0.44	-0.42	.85
MMR total	3.74	0.63	1.58–4.93	-0.61	0.06	.94
SHS total	4.65	1.42	1.00–7.00	-0.37	-0.49	.87

Note. M = Mean; *SD* = Standard Deviation; *Sk* = Skewness; *Ku* = Kurtosis; *α* = Cronbach's alpha.
MMR = Music in Mood Regulation scale; SHS = Subjective Happiness Scale.

Method

Participants

The study used convenience sampling and included 507 emerging adults from Serbia, aged 18 to 30 years. The literature emphasizes that the boundaries of emerging adulthood are not strictly age-defined, but rather fluid and context-dependent (Arnett, 2004, 2007, 2018; Arnett et al., 2014). Therefore, participants aged 30 were also included to allow for an additional year of variability beyond the commonly used upper age limit of 29. The average age of the participants was 22.8 (*SD* = 2.8). Half of the sample consisted of participants aged 18 to 22 years, while the other half included participants aged 23 to 30 years. Females made up 61.3% of the sample, males 38.1%, and 0.6% of the participants chose not to specify their gender.

Procedure

Data were collected online using Google Forms, chosen for its accessibility across multiple devices (e.g., smartphones, laptops, tablets) and its broad distribution capabilities. Participants were recruited using a snowball sampling method, where the survey link was shared via digital communication channels, including social media platforms (e.g., Facebook) and messaging apps (e.g., WhatsApp). On the Google Forms platform, participants were provided with an informed consent form, which they reviewed before proceeding. Completing the questionnaire took approximately 10 minutes.

Instruments

This study utilized two instruments. The first was the *Music in Mood Regulation scale* (MMR; Saarikallio, 2008), a self-assessment scale consisting of 40 items related to seven previously mentioned strategies for mood regulation through music (Entertainment, Revival, Diversion, Solace, Discharge, Mental work, Strong sensation). Participants responded on a five-point Likert scale ranging from "strongly disagree" to "strongly agree" (e.g., "For me, music is a way to forget about my worries"; "When I'm really angry, I feel like listening to some angry music"). The MMR demonstrated excellent reliability for the overall instrument (α = .94) and good reliability for its subscales (α = .71 to .86).

The second instrument used was the *Subjective Happiness Scale* (SHS; Lyubomirsky & Lepper, 1999), one of the most widely used instruments for assessing global subjective well-being, consisting of four items, that participants rated using a seven-point Likert scale. It assesses the individuals' general perception of their happiness, their perceived happiness compared to peers, and how well they align with descriptions of generally happy or less happy people. The SHS demonstrated adequate reliability in this study (α = .87), similar to a study examining the psychometric properties of the Serbian adaptation of SHS in a sample of Serbian young adults (Jovanović, 2013).

Results

Descriptive statistics

The aim of this study was to examine how music-related mood regulation strategies are associated with subjective happiness in emerging adults. Table 1 presents descriptive statistics and internal consistency coefficients for the MMR and the SHS scale among emerging adults. The total MMR score was moderate, indicating a generally balanced use of music for various emotion regulation purposes. However, when interpreting the total score, it is essential to consider that individual strategies may vary in their adaptive functions and psychological implications. For instance, Discharge may serve a different regulatory purpose compared to strategies like Entertainment or Mental work (Saarikallio, 2008). Among the seven MMR subscales, Entertainment had the highest mean score, indicating that listening to music for enjoyment and fun was the most commonly utilized mood regulation strategy in this sample. This was followed by Revival and Strong sensation, both reflecting the use of music to energize oneself or to experience strong emotional responses. Solace and Mental work had moderate mean values, suggesting that participants frequently used music to reflect on emotional experiences or find comfort. The subscale with the lowest average score was Discharge, which refers to venting negative emotions such as anger or sadness through music. Similarly, Diversion, indicating the use of music to distract from negative thoughts, was somewhat less preferred compared to other strategies. Regarding subjective happiness, the SHS total score indicated a moderately high level of subjective happiness in this sample.

In terms of distribution characteristics, skewness and kurtosis values for most variables were within acceptable ranges, defined as absolute skewness values less than 2 and kurtosis values less than 3, suggesting no severe deviations from normality. However, the Entertainment subscale showed relatively high negative skewness and leptokurtic

kurtosis, indicating a distribution heavily skewed toward higher ratings and a peaked distribution, reflecting that many participants rated this strategy toward the upper end of the scale.

Correlational analyses

To examine the relationship between mood regulation strategies through music listening and subjective happiness, the correlation between the total MMR score and each individual strategy with the subjective feeling of happiness was calculated. Although the MMR scale comprises seven subscales reflecting distinct strategies for using music in emotion regulation, previous research (Saarikallio, 2007) has shown that the scale has strong internal consistency and can be meaningfully interpreted both at the level of individual subscales and as a total score. The total MMR score reflects a higher-order factor representing general engagement in music-based mood regulation. In the present study, it was used to capture participants' general tendency to rely on music as a mood-regulating resource in daily life. The correlation analysis (Table 2) revealed a significant weak negative correlation between the total MMR score and subjective happiness. A closer inspection of the correlations with specific strategies indicated that this association was driven solely by the weak negative correlation between the Discharge strategy and happiness.

Table 2. Correlations between subjective happiness and music mood regulation strategies

	Subjective happiness
Entertainment	.09
Revival	.09
Strong Sensation	-.02
Diversion	.07
Discharge	-.24**
Mental Work	-.04
Solace	-.06
MMR total	-.32**

Note. $^{**}p < .01$ (2-tailed).

Discussion

The Discharge strategy: cathartic expression and its complex relationship with subjective happiness

The results of this study revealed a significant but weak negative correlation between the overall tendency to regulate mood through music and subjective happiness, with Discharge being the only one of the seven individual strategies to show a significant negative correlation with happiness. These findings raise important questions regarding the nature of the Discharge strategy and its role in mood regulation among emerging adults.

First, the Discharge strategy, which relies on releasing accumulated negative emotions through music (e.g., venting anger through aggressive music), may indicate a focus on negative affect. Emerging adulthood, as conceptualized by Arnett's (2004) model, often involves emotional instability and uncertainty. In this context, music may serve as a medium for expressing frustration, sadness, or anger. However, as Zimmerman and Iwanski (2014) noted, strategies that do not promote adaptive emotion regulation patterns may be less effective in achieving long-term well-being. In line with this, it can be assumed that such a pattern of releasing difficult emotions through music could reduce overall subjective happiness. Future research should explore whether this strategy, regardless of this, allows individuals to shift their attention toward more positive feelings.

Second, while the Discharge strategy may provide temporary, short-term emotional relief, it may lack the long-term benefits needed for both achieving and sustaining subjective happiness. Proactive strategies, such as enhancing positive emotions (e.g., Entertainment) or promoting emotional renewal through music (e.g., Revival), appear to offer deeper and more enduring benefits. In contrast, emotional Discharge is often more reactive than proactive in its approach to mood regulation, which may explain its association with lower levels of subjective happiness. Although no positive correlations between more proactive strategies and happiness were obtained, likely due to the cross-sectional nature of the study, it is possible that certain proactive strategies of mood regulation (with or without music) may contribute to subjective happiness over the long term. However, this remains to be explored in future research.

Third, the use of the Discharge strategy may indirectly reflect the presence of unresolved emotional challenges experienced by a person. Emerging adults who heavily rely on Discharge may be navigating emotionally intense periods, using music as a form of emotional expression. However, the lower levels of subjective happiness may suggest that the underlying issues, despite the use of Discharge, probably remain unresolved. This finding reveals the need for further exploration of

how music choices, emotion regulation strategies, and contextual factors collectively influence happiness.

Beyond immediate relief: non-significant associations of other strategies with subjective happiness

Following the discussion of the unique role of the Discharge strategy, it is equally important to reflect on the lack of significant associations between the remaining music-based mood regulation strategies and subjective happiness, as this may reveal important variations in how individuals engage with music for emotion regulation and its potential implications for long-term well-being.

Three of the strategies—Entertainment, Revival, and Strong sensation—can be described as primarily hedonistic, aiming to induce or maintain a pleasurable mood. Entertainment involves enhancing mood through enjoyment, Revival is focused on restoring energy during moments of emotional fatigue, and Strong sensation refers to seeking intense emotional or physiological reactions (e.g., chills) while listening to music (Saarikallio, 2007). The absence of significant correlations between these strategies and subjective happiness may reflect their temporary nature. That is, while they may boost positive mood in the short term, their effects might not extend to sustained well-being. Furthermore, individual differences and the limits of a cross-sectional design may have hidden more complex, long-term effects that future longitudinal and qualitative studies may be better suited to reveal.

