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Expressing Emotions Through Music

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Abstract

Music evokes strong emotions across listeners although it conveys no biologically relevant information regarding the survival challenges in the environment. Here we review the neurobiology and psychology of emotional communication through music, focussing on the functions and mechanisms of musical emotional expressions in social interaction and extend our analysis of the communicative space beyond the pure acoustic features to the interaction of musical emotional cues with other verbal and nonverbal communication channels. Activation likelihood estimation (ALE) meta-analysis of neuroimaging studies shows functional overlap for brain systems involved in music production and emotions. Musical emotion communication however differs from other common expressive channels (faces and bodies, utterances, and semantics) in its timescale, context, spontaneity and interactivity. Because musical emotional communication can be modulated by affective information communicated through other verbal and nonverbal channels, musical communication provides a flexible means for context-dependent and culturally malleable communication of emotions, which is particularly well suited for large-scale social affiliation and bonding.

Introduction

Music is culturally universal, has existed since prehistory, and is specific to humans [1]. People engage in music for various purposes such as fostering interpersonal relationships and building and expressing personal identity [2–4]. All these functions however share a common component - emotionality. Nearly 90% of adults listen to music every day, and practically everyone (98%) states that music supports their mental and physical health by providing emotion-related benefits such as stress relief or relaxation from it [5]. Music serves as a medium for the performers to express and communicate emotions. In one survey where subjects were required to select from a comprehensive list of options what they thought music in general expresses, every single participant chose “emotions” as an expression of musicality [6]. Performers also consider expressivity in music primarily as a tool for increasing the affective impact of the music, and a majority (83%) of the musicians report that they deliberately try to express specific emotions during their performances [7].

Emotions act as survival intelligence, organizing human and animal behaviour by adjusting their actions across multiple physiological and behavioural scales [8,9]. These physiological and psychological states may also be communicated to others through various emotional expressions to convey behavioural intentions and increase the predictability of social interaction [10]. Facial and bodily expressions of emotions have likely evolved to facilitate rapid social communication and negotiation in situations that acutely affect individuals safety, survival or reproduction success [10]. Capacity for inferring emotions from music appears also similarly universal as it does not even require previous exposure to the musical culture [11]. Yet whereas facial expressions and emotional vocalizations may reflect the individual’s internal states that enable perceivers to adjust their behavior accordingly, music often expresses emotion in a more symbolic and stylized form, enabling the induction and sharing of emotions across a large number of listeners and performers through empathy and emotional contagion. Music-induced emotions are typically detached from immediate real-life events and emotions are rarely expressed through music in survival salient situations. Therefore, it is likely that emotional communication through music also serves different adaptive functions than, for example, emotional expression with faces or bodily postures.

As music is unique to humans [1], it is likely that musical emotional expressions support functions that are unique or at least uniquely important for humans. Recent evolutionary accounts of music have focused on its social functions such as promoting bonding or credibly signaling parental care and coalition strength [12,13] and while human capacity for recognizing emotions from music have been extensively studied [6,14] the psychological and neural mechanisms involved in generating the musical emotional communication have remained poorly specified. Here we review the neurobiology and psychology of emotional communication through music. Instead of focusing on the listeners’ ability to infer affect from musical communication, we focus on the functions and mechanisms of musical emotional expressions in social interaction and extend our analysis of the communicative space beyond the pure acoustic features to the interaction of musical emotional cues with other verbal and nonverbal communication channels.

Music as emotional communication

Communication of emotions through music is accurate. Meta-analyses have shown that basic emotions (happiness, anger, sadness, fear, tenderness) can be expressed through music as accurately as through facial or vocal expressions, with raw accuracy scores exceeding 0.7 [15]. Meta-analyses also show that music consistently engages the brain's affective circuits [16,17] and music-evoked emotions can also be decoded accurately from haemodynamic signals, supporting the discrete nature of musical emotional experiences [18]. However, such decoding is most accurate in the auditory and motor cortices rather than in limbic and paralimbic emotion circuits, confirming that the acoustic and motor resonance of the music are the most important constituents of musical emotion. In line with this, different music-evoked emotions elicit culturally consistent bodily feeling fingerprints that match closely those evoked with survival-related events [9,19], indicating that music has the capacity to engage the autonomic systems and prepare the body for action. Research on musical emotions has typically focused either on a few discrete categories such as happiness, sadness, or fear, or on dimensions, typically valence and arousal. While this approach has practical advantages, it is widely acknowledged that music can communicate and elicit emotions that extend beyond a few basic categories, including aesthetic emotions such as awe, nostalgia, or being moved [14]. Consequently, music-specific models have been proposed to account for these musical experiences [20–22].