Two other strategies—Mental work and Solace—are more introspective and oriented toward self-reflection and emotional processing. Mental work involves using music to think through emotional experiences, while Solace refers to using music for emotional comfort and validation (Saarikallio, 2007). Although these strategies are often considered adaptive, they showed no significant relationship with subjective happiness in this study. One possible explanation is that individuals who rely on them may already be experiencing emotional distress, particularly during vulnerable life periods, such as emerging adulthood. In this sense, the use of these strategies may reflect a current need for support rather than a general state of low well-being. Additionally, as noted by Saarikallio and Erkkilä (2007), these strategies may foster emotional insight and personal growth over time, a process that is unlikely to be captured in a single time-point assessment of subjective happiness.

The Diversion strategy, using music to distract oneself from negative thoughts or feelings (Saarikallio, 2007), also showed no significant correlation with subjective happiness. While this approach may provide temporary relief in acutely stressful situations, as is the case with the Discharge strategy, excessive reliance on it may signal or reinforce avoidant coping mechanisms that could be maladaptive in the long term. Similar to the other non-significant correlations, the context of use, individual coping styles, and the temporal trajectory of emotion regulation outcomes may all play important roles, highlighting the importance of future research using longitudinal or mixed-method approaches.

Compared to the six previously discussed strategies, Discharge can be conceptualized as a more cathartic and expressive form of mood regulation, aimed at releasing intense negative emotions rather than enhancing or reflecting on emotional states. This functional distinction may help explain why Discharge was the only strategy significantly correlated with subjective happiness. The other strategies, generally thought to produce short-term effects, primarily aim to enhance positive emotional states. In contrast, Discharge focuses on the release of negative affect, highlighting an important difference in emotional valence. Notably, Discharge also exhibited the highest standard deviation among all strategies, suggesting greater variability in its use among participants. Such variability may have enhanced the statistical power to detect a significant statistical relationship. In contrast, the lower variability observed in other strategies could have reduced the statistical power needed to identify potential associations with subjective happiness. These findings underscore the importance of considering both the functional characteristics and variability of individual strategies when interpreting their psychological implications.

Limitations

It is important to acknowledge the correlational nature of this study, which limits the ability to draw causal conclusions between subjective happiness and the frequency of Discharge use. It remains unclear whether lower levels of subjective happiness lead to greater reliance on the Discharge strategy or vice versa. The correlations observed were relatively weak, which underscores the

importance of interpreting these findings with caution. Nonetheless, even small effects may hold meaningful implications in the context of emotion regulation research. Future studies employing longitudinal designs could provide greater clarity on the directionality and causality of these relationships.

Conclusion

In the challenging world of emerging adulthood, it is essential to encourage more conscious, balanced, and adaptive music-based mood regulation strategies that not only facilitate the release of negative emotions but also foster positive feelings and long-term well-being. Music can serve as a powerful emotion regulation tool, but it requires appropriate guidance. Future research should explore the hypothesis that Discharge may be a potentially maladaptive strategy, or at least be maladaptive under certain conditions. For instance, there is a need for a deeper understanding of the specific mechanisms through which strategies such as Discharge affect emotional functioning. Additionally, research examining the long-term effects of different music-based mood regulation strategies could offer crucial insights for designing preventive and educational programs aimed at promoting emotional well-being among emerging adults.

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Embodiment, Emotion and Social Bonding on the Dancefloor: Initial Findings from a Replica Club Study

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Abstract

Participating in electronic dance music (EDM) events fosters feelings of community and connectedness and is associated with strong emotional experiences (Cannon & Greasley, 2021). With syncopated rhythms promoting entrainment to the beat, EDM enables interpersonal synchrony, which enhances social bonding (Tarr et al., 2016). On the dancefloor, rhythmic entrainment may create a sense of continuous, embodied pleasure that is conveyed to others via dance movement, resulting in collective emotional experiences (Witek, 2017). Despite evidence of these processes in research on subjective accounts of EDM participation, the interrelations between emotional and interpersonal synchrony and their contributions to social bonding in an EDM context are yet to be systematically examined. This preliminary study trialled a quantitative methodological approach to assess how EDM events facilitate social connectedness through shared movement and emotional experiences on a real-world dancefloor. A small group of participants ($N = 5$) danced to a DJ mix in a replica club environment while accelerometers measured their movement. Social bonding was assessed before and after the event, and emotional experiences (emotional contagion, *kama muta*, perceived emotional synchrony and embodied pleasure) were measured post-event. Preliminary results reveal increased social bonding scores following group dance to EDM, and evidence of embodied pleasure, emotional contagion and rhythmic entrainment on the dancefloor, shown by Fourier analysis of accelerometer data. Findings are discussed in relation to implications for follow-up research.

Keywords: entrainment, synchrony, social bonding, emotion, electronic dance music

Introduction

Electronic dance music (EDM) is designed for the dancefloor. It is characterised by inherent rhythmic properties, such as the repetitive drum pattern and high pulse clarity, which promote movement (Burger & Toiviainen, 2020; Zeiner-Henriksen, 2010). It is a prime example of 'groovy' music, facilitating entrainment through optimum levels of rhythmic syncopation (Witek et al., 2014). This, in turn, leads to interpersonal synchronisation amongst a group of dancers and has been observed in studies in which movement is measured amongst participants on real-world dancefloors (Ellamil et al., 2016; Solberg & Jensenius, 2017). Interpersonal synchrony is positively related to social bonding across many experimental studies both in musical and non-music contexts (e.g. Bamford et al., 2023; Hove & Risen, 2009; Stupacher et al., 2017; Tarr et al., 2016; Wiltermuth & Heath, 2009). In the context of research on subjective experiences of EDM event participation, which reveals associations between participation at EDM events and social connection (e.g. Cannon & Greasley, 2021; Kavanaugh & Anderson, 2008; Little et al., 2018; Riley et al., 2010; Takahasi & Olaveson, 2003), this leads one to consider how embodied processes (i.e. entrainment and interpersonal synchronisation) on the dancefloor may underpin these lived experiences. Moreover, cross-disciplinary literature on EDM culture situates EDM events as a source of collective effervescence (e.g. Garcia, 2020; Liebst, 2019; Olaveson, 2004) a profound feeling of unity and shared positive energy that may arise in communal activities (Durkheim, 1912). Garcia (2020) posits that collective effervescence may underpin notions of the 'vibe'; a colloquialism commonly used amongst participators in EDM culture that is iterated in subjective accounts of participation. The 'vibe' may be seen as a communal, positive energy that characterises an EDM event (Rill, 2006; Sommer, 2001; St John, 2008), and frequently accompanies accounts of profound embodied and emotional connection with the music (e.g. Fikentscher, 2000). Indeed, it may be the sustaining of the 'vibe' that creates a sense of connectedness and community between participants (St John, 2008). As such, it may be theorised that 'the vibe'

and associated feelings of social connection may be related to participants' collective embodiment of EDM. Embodying the music via entrainment facilitated by the syncopated beat of EDM is an inherently pleasurable process. Witek (2017) suggests that syncopation underpins the structural intricacy of groove, creating rhythmic spaces that encourage the body to engage through entrainment. As the body fills these temporal gaps, the drive to complete the groove enhances the pleasure of participation and reinforces dance movement. This participatory pleasure may be expressed outwardly on the dancefloor through movement, which is then observed by other participators, and, as such, dance may be considered a mediator for embodied emotional expression (White & Egermann, 2021). Where the musical processes of EDM may serve to facilitate synchronous movement, it may be the recognition of moving in synchrony with others, and the emotional contagion experienced through the observation of pleasurable dance that, in turn, evokes powerful emotional responses within a group setting. Furthermore, the recognition of synchrony may also lead to feelings of *kama muta* (or 'moved by love'), a profound emotional state characterised by a sense of unity and sometimes accompanied by chills or tears (Fiske et al., 2019). A positive association between *kama muta* and social connection has previously been found in research on virtual concert settings (Swarbrick et al., 2021), however this phenomenon has not yet been explored in an EDM context. Overall, existing research suggests that embodied and emotional experiences with music, when shared among participants, may reinforce social bonding amongst a group (see Brown & Fredrickson, 2021; Fiske et al., 2019; Newson et al. 2021; Pizarro et al., 2021). Despite the potential for emotional and interpersonal synchrony to foster connectedness, the extent to which these experiences may be interrelated and contribute to social bonding in an EDM context is yet to be systematically examined. Though previous research has analysed group entrainment and interpersonal synchrony to music in a replica EDM setting (Solberg & Jensenius, 2017), and in a real-world disco event (Ellamil et al., 2016) relationships between emotional experiences, social bonding and movement have not been examined within a naturalistic, real-world EDM context. The current preliminary study builds upon previous research by trialling an experimental paradigm to investigate associations between these factors that may be utilised in an EDM context.