Perception-oriented accounts have highlighted acoustic features that predict emotion ratings by passive listeners. Among these, the influential "common code" hypothesis [6] proposes that music and vocal expression of emotion rely on shared acoustic cues to convey emotion. Cross-cultural studies indicate that some aspects of emotion perception in music may be largely culturally invariant while others are substantially influenced by cultural learning: basic emotions such as happiness, sadness, and fear are recognized above chance across cultures, whereas more complex states (e.g., peace, longing, spirituality) are less reliably perceived [11,23,24]. Recognition is also generally more accurate for culturally familiar music, reflecting an in-group advantage. Acoustic analyses further suggest that the cues performers use and listeners rely on overlap substantially with those known from emotional speech, supporting the view of a shared "common code" across modalities.

Musicians vary timing, amplitude and timbre of their playing as these deviations are critical for delivering the aesthetic emotional experience similarly as prosody in speech is used for altering the interpretation of the semantic meaning [25]. Experimental studies have shown that these characteristics and particularly timing and amplitude influence the emotions communicated. However, this effect is strongly dependent on the listeners' musical training, pointing towards a learning-based mechanism in interpreting the expressivity conveyed by the performer [26] and particularly the emotional connotations of higher-level musical features such as the major–minor distinction with no equivalent in speech appear to arise through enculturation [27,28]. Taken together, these findings suggest that universality in musical emotion perception is strongest for basic emotions and tied to relatively low-level cues such as tempo and roughness, while finer distinctions are shaped by cultural learning. Yet, more recent large-scale work showed that both U.S. and Chinese listeners consistently distinguished at least 13 categories of musically induced feelings, including triumph and erotic desire, suggesting that cross-cultural commonalities can extend beyond basic emotions [14].

What makes music a special emotional signal

Emotional expression through music shares some similarities with the other verbal and non-verbal emotion communication channels (Table 1) yet its unique characteristics make it stand out from the conventional “biological” channels. First, facial and bodily expressions operate on subsecond temporal scales [29], whereas music is more akin to semantic emotional information in spoken and written language where affect is conveyed in timescales ranging from seconds to minutes. Although emotions can be accurately recognised from subsecond musical snippets [30], the inherent communicative time window of musical pieces is significantly longer (tens of seconds to minutes) and short musical bursts are rarely used for communicative purposes. Emotional expression in music is partly based on predictive processes and rhythmic entrainment that emerge only over time with the unfolding of musical structure [31,32]. Unlike other expressive channels, music can sustain and deepen affective engagement through repetition - a process that by definition takes time:whereas we rarely repeat the same facial expression or utterance over and over, a musical phrase may recur many times within a piece, allowing emotion to unfold gradually.

Second, facial and bodily expressions as well as verbal and semantic emotional communication are typically used in dyads or small groups, whereas musical communication readily scales to large groups and is often directed at larger audiences [1]. One notable exception is however the ubiquitous practice of infant-directed singing such as lullabies which are typically confined to dyadic contexts and serve to calm and strengthen bonds between the parent and child [12].

Table 1. Basic characteristics of musical emotional expressions in relation to other primary ways of expressing emotions. Note that musical performance can contain affective elements from all the other communication channels as well.

Modality	Timescale	Context of use	Spontaneity	Interactivity
Facial and bodily expressions	Subsecond	Dyads and small groups	Spontaneous and planned	Bidirectional
Utterances	Subsecond	Dyads and small groups	Spontaneous and planned	Bidirectional
Semantics	Seconds - minutes	Dyad, small and large groups	Spontaneous and planned	Bidirectional
Music	Seconds to minutes	Small and large groups	Planned	Unidirectional or parallel

Third, whereas all other modalities for emotional expression range from purely spontaneous and automatic to carefully planned displays, musical expression is practically always planned. Although facial expressions occur routinely in everyday contexts [33], bursting into singing or playing simply does not occur spontaneously in adults similarly as smiling or laughing. One study found that spontaneous

[1] We recognize that today these boundaries can be overcome through digital communication and mass media, and the presented distinctions apply to emotional communication without technological aids.

singing occurred only rarely and only in one fourth of studies participants and these constituted only 4% of the recorded sound episodes [34]; these estimates match closely with retrospective surveys [5]. Naturalistic recordings from toddlers however indicate that young children routinely and spontaneously engage in singing both improvised and learnt songs, particularly during free play. Interestingly, spontaneous singing alone was far more common than social singing at others, and self-singing was also more improvisatory rather than the "performative" social singing that consists mainly of learned songs [35]. This indicates that already young children understand the communicative and social value of music, and that they begin to shape their music-making to match with the social communicative norms.