Aims

The overarching aims of the current study were to trial a methodological approach for the measurement of emotion, social bonding and movement on an EDM dancefloor and to test the efficacy of analysis pipelines for the assessment of interpersonal synchrony and entrainment. As such, the study was guided by the following exploratory research questions:

1. Can accelerometers be used to effectively measure the movement of dancers within a club-like environment?
2. Can accelerometer data be analysed effectively to measure both (a) rhythmic entrainment to the music and (b) interpersonal synchrony between a dancer and a group?
3. Do participants report strong emotional experiences following an EDM event as measured through self-reported experiences of *kama muta* and distributed, embodied pleasure?
4. Does self-reported social bonding with a group increase following engagement in an EDM event?
5. Can the degree to which a dancer is (a) rhythmically entrained to the music, and (b) interpersonally synchronised with the rest of the group, be effectively correlated with scores on self-report measures of emotional experience and social bonding?

Method

Participants

Volunteer sampling was used to recruit participants at the University of Leeds who had an interest in EDM, advertising on institutional mailing lists and within research groups. Five participants (two male, three female, aged 25-41) were recruited. Participants were provided with an information sheet and required to complete a consent form prior to scheduling their involvement in the study. The study received full institutional ethical approval (FAHCS ref. 1120).

Materials

Empatica E4 wristbands were used to measure movement using the 3-axis accelerometer function with a 32 Hz sampling rate. The accompanying *E4 Connect* software was used to upload sensor recordings and for initial inspection of data. A pre-event and post-event survey were created for participants to complete before and after the dance session. The pre-event survey included a social

bonding index (SBI) adapted from Tarr et al. (2016), measuring each participant's degree of connectedness, likeability, similarity in personality and closeness with the participant group. The post-event survey included a repeated SBI in addition to a 3-item measure of emotional contagion (ECS) (Garrido & Macritchie, 2018), an 18-item perceived emotional synchrony scale (PESC) (Páez et al, 2018), the 24-item *kama muta* scale (KAMMUS-2) (Zickfeld et al., 2019) and a 7-item 'embodied pleasure' scale (EPS), a novel scale designed for this study to measure the degree to which participants experienced pleasure associated with musical embodiment for the duration of the event (cf. Garcia, 2005; Witek, 2017). Data on participants' preference for the music, their desire to dance, and perceived ecological validity of the replica club set-up was also collected in addition to demographic information. All scale items were measured on 5-point or 7-point Likert scales.

Figure 1. Participants on the dancefloor during the study.

Procedure

Participants completed the study in a performance studio at the university, adapted to mimic a club-environment. Inspired by a similar setup used by Solberg and Jensenius (2016), this featured a dancefloor space, dynamic lighting sequence, and multi-channel surround sound speaker system. Figure 1, below, shows the venue setup during the dance session. Participants first completed the pre-event survey before being fitted with *Empatica E*4 wristbands. Participants then danced to a pre-recorded DJ mix for approximately 30 minutes. During this time, the main lighting was dimmed to create a dark, club-like environment and a dynamic lighting sequence was activated. Participants then completed the post-event survey to finish the study. Surveys were completed on participants' mobile devices on *Qualtrics* via a QR code. Anonymous participant ID codes were created to link survey responses to the wristband serial numbers assigned to each participant. All *Empatica E4* wristbands were synced with the internal clock of the researcher's laptop immediately prior to data collection. During the dance session, the laptop was set up to simultaneously screen record the ongoing timestamp of the DJ mix alongside the internal clock time, to use for later alignment of datasets.

Results

Accelerometer data pre-processing

Initial inspection of accelerometer data on *E4 Connect* showed all wristbands effectively recorded participants' movement for the duration of the dance session. Accelerometer data for each participant were then exported to Excel. As accelerometer recordings differed in duration between participants, all participants' acceleration datasets were truncated equally to represent an equivalent time-window that captured the beginning and end of the DJ mix. This was achieved by using using the UTC timestamp (converted from Unix) recorded by participants' wristbands at each timepoint (sample) and aligning it with the corresponding timestamp of the DJ mix. Truncated acceleration datasets were imported to MATLAB. The Euclidean norm (magnitude) was then calculated across each dataset using the formula $\sqrt{x^2 + y^2 + z^2}$ (Förstel et al., 2018). This represents overall acceleration at each timepoint, capturing the intensity of movement across all axes, at the loss of directional information with higher magnitude values (Katevas et al., 2015). Participants' datasets were then filtered using a Butterworth bandpass filter with a lower cutoff of 0.6 Hz and an upper cut-off of 5 Hz, a typical frequency range associated with meaningful human movement (Godfrey et al., 2008; Swarbrick et al., 2022).

Entrainment

Spectral analysis was used to assess the degree to which each participant was rhythmically entrained

to the music for the duration of the DJ mix. A fast Fourier transform (FFT) was applied to each participant's acceleration data, converting it into the frequency domain (Hz). Power spectrums in which the complex magnitude of the FFT were plotted against frequency were created for each participant on MATLAB. The average BPM of the DJ mix was calculated by applying the *mirtempo* function from MIRtoolbox for MATLAB (Lartillot & Toiviainen, 2007) to the audio file of the mix (truncated to match the time-window of the acceleration datasets), giving an average tempo of 125.96 BPM. The half-time and double-time BPM values of the DJ mix were also calculated and these values, along with the normal-time BPM, were plotted on participants' power spectrums, as shown in Figure 2. Spikes in participants' acceleration amplitude predominantly corresponded with the BPM of the music at each metrical level, suggesting rhythmic entrainment.

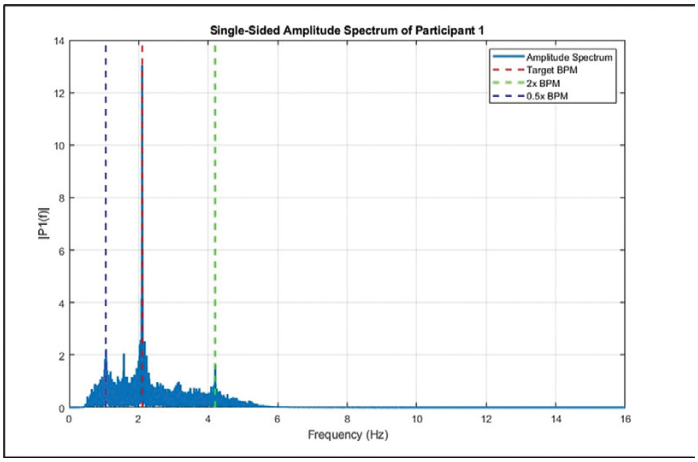

Figure 2. Average BPM of DJ mix at each metrical level plotted over the Fourier transformed single-sided amplitude spectrum for participant 1. Note. [P1(f)] represents the power of frequencies within the signal.

To calculate the degree to which participants were entrained for the duration of the mix, the trapezoidal numerical integration was used to analyse the relative power of the frequency corresponding to the average BPM of the DJ mix for each participant at each metrical level, with a tolerance window of ± 2.5%. This was computed on MATLAB using the *trapz* function and may be expressed as the following formula, where *a* represents the lower frequency limit, *b* the upper frequency limit and *f* the power spectrum of the given Fourier transformed signal:

$$Integral \approx \int_a^b f(x)dx$$

To compare entrainment between participants, the integrals calculated using the formula above were normalised. This was achieved by calculating the proportion of frequency power within the tolerance window relative to the overall frequency power in each signal. The integral of the whole frequency spectrum (0 Hz to 16 Hz) was computed for each participant using trapezoidal numerical integration. Each participant's integral values at each metrical level were then divided by their overall integral value to calculate the entrainment proportions. These values were multiplied by 100 to convert them to percentages, as displayed in Table 1. Total proportions of entrainment relative to overall signal power were low. This may be due to the narrow tolerance window used when calculating the integrals at the target BPM, and the compounding degree of spurious frequencies within the acceleration signals.

Table 1. Participants' proportionate entrainment (%) at each metrical level and summed total entrainment proportion (%) relative to overall frequency power.

Participant No.	% 1x	% 2x	% 5x	Total %
Participant 1	11	3	4	18
Participant 2	11	3	4	18
Participant 3	9	3	3	15
Participant 4	10	2	4	16
Participant 5	8	2	4	14

Quantity of motion

Quantity of motion (QoM) was analysed following procedures used in existing movement and live music research using accelerometers (cf.

Swarbrick et al., 2022). It must be noted that the pre-processing steps used in QoM analysis differ from those applied in entrainment analysis as specified earlier. Movement axes were not combined beforehand for this analysis as a Euclidean approach was executed as part of the initial QoM calculation on MATLAB. A Butterworth bandpass filter (0.6 – 5 Hz) was therefore applied to the accelerometer data on each movement axis for each participant prior to this analysis. A QoM time series was calculated for the duration of the DJ mix for each participant's accelerometer dataset. This was calculated by taking the absolute change of the accelerometer data at each time point to represent when participants were moving to the music using the formula $QoM\ \sqrt{(xt2 - xt1)^2 + (yt2 - yt1)^2 + (zt2 - zt1)^2}$ where t represents time ($t1$ and $t2$ represents two consecutive time points or samples). QoM data for each participant was smoothed using a Savitzky-Golay filter (order: 1, window: 299) (Swarbrick et al., 2022). Table 2 shows the mean quantity of motion (mQoM) for each participants' overall signal duration computed by calculating the mean of participant's QoM values at each time point. A notably high mQoM compared to the group can be seen for participant 1.

Table 2. Mean quantity of motion (mQoM) values for the overall DJ mix expressed in units of acceleration per time step (m/s^2) and average degree of synchronisation (*Rho*) for each participant.

Participant No.	mQoM	*Rho*
Participant 1	720.86	.324
Participant 2	469.65	.373
Participant 3	495.04	.381
Participant 4	348.39	.367
Participant 5	421.70	.383

Group synchrony

Cluster phase analysis was used to measure how synchronised each participant was with the overall participant group. This was carried out following the guidelines of Richardson et al. (2012), using their Cluster Phase Analysis Toolbox provided for MATLAB. The phase time series for each participant's accelerometer signal was computed using a Hilbert transform. The average (cluster) phase time series was then computed by averaging the phase values for all participants at each time point. The relative phase for each participant was then calculated at each time point by subtracting the group's average (cluster) phase from each participant's individual phase time series. The relative phases over all time points for each participant were then summed for each time series and divided by the number of time points, giving the mean relative phase for each participant. The resulting degree of synchronisation value (*Rho*) indicates how consistently a participant's movement is synchronised with the group on a scale between 0 and 1. Higher *Rho* values indicate a greater degree of synchronisation with the group. The *Rho* for each participant is displayed in Table 2. The average of all mean relative phases of all participants at each time step was $M = .382$, representing the mean degree of overall group synchronisation. This suggests that the group had a relatively low degree of overall group synchrony. This may be due to individuals having unique dance styles (Marchiano & Martinez, 2018) which may be rhythmically synchronised with the music but may not be captured as synchronous behaviours between individuals by phase analysis.

Emotional experiences

In line with the exploratory research aims of the current study and small sample size, descriptive statistics are presented to illustrate results on Likert-scales of emotional experience. Total scores for the EPS, KAMMUS-2 and PESC scales were calculated for each participant by summing their scores across each scale's respective items. Reliability analysis was also conducted for each scale. Table 3 shows the mean scores, standard deviations, range and Cronbach's alpha value for each of these scales. It was hypothesised that participants would experience moderate to high levels of embodied pleasure, *kama muta* and perceived emotional synchrony during the dance session. A high mean total score on the EPS suggests that participants experienced strong feelings of embodied pleasure ($M = 37$, $SD = 6.33$). A relatively low mean total score on the KAMMUS-2 ($M = 61.60$, $SD = 12.44$), suggests that participants experienced low to moderate levels of *kama muta*. The mean value for total perceived emotional synchrony levels suggests this was experienced moderately ($M = 62.80$, $SD = 19.37$). These results partially support the hypothesis and suggest that embodied pleasure is a salient emotional experience within an EDM context. In addition, the highest mean rating to the ECS was in response to the item 'The response of other people in the audience amplified my own emotional response to the music' ($M = 5.40$), suggesting emotional contagion was present amongst the group.

Table 3. Descriptive statistics of variables measuring participants emotional experiences (*N* = 5).

Variables	EPS	KAMMUS-2	PESC
M	37.00	61.60	62.80
SD	6.33	12.44	19.37
Range	26-42	43-77	45-95
α	.866	.825	.965

Social bonding

The difference between participants' pre-event and post-event SBI scores was calculated. It was hypothesised that participants' levels of social bonding with the group would increase following the dance session. It was found that participants' mean social bonding scores increased from pre-event (M = 12.40, SD = 2.70) to post-event (M = 15.40, SD = 3.29), supporting the hypothesis. A Wilcoxon signed rank test showed that participants' overall increase in social bonding scores was significant (Z = -2.041, p < 0.05), though this is tenuous in the context of the small sample size. This lends tentative support to the hypothesis that dancing in a group at an EDM event promotes social bonding.

Music preference & ecological validity

All participants "somewhat liked" (n = 2), "liked" (n = 2) or "really liked" (n = 1) the style of music playing. All participants reported a desire to dance either "often" (n = 3) or "all of the time" (n = 2) suggesting the music had a high level of groove and was conducive to dance movement, as would be expected of EDM (Burger & Toivianien, 2020). All participants reported they either agreed (n = 2) or strongly agreed (n = 3) with the statement "I felt like I was able to dance how I would usually at a real-world dance music event (i.e., nightclub or festival)" and "somewhat agreed" (n = 1) or "agreed" (n = 3) that the music playing gave the impression there was a DJ in the room, with one participant stating they "neither agreed nor disagreed" with this statement. Most participants also "agreed" (n = 2) or "strongly agreed" (n = 2) that during the dance session they felt they were at a dance music venue. Only one participant "somewhat disagreed" with this statement. These results suggest that the musical stimuli and replica club set-up used were largely effective in approximating the feel of real-world EDM context.

Correlations

Scatterplots were created to inspect possible relationships between total scores on both (a) emotional experience scales and (b) SBI increase values (the difference between pre- and post-event SBI total) with entrainment, *Rho* and mQoM values. As shown in Figure 3 below, there was a positive trend indicated between SBI increase and entrainment value. However, this is tenuous given the small sample size employed in this preliminary study. Correlational analysis was not conducted due to the small sample, and future work would benefit from employing such analysis on a larger sample.

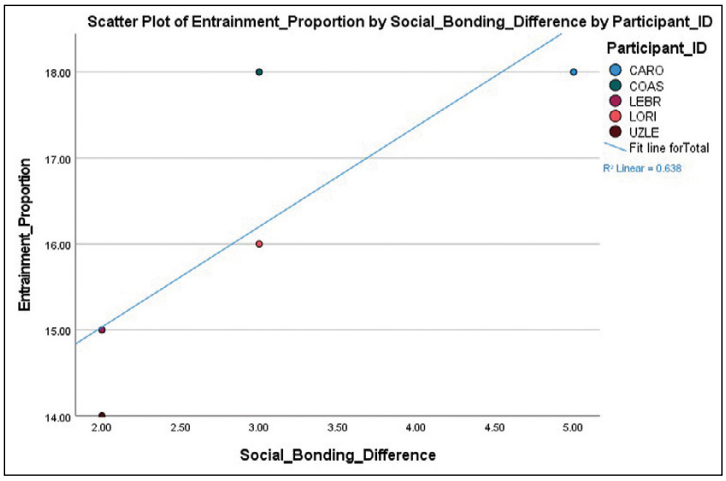

Figure 3. Entrainment proportion plotted against social bonding increase value (post-event) (*N* = 5).

Conclusion

The aim of the current preliminary study was to trial measures of interpersonal synchrony, entrainment, emotional experiences, and social bonding on a real-world dancefloor and test analysis methods for the assessment of relationships between these variables. Testing of three analysis pipelines for the assessment of interpersonal synchrony (QoM and cluster phase analysis) and entrainment (spectral analysis) using time series data yielded from wrist-worn accelerometers in a replica club setting achieved this preliminary aim. Initial findings indicate a possible relationship between

entrainment and social bonding on the dancefloor and suggest that experiences of embodied pleasure and emotional contagion are salient. However, due to the limited sample size, and the lack of a control group, no conclusions should be drawn here regarding relationships between movement, emotional experiences, and social bonding. The experimental and data analysis procedures and associated MATLAB toolboxes developed here should subsequently be employed in further field studies with increased ecological validity and sample size to further examine these relationships. Planned follow-up studies by the authors aim to collect data in a true real-world EDM event using smartphone accelerometers and, additionally, examine the role of DJ behaviour (cf. Biehl, 2019). It may be fruitful in follow-up research to gather more contextual data on interaction behaviour between participants, and shared emotional responses to the music, via analysis of video recordings or through observational techniques. This research is warranted to develop our understanding of embodied and emotional experiences at EDM events and their role in facilitating social bonding.