Fourth, whereas emotional communication through other verbal and nonverbal channels is based on interactive sensorimotor loops where senders and receivers constantly update their expressions based on the messages they encode from others [36], musical communication is typically unidirectional or parallel. Musicians playing in an ensemble adjust tonality, pitch, and rhythm with each other, but repeated exchange of emotional musical signals that would iteratively influence the emotional nature of the musical signals is uncommon and limited to special cases such as musicians trading licks during jam sessions, expert jazz musicians engaging in mutual adaptation to each other's improvised phrases, or exchange of - primarily verbal - insults in rap battles.

Brain mechanisms for music production and emotions

To address the brain basis of musical emotional communication, we conducted a meta-analysis (Supplementary Methods and Fig 1) of BOLD-fMRI and PET responses to i) music production in general and ii) emotional music making. Altogether 40 studies, 848 subjects, and 1727 activation foci were included in the analysis (**Table S-1**). Because only a single study investigated specifically emotional music making, all studies were pooled together and the resulting ALE map was then compared with automatically generated meta-analytic maps for keywords "emotions" and "music" (Oct 15th 2025) derived from the NeuroSynth database [37] as well an ALE map from a recent meta-analysis on brain basis of music-evoked emotions [16]. This analysis (Fig 1 and https://neurovault.org) revealed that music making consistently engaged M1, Supplementary motor area (SMA), bilateral superior temporal (STG) and Heschl's gyrus, primary somatosensory cortex (S1), anterior insula, pallidum, anterior and midcingulate cortices. The effects in midcingulate cortices, insula, Heschl's gyrus and superior temporal gyrus, SMA, and postcentral and precentral gyri were also observed for music in general. Of these effects, those in superior temporal cortices (Heschl's gyrus) overlapped with musical emotions ALE map.

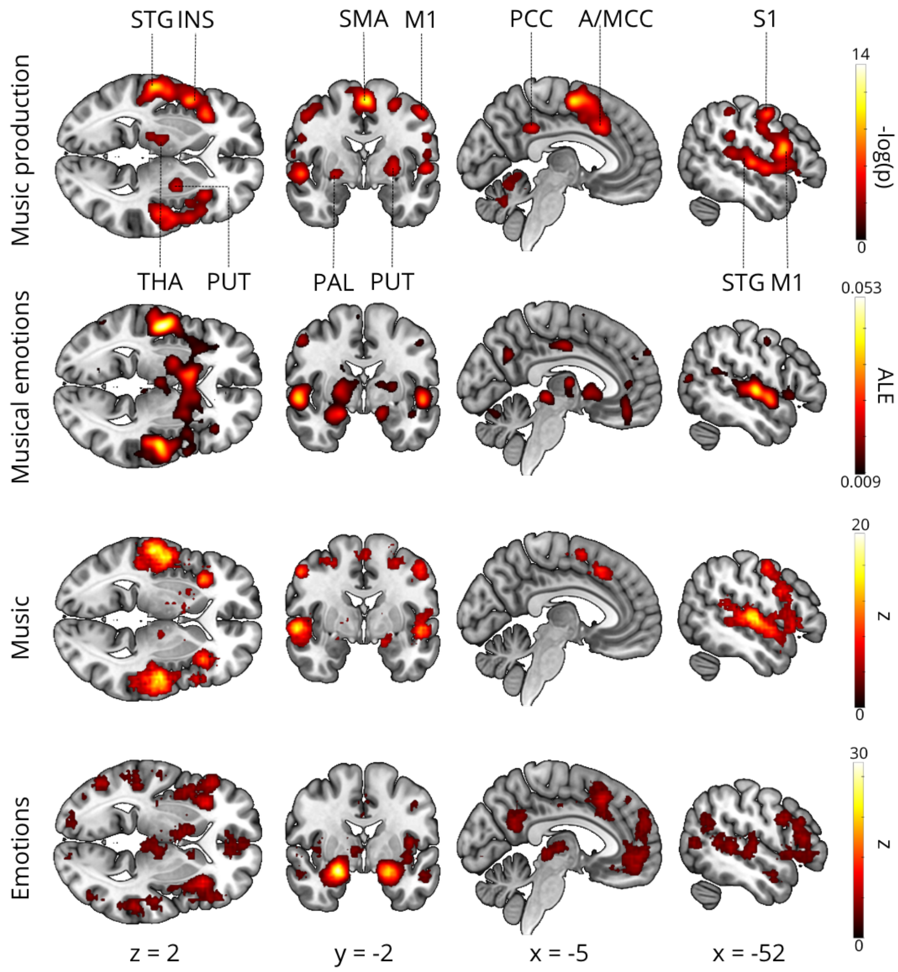

Figure 1. Brain regions involved in making music significantly overlap with those involved in processing of emotions and emotional expressions. The data are cluster-corrected at $p < 0.01$ (FWE Montecarlo) .