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Exploring the Intersection of Affect and Musical Engagement to Define Affective Computing in Musical Collaboration

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Abstract

This paper explores the interplay between affect and musical engagement, drawing on psychological theories and empirical studies. We propose extending this exploration into telematic music, investigating the potential for creating an emotional AI collaborator. The study aims to compile a dataset for machine learning (ML) by converting physiological responses, self-reported emotions, and musical passages. That data will allow for the generation of symbolic music from ML techniques. This exploration involves a social-psychological inquiry into human perceptions and feelings towards musical engagement and a deeper investigation into the physiological and neuroscientific responses when exposed to musical stimuli. This paper introduces Affective Computing in Musical Collaboration, exploring the intersection of physiological factors and music, particularly in telematic settings, to foster emotional expression and collaboration. It employs flow theory to understand musical engagement, examining cognitive, affective, and psychophysiological indicators to characterize flow states. Integrating AI, machine learning, and human feedback is proposed to deepen understanding and enable continuous measurement of physiological patterns, thereby advancing music information retrieval knowledge and enhancing emotional expression, collaboration, and engagement in musical performance.

Keywords: affect, musical engagement, telematic music, emotional ai collaborator, human-computer interaction

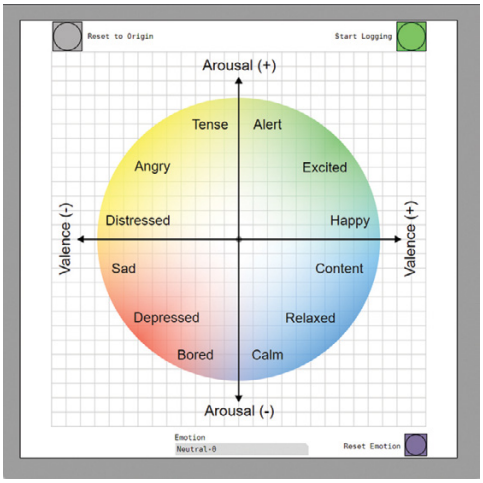
Introduction

This work defines Affective Computing in Musical Collaboration (ACMC) as a combination of physiological factors in the context of music, and extends into telematic music, resulting in an interdisciplinary field focused on developing advanced technological tools and systems to facilitate emotional expression, engagement, and collaboration in telematic music performances. Flow theory emerges as a critical framework, defining musical engagement as a state of total focus and intrinsic motivation. Various cognitive, affective, and psychophysiological indicators are examined to characterize the flow state during musical performance. Machine learning is proposed to identifty physiological flow patterns, aiming to deepen our understanding and enable continuous measurement without interrupting activities. This work advocates for interdisciplinary research integrating AI, human feedback, and machine learning to advance the knowledge of flow dynamics while defining ACMC. It highlights the importance of contextual factors in moderating flow physiology and emphasizes the need for further exploration of behavior, cognition, physiology, and flow dynamics. ACMC is essential for its ability to enhance emotional expression in music, facilitate remote collaboration, push the boundaries of human-computer interaction, advance emotional AI, as well as to enrich the user experience and engagement in musical performances. ACMC opens new possibilities for artistic expression, collaboration, and innovation in the digital age by bridging the gap between technology and musical creativity. By focusing specifically on musical collaboration, ACMC emphasizes the integration of emotion recognition technologies, music information retrieval tools, human-computer interaction principles, and AI-driven systems to enhance emotional expression, engagement, and collaboration in musical contexts.

The relationship between affect (emotional experience) and musical engagement is a complex and multifaceted topic extensively explored in psychology, neuroscience, and musicology. Various theories and studies contribute to understanding of how music evokes emotions and engages individuals both emotionally and cognitively. There are two tangents in the relationship between affect and musical engagement. A more social and psychological inference happens when querying humans about their thoughts about musical

engagement and how they feel. This is typically represented in qualitative feedback that includes more interpretations from discursive work, with deeper cultural or societal references. However, we recognize that there are strong ties to human factors and deeper connections in neuroscience. When a stimulus such as music is introduced to a human, physiological changes can be tracked along by looking at how neural coding or processing of sound frequency can be represented and measured through electroencephalography (EEG), reflecting brain stem activity that is phase-locked to sound waves and represents the sound frequency, timbre, and harmonics (Janisse, 1970; Kim et al., 2023; Wang et al., 2020; Zajonc, 1968). Physiological changes are examined using event-related potentials (ERP), which are very low voltages generated in the brain structures in response to specific events or stimuli (Blackwood & Muir, 1990; Sur & Sinha, 2009), and their amplitudes within a given time window regarding sounds or an event. For analysis, the observation is generally focused on the separability of the musical events and, in turn, the separability of ERP amplitudes. The phenomenological state posits human musical engagement—*flow*—as an active motivator and fundamental engagement metric (Csikszentmihalyi, 2009; de Manzano et al., 2010; Jackson, 2002; Wrigley & Emmerson, 2013). A range of cognitive, affective, and psychophysiological indicators during a musical performance can be used to characterize what is known as a flow state. Cognitive factors include a sense of effortlessness in action and what is sometimes referred to as total focus during those actions (Šimleša et al., 2018). Affective factors include a loss of self-consciousness and high intrinsic motivation (Landhäußer & Keller, 2012). Neural markers of flow have event-related potentials. Psychophysiological markers of flow or emotion include salivary cortisol, blood pressure, heart rate variability, and skin conductance (Nakamura & Roberts, 2016). Flow is a part of functional group psychological theory and is vital to successful group improvisations and performances. It is also an engagement metric for human-machine creative partnerships (Gifford et al., 2017; Pachet, 2006).

Therefore, while the physiological and neuropsychological methods (e.g., ECG, EEG, EMG, fMRI, eye tracking, saliva sampling, etc.) and aspects of human factors were emphasized previously in the context of flow and event-related potentials, they can broadly be understood as markers in the categories of physiology, emotion, cognition, and the contextual factor for flow. Consequently, there is a need for an overall engagement metric of flow that aligns with the current flow research results (Peifer et al., 2022). The insights gained from the recent research show a gap in clear physiological patterns of flow, indicating that this is the next major step in research. Peifer et al. (2022) argue that identifying physiological patterns of flow requires the integration of multiple indicators, suggesting that ML can help uncover these patterns in real time (Peifer et al., 2022). Moving toward that end, this argument proposes Affective Computing in Musical Collaboration (ACMC) as an interdisciplinary field that develops advanced technological tools and systems that facilitate emotional expression, engagement, and collaboration in telematic music performances. One example of such a tool is a real-



Figures 1 and 2 - L2Ork Tweeter interface (zoomed in) and Russell's circumplex of affect module in Pd-L2Ork

time, human-classified emotional MIDI dataset for symbolic music generation from the context of a computer music ensemble and through the telematic music platform, L2Ork Tweeter (Bukvic, 2020). Russell's circumplex of affect (Russell, 1980) module connects with L2Ork Tweeter to classify the emotion. It also aims to explore the integration of AI with human feedback from physiological factors and emotional context into a novice computer music ensemble (Kerobo & Bukvic, 2024). To classify the position as a further step in human-computer interaction, flow research, and machine learning with regards to human factors variables, this will first cover theoretical foundations regarding the psychology, neuroscience, and musicology perspectives from a human factors perspective and theoretical foundations regarding the machine learning, natural language processing (NLP), and symbolic music generation perspectives. Finally, the goal of investigating telematic music as a new context for emotional AI in musical collaboration has not been achieved yet. It is generally acknowledged that machine learning will advance this field of research. It is commonly recognized that reinforcement learning from human feedback (RLHF), along with various human factors, will be the way to utilize machine learning to identify and subsequently improve the flow pattern by offering suggestions or changes correlated to changes in music for emotional provocation. Furthermore, it can answer the second research question brought forth by Peifer et al., "How context conditions, such as characteristics of the task (e.g., difficulty) or conditions at the interface between context and person (e.g., task relevance), moderate the typical physiology of flow" (Peifer et al., 2022). The physiology of flow, when studied in conjunction with emotion, cognition, behavior, and contextual factors, underscores the need for further interdisciplinary research to develop AI and explore the relationships between behavior, cognition, physiology, contexts, and flow.

Extending the phenomenon

Components

The desire to contribute to music information retrieval (MIR) and flow research by studying affect (emotion) and musical engagement in the context of telematic music represents an ambitious interdisciplinary approach to understanding the complex relationship between music, emotion, and technology. This approach is represented by Kerobo and Bukvic in *Real-Time Human-Classified Emotional MIDI Dataset Integration for Symbolic Music Generation* (2024). The following subsections identify the critical components of this research.

Telematic music: It refers to music performance that involves participants in different locations connected via telecommunications networks. This allows for real-time collaboration between musicians who may be geographically dispersed, opening up new possibilities for musical interaction and exploration.

Affect and musical engagement: Affect, or emotion, plays a crucial role in how music is perceived and experienced. Understanding how unique musical elements evoke emotions and engage listeners is essential for creating impactful musical experiences. By studying affect and musical engagement in the context of telematic music, this research can gain insights into how technology-mediated interactions shape emotional responses and musical engagement.

L2Ork and L2Ork Tweeter: L2Ork (Bukvic, 2009) is a Linux-based laptop orchestra developed at Virginia Tech that enables collaborative music-making using open-source software and hardware. L2Ork Tweeter (Bukvic, 2020) serves as a tool or platform for capturing both physiological responses and self-reported emotions during musical experiences, with the Russell's circumplex of affect module and other additions. Using these tools, this research can collect data on subjective emotional experiences and physiological reactions to telematic music performances.

Encoding variables in files for datasets: MIDI files are a standard format for representing musical information in a digital format (*MIDI. Org – Expanding, Promoting, and Protecting MIDI Technology for the Benefit of Artists and Musicians around the World.*, n.d.). OpenSoundControl (OSC) is a data transport specification (an encoding) for real-time message communication between applications and hardware (Wright & Freed, 1997). OSC can be understood as a more flexible alternative to MIDI; OSC removes many of the ideological and hardware-related restrictions inherent to MIDI in favor of an open-ended user-defined address-space model that provides arbitrary parametric control through standard networking hardware (Wright & Freed, 1997). In addition, Tweeter files are defined by their own file format, which is trained on an LLM or, more recently, transformer models, capable of generating music and instruments in real-time based on parameters (Bukvic, 2020). By encoding variables such as physiological responses, self-

reported emotions, and musical passages into MIDI files, this research will create a structured dataset for analysis and training machine learning models.

Transformer for symbolic music generation: In the recent past, Recurrent Neural Networks (RNNs) were the dominant type of artificial neural network well-suited for sequential data, such as music (Eck & Schmidhuber, 2002a, 2002b; Medsker & Jain, 1999). However, the sequence-to-sequence model has issues, the main one being recurrence when the input sequence is quite long and contains a lot of information. Not every piece of the input sequence context is required at every decoding stage for all production activities (Yu et al., 2019). More recently, transformer models have revolutionized various fields, including natural language processing and image generation. Similarly, they have shown promise in symbolic music generation, offering unique advantages over traditional RNNs and other sequence modeling architectures (Sulun et al., 2022). Transformer models can be conditioned on additional information, such as genre labels, artist styles, or user preferences, to generate music that aligns with specific criteria. Transformer models can produce highly personalized and contextually relevant music compositions by incorporating conditional information into the generation process. By training a transformer on the encoded dataset, this research can develop a model capable of generating symbolic music that reflects the aesthetic preferences and emotional responses of the ensemble participating in the telematic music performance.

Personalized music generation: The ultimate goal of this research is to create a personalized music generation system that captures the unique aesthetic of the ensemble involved in the telematic music performance. The generated music can be tailored to resonate with the ensemble's preferences and emotional states by leveraging data on affect, musical engagement, and physiological responses. This interdisciplinary approach combines music, psychology, technology, and machine learning concepts to explore new frontiers in understanding and creating music. It has the potential to advance our understanding of the relationship between music and emotion and develop innovative tools for personalized music creation in collaborative settings.

Affect and musical engagement in telematic music

Understanding affect (emotion) and musical engagement in the context of telematic music is crucial for several reasons. Telematic music involves remote collaboration between musicians, often separated by geographical distances. Understanding how affect and musical engagement influence the experience of performers and audience members can help enhance the overall user experience. By catering to emotional responses and fostering engagement, telematic music performances can become more immersive and impactful. Affect plays a significant role in communication and collaboration, even in remote settings. Emotions can affect how performers interpret and respond to each other's cues, gestures, and expressions during telematic music performances. By understanding affect, musicians can better coordinate their efforts and create cohesive musical experiences across distances (Schlagowski et al., 2023). Telematic music relies on technology to facilitate remote communication and synchronization between musicians. Understanding how affect and musical engagement interact with technological interfaces can ensure the informed design of better tools and platforms for telematic music production. Technology can enhance the quality and authenticity of telematic music performances by incorporating features that support emotional expression and foster engagement. Telematic music blurs the boundaries between physical and virtual spaces, creating unique social dynamics that influence the musical interaction between participants. Studying affect and musical engagement in telematic music can illuminate these social dynamics, revealing how technology-mediated communication shapes interpersonal relationships, group dynamics, and collaborative creativity. For audiences experiencing telematic music performances remotely, understanding affect and musical engagement can facilitate a deeper connection with the music and performers. By designing experiences that evoke specific emotions and encourage active participation, telematic music can transcend geographical barriers and create meaningful connections between performers and listeners. A further extension or research proposition can utilize an audience component for emotional input and a feedback loop. Therefore, understanding affect and musical engagement in telematic music is essential for optimizing user experiences, improving communication and collaboration, informing technological design, studying social dynamics, and facilitating audience connection. This research opens new opportunities for creative expression, collaboration, and community building in the

digital age by exploring the intricate relationship between emotion, engagement, and technology in telematic music.

Affective Computing in Musical Collaboration – ACMC

Affective Computing in Musical Collaboration is an interdisciplinary field that designs technological systems that support emotional expression and engagement in telematic music-making. ACMC integrates insights from affective computing, human-computer interaction, music psychology, and machine learning to create innovative solutions that enhance the emotional and creative aspects of remote musical interactions. The components of the field are defined as follows:

Affective computing in music: ACMC leverages principles from affective computing to develop algorithms and systems capable of recognizing, interpreting, and responding to emotional cues in musical performances. This involves integrating emotion recognition technologies, such as facial expression analysis, voice analysis, and physiological sensing, into telematic music platforms, such as facial expression analysis, voice analysis, and physiological sensing.

Human-Computer Interaction (HCI) for musical collaboration: ACMC focuses on designing intuitive and responsive user interfaces that facilitate seamless collaboration between human performers and AI-driven systems. This involves developing interactive interfaces, gesture recognition systems, and adaptive feedback mechanisms that enhance the flow of communication and creativity in remote musical ensembles.

Telematic music technologies: ACMC explores novel technologies and platforms tailored explicitly for telematic music performances, including developing networked audiovisual systems, latency compensation techniques, and immersive virtual environments that enable real-time musical interaction and expression across geographical distances.

Emotional AI for music generation and interaction: ACMC advances the field of emotional AI by developing intelligent systems capable of generating expressive musical content and engaging in emotionally responsive interactions with human performers. This involves training AI models on large-scale datasets of emotional music performances and incorporating emotional intelligence algorithms into music generation and interaction frameworks.

Flow research and real-time feedback: ACMC incorporates flow research methodologies to investigate performers' psychological states during telematic music performances. By collecting qualitative and quantitative data on emotional experiences, engagement levels, and flow states, ACMC aims to provide real-time feedback to performers, enhancing their creative expression and musical communication. The research directions are as follows:

Emotional expression in telematic music: Projects investigate how emotional cues are communicated and interpreted in remote musical collaborations and how technology can facilitate expressive communication across distances.

AI-driven collaborative music making: exploring the role of AI-driven systems as collaborators and co-creators in telematic music ensembles and developing ML models that adaptively respond to human emotions and intentions.

Technological infrastructure for telematic music: designing scalable and reliable networked audiovisual systems, latency compensation techniques, and immersive environments to support telematic music performances with high emotional and creative engagement levels.

User experience design: examining user interface design principles and interaction paradigms that optimize emotional engagement, flow, and collaboration in telematic music platforms.

Ethical and sociocultural implications: This intersection examines the ethical implications of utilizing emotional AI in musical contexts and explores sociocultural factors that influence emotional expression and engagement in telematic music performances.

Pitfalls and ethical concerns in ML-mediated music: Despite its potential, AI collaboration in music poses several challenges. First, over-reliance on AI may diminish human creativity, leading to homogenized or formulaic outputs. Performers might defer expressive agency to the system, reducing improvisational spontaneity. Second, biases embedded in training datasets could reinforce narrow emotional or stylistic norms, marginalizing non-dominant musical expressions. Finally, an illusion of collaboration may arise if AI responses are misinterpreted as authentic co-creation rather than preconditioned outputs. These concerns

necessitate ethical oversight and transparent design in emotional ML systems.

Aesthetic framework for evaluation: To evaluate AI collaboration in music, this paper proposes an aesthetic framework grounded in phenomenological flow, affective depth, and perceived co-agency. Baseline comparison draws from existing telematic ensemble practices, assessing expressiveness, diversity, and coherence. This evaluation incorporates the following factors: emotional fidelity, which investigates how accurately the AI reflects the performer's intended affect; creative augmentation, which explores whether AI expands the expressive range or constrains it; flow enhancement, which examines whether immersion and engagement are sustained or disrupted by AI intervention; human-machine synergy, which investigates whether the AI is perceived as a collaborator or merely a tool. This framework promotes a reflective critique of AI's artistic role, aligning technological novelty with experiential richness. Conclusively, ACMC represents an exciting new frontier that integrates technological innovation, emotional intelligence, and artistic expression to enhance the quality and depth of telematic music collaborations. Through interdisciplinary research and collaboration, ACMC aims to advance human-computer interaction and emotional expression in musical contexts, paving the way for transformative advancements in the field.

Methodology

Tweeter dataset

The previous work starts like most music, and this continues as subjective. Pd-L2Ork and L2Ork Tweeter are used for *direct* samples to create a dataset containing pairs of MIDI files and emotional

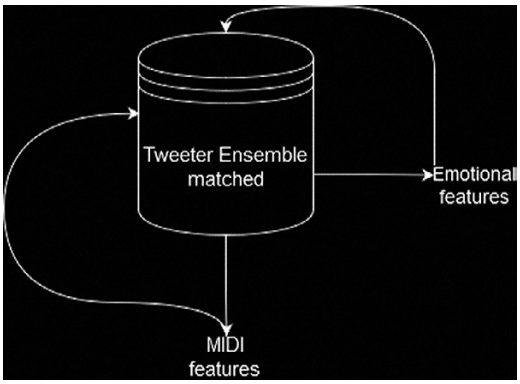


Figure 3. Dataset creation pipeline. MIDI (density, tempo, key) and emotion (valence, arousal) co-evolve in feedback loops.

labels. In particular, we match the using aesthetics and intuition as personal preferences. The reason we opted for the creation of a new dataset was to train the model on samples that are matched using a reference that is not labeled by experts, as others have done (Hung et al., 2021; Sulun et al., 2022).

Rather than correlating each MIDI sample with a song using a previous API, they are matched in real-time across the fourteen parts of L2Ork Tweeter. By doing so, the dataset creation pipeline is shortened by directly judging the MIDI information being recorded. This involves low-level MIDI features such as note density, the number of notes per second, tempo, and the correlation to the other twelve parts of the ensemble. These low-level features also model the arousal and valence dimensions of the circumplex model of affect (Russell, 1980). In totality, the existing symbolic music generation models are extended to incorporate

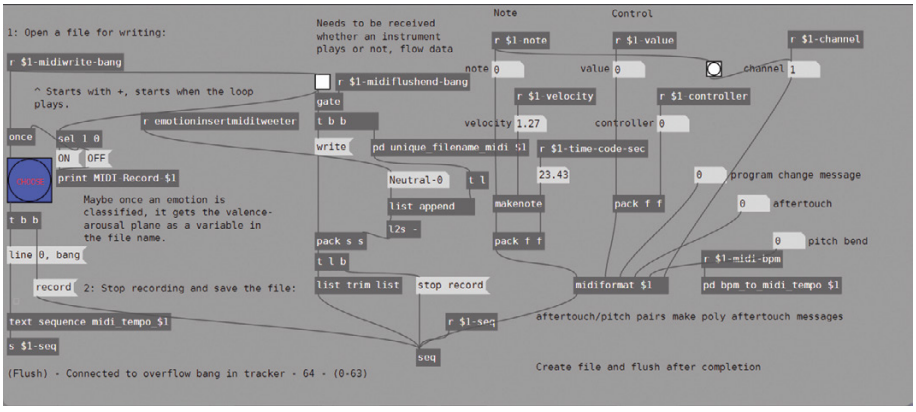


Figure 4. MIDI Subpatch. A flexible, modular system for dynamic MIDI input, enabling real-time control, visualization, storage, and complex operations like tempo mapping and file writing.

emotional conditioning and develop mechanisms to dynamically adjust model parameters based on real-time emotional input. This allows generated music to reflect the desired emotional context and implement a feedback loop where the generated music influences the performer's emotional state, creating a continuous interaction between the performer, the emotion classifier, and the music generation model.

The Pd-L2Ork MIDI subpatch in L2Ork Tweeter handles MIDI control, data display, routing, formatting, and file writing with unique filenames, using objects like receivers, float atoms, pack, and midiformat. Messages like *write* indicate commands to save MIDI data to a file using seq or sequence. For specialized MIDI handling events, the subpatch pd bpm_to_midi_tempo $1 is focused on converting beats per minute (BPM) to a MIDI tempo map message, which involves mathematical calculations to convert BPM into microseconds per beat and then further encoding it into a MIDI tempo message. For interactive elements and triggers, the bng (bang) and tgl (toggle) objects allow for user interaction, triggering various processes such as starting/stopping recordings or initiating data flow. The sel (select) and gate objects direct flow control, useful for conditional operations and data routing based on user inputs or system states. For additional elements, we have comments and instructions, like text objects. These provide instructions or annotations, guiding the user or explaining parts of the patch (e.g., "Open a file for writing," "Stop recording and save the file," etc.). Conditional logic and event handling through various trigger (t) objects are used to sequence operations, ensuring that events occur in a specific order (e.g., first clear a buffer, then start recording). Finally, there are MIDI control special cases akin to handling MIDI events like program change messages, aftertouch, and pitch bend with dedicated routes and formatting that suggest specialized use cases, possibly for performance or detailed control setups. The MIDI subpatch, combined with the Russell's circumplex of affect module, allows for synchronous writing of twelve distinctive MIDI loop-based patterns, each with its own expressive and implicit nuances. When users define the emotional state of their part or any given ensemble part, it adds that into the file name that also encodes the value of valence/arousal along with the date, time, and instrument/part it came from. By doing so, a feedback loop is created, in which a change in what users hear directly influences how they classify the emotion in correlation to the music.

Training data and pre-processing

The goal is to pre-train a non-conditional "vanilla" model for music generation on the Tweeter Dataset, which is not a subset of another database. This can be understood as any instrument, and this dataset was used to represent a new whole. It also still has separate note-on and note-off tokens for each instrument, as the polyphony is spread throughout each of the parts of the ensemble in the creation. A major difference from previous datasets (Ferreira & Whitehead, 2019; Hung et al., 2021; Panda et al., 2013; Sulun et al., 2022) and the proposed one is the fact that the material classified as a song is not a traditional song. Each of the 12 parts within L2Ork Tweeter utilizes a monophonic instrument that is coupled by a 64-note loop. The loop-based patterns are fairly small but can last up to one minute. Therefore, after pre-processing, the non-conditional training data split has 1860 loop-based patterns. To train the conditional models, the available weights from the vanilla model are first transfered and then fine-tuned on the low- and high-level for this dataset, which includes MIDI and emotional features for conditioning. After pre-processing, the conditional training data split has around 1000 loop-based patterns. Before tokenization, there is no need to convert to MIDI because the data is already in that format. We use the pretty_midi package for processing the MIDI data, as in Sulun et al. (2022). For tokenization, we use the event-based MIDI representation (Oore et al., 2020; Sulun et al., 2022). During preprocessing, we discard MIDI notes outside the piano range (21–108) and use 125 time-shift tokens (8 ms–1 s in 8 ms steps, following Oore *et al.*, 2020). Following Sulun et al. (2022), by introducing a <START> token to signify sequence commencement and a <PAD> token for sequence padding as needed, we establish the token set for our vanilla (non-conditional) model. Training input sequences are extracted as fixed-sized chunks from MIDI sequences. Each chunk's initial point is determined with a 50% probability: it either aligns with the start of a random bar, prompting insertion of the <START> token, or it is randomly selected from any point in the sequence, omitting the <START> token. This methodology proves essential for generating sequences longer than the training input length, as observed in Sulun et al.'s work (2022), during inference. A wide value range was chosen to vary loop emotions, expanding

training data. Conditioning used two values: Tweeter valence and average MIDI note density.

Models

The model's core is the music transformer, also used by Sulun et al. (Huang, Cooijmans, et al., 2019; Huang et al., 2018; Huang, Hawthorne, et al., 2019; Sulun et al., 2022). A 145M-parameter decoder-only transformer (20 layers, 768-dim, 16 heads, 3072-FFN) was used, and conditioning methods for emotion-based music generation were tested. Following Sulun et al., *discrete-token* conditioning was used by binning valence and arousal into control tokens. In thorough detail, the condition values were segmented into five equally sized bins, with the midpoint bin assigned the index 0. These bins correspond to verbal quantifiers denoting *very low*, *low*, *moderate*, *high*, and *very high* conditions, mirroring previous approaches. The control tokens associated with valence and arousal precede the music tokens, effectively concatenated along the sequence dimension, specifically when the sample originates from the commencement of a given musical bar. Subsequently, this sequence undergoes processing within the transformer architecture. An evident drawback of this model surfaces during inference. Once the generated sequence reaches the same length as the input, the input is truncated from the start, resulting in the omission of control tokens. Additionally, information loss is incurred due to the discretization of continuous values. Adhering to precedent, normalized continuous condition values for the *continuous-token* input are utilized. Each value undergoes processing through an individual linear layer, yielding condition vectors of equivalent length to the music token embeddings. These vectors and embeddings are then concatenated along the sequence dimension and passed into the transformer. Even throughout inference, including after the generated length aligns with the input length, we persist in inserting the condition vectors at the sequence's outset. Building upon this foundation, the final approach, termed *continuous-concatenated*, entails consolidating the two normalized continuous condition values into a single vector. This vector is replicated along the sequence dimension and concatenated with each music token embedding. The conditioning vectors and token embeddings maintain lengths of 192 and 576, respectively, ensuring consistency in the total feature length of the transformer input across all models. All conditional models undergo training via fine-tuning of the pre-trained vanilla (non-conditional) model. A representation of the models is not in the focus of this project but it can be found in Sulun et al. (2022).

Evaluation

Assessing music generation models remains a dynamic field, with no prevailing consensus currently established. Rather than embarking on intricate endeavors to replicate subjective listening experiments, this study employs objective, quantitative evaluation methods. The present model evaluation employs negative log-likelihood (NLL), top-1, and top-5 accuracies as metrics, following the methodology outlined by Hung et al. (2021) and Sulun et al. (2022). In assessing top-*n* accuracy, a model's prediction is deemed accurate if the ground-truth class ranks within the top n probabilities of the model's output for each token. Consistent with this training setup, evaluation is conducted on chunks of length 1216, with loss calculated for every token in the target sequence. This approach presents a heightened challenge compared to predicting the subsequent token in a sequence, particularly evident when the model attempts to predict the initial note of a song solely from the <START> token. To ensure comprehensive coverage of the test split, non-overlapping chunks are processed sequentially, yielding 1836 for evaluation. Additionally, a quantitative assessment of emotional content in samples generated by these conditional models is undertaken, as previously explored by Hung et al. (2021) and Sulun et al. (2022). To achieve this, a regression model is trained on the training data split to predict emotion values. This model, structured as a music transformer with eight layers, produces two continuous values: valence and arousal. Subsequently, employing the trained conditional generation models, inference is conducted using various conditions and emotional content is predicted using the regression model. The normalized L_1-distance is utilized between the regression model predictions and the conditions provided during inference for error quantification. To ensure equitable comparison with the discrete-token model, condition values are selected as the midpoints of the bins corresponding to the discrete condition tokens (-0.8, -0.4, 0, 0.4, and 0.8). The present paper mirrors Sulun et al. (2022) by generating a set of 25 condition value pairs for evaluation by employing five values for valence and arousal each. Eight samples are generated without selective bias for each model-condition combination and the average error is reported.

Each sample consists of 4096 tokens, and the regression model processes inputs of length 1216, mirroring the generator setup. Sample inputs for the regression model utilize a sliding window with 50% overlap, and the outputs are subsequently averaged.

Results

Table 1 presents the performance of various models based on prediction accuracy. The continuous-concatenated model demonstrates superior performance across all metrics compared to other models, notably surpassing the state-of-the-art discrete-token model by a significant margin, particularly in negative log-likelihood and top-1 accuracy. In Table 2, the regression-based evaluation further confirms the continuous-concatenated model's superiority in conveying emotion compared to alternative models. Notably, the vanilla approach is omitted from this analysis as it lacks emotional conditioning.

Tables 1 and 2. Table 1 (T1): Model performance was evaluated using NLL (lower is better), Top-1/ Top-5 accuracy (higher is better). Table 2 (T2): 'Error' (normalized L1 distance between inference conditions and regression outputs).

(T1) Model	NLL	(T2) Model	Error
vanilla	0.7856	discrete-token	0.2305
discrete-token	0.7546	continuous-token	0.2166
continuous-token	0.7387	continuous-concatenated	**0.2162**
continuous-concatenated	**0.7101**		
Top-1	Top-5		
0.7992	0.9364		
0.8061	0.9379		
0.8152	0.9385		
0.8208	0.9388		

Analyzing the performance gap among the models presented, the primary limitation of discrete-token and continuous-token models is attributed to their treatment of condition values. Unlike the continuous-concatenated model, these models assign equal importance to condition values and tokens in the sequence. Sulun et al. (2022) argue that while tokens aid local predictions, condition values have a global impact, directly influencing the entire generated sample. Their proposed continuous-concatenated model effectively leverages condition information by integrating it into each embedding of the input sequence for the transformer. The present models are slightly inferior to the former, with the unique dataset deriving minimal loss compared to larger datasets.

Subsequent exploration of these methods can incorporate continuous-valued conditions, offering finer control over the generation process. This approach also enables dynamic adjustments to conditions throughout the generation, potentially yielding more intricate and progressive compositions. In summary, this work represents a significant step towards establishing a clearer connection between emotion, symbolic music, and collaboration over distance (telematics). The Tweeter dataset currently exhibits minimal loss in comparison to the Lakh-Spotify dataset, and the individual personalizes the representations. In this case, it does this with a considerably smaller dataset, but it will be improved soon by more human-generated loop-based patterns.

Conclusion

Understanding affect and musical engagement in telematic music is crucial for several reasons. It allows for a deeper comprehension of how emotions shape the experience of both performers and audience members in remote musical collaborations, enriching user experiences and fostering meaningful connections despite geographical distances. Additionally, studying affect and musical engagement can enhance human-computer interaction in music-making processes. Advancements in emotional ML influenced by human factors in music can lead to more intuitive and responsive technology that complements human creativity and expression. Integrating emotional AI into telematic music via L2Ork Tweeter facilitates seamless collaboration and opens new avenues for exploring the emotional dimensions of music through technology. Furthermore, tracking affect and musical engagement through qualitative and quantitative data enables real-time feedback mechanisms, offering insights into the dynamic interplay between performers, audience, and technology. This real-time feedback loop contributes to the next dimension of flow research, where performers can achieve heightened focus, immersion, and creativity. By encoding variables such as physiological responses, self-reported emotions, and musical passages into

MIDI files, this approach bridges the gap between technology and musical creativity, paving the way for innovative approaches to music information retrieval. Affective Computing in Musical Collaboration (ACMC) represents an interdisciplinary approach to leveraging technology to enhance emotional expression, engagement, and collaboration in musical contexts, particularly in telematic music performances. By integrating insights from emotion recognition, human-computer interaction, ML, telematics, user experience design, and ethics, ACMC aims to push the boundaries of what is possible in the intersection of emotion, technology, and music, enriching the experiences of performers and audiences alike. In conclusion, understanding affect and musical engagement in telematic music enhances user experiences and human-computer interaction and fuels advancements in emotional AI, music information retrieval, and flow research. By integrating qualitative and quantitative data tracking and encoding variables into MIDI files through L2Ork Tweeter (Kerobo & Bukvic, 2024), a telematic music environment, we embark on a journey to deepen our understanding of music's emotional and creative dimensions, ultimately enriching the intersection of technology and musical expression through human factors, HCI through telematic music, and MIR for machine learning.

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