Meta-analytic map for music production and emotions showed overlap with meta-analytic map for emotions in midcingulate cortices, M1, SMA, insula, thalamus, and superior temporal cortices. Emotions further activated ACC, amygdala, and fusiform gyri, whereas these effects were absent for music making, while the amygdala activations were observed for musical emotions and emotions in general. Functional coactivation analysis at regional level revealed that the most consistent joint effects for music making, music in general, emotions and musical emotions were observed in superior temporal cortices and post-and precentral gyrus (**Fig 2**). These results suggest that music making engages partially similar brain networks as emotions in general and in more limited manner those involved in musical emotions. While paralimbic activations were observed for emotions in general as well as musical emotions, limbic activations were markedly absent for the music making ALE analysis. Finally, music making uniquely engaged auditory cortical (PAC) core, belt and parabelt areas. In addition to encoding the acoustic features of the musical signal, these regions hold emotional representations of music as well as its musical and semantic (lyrical) information [18,38].

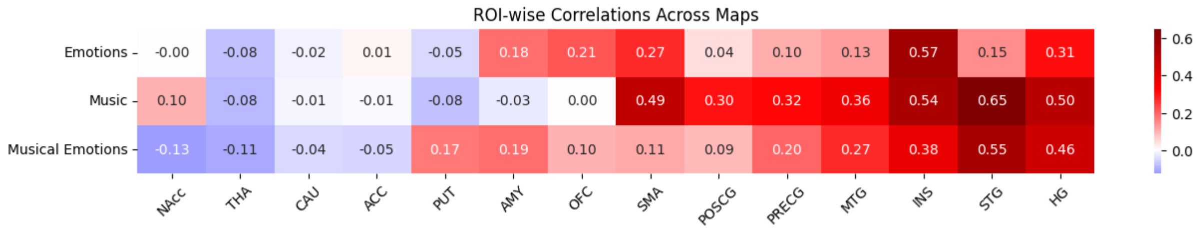

Figure 2. Regional overlap between brain regions involved in music making (the present meta-analysis), musical emotions [16] emotions in general (from NeuroSynth) and music in general (from NeuroSynth).

Altogether these results confirm that music making robustly engages the somatomotor regions involved in the execution of the music as well as temporal cortical regions involved in auditory processing. The midcingulate regions likely reflect the motor and cognitive control, whereas the insular activations fall within the anterior affective and cognitive subdivisions of the insular cortex [39–41]. This indicates that music making robustly engages numerous components of the "extended" emotion circuits in the brain, whereas activations in the core limbic areas are missing. While real-life music performance is often an emotionally engaging experience for the player, performing a scanner compatible music production task may not in itself thus ben affective act at the neural level. This highlights that music making can be non-emotional, even though the resulting musical expression causes emotions in others. This parallels data from other modalities with potential emotional communicative value. For example, when comparing brain responses to displaying versus observing facial expressions, both tasks robustly engage the somatomotor and paralimbic regions, whereas limbic activations are observed only when observing expressions [42]. Emotion circuit activation may thus not be a central feature of the communicative acts intended at expressing emotions at others, at least when the expression is not caused by spontaneously occurring affect.

Verbal modulation of musical emotions

Music is a significantly more complex signal than other emotion communication channels. Whereas facial and bodily emotional expressions rely on muscle configurations and kinetics, musical expression can be achieved through multiple acoustic features (pitch, loudness, rhythm, timbre, harmony…) and most notably, the lyrics. Singing appears in every culture, is predominantly done in groups, and serves functions such as dance, healing, love, and childcare [43]. Singing is also an effective means for musical emotional communication, because the brain processes singing as both language and music [38]. A large bulk of evidence suggests that affect can be conveyed effectively through semantics of written text and speech [44]. Lyrics are also used for communicating emotional qualities in songs and for example during the past 50 years, the most common themes of the lyrics of popular music pertain to emotional topics such as relationship and love, sex, music, dance, and partying and good times [45]. Lyrics are so omnipresent that with some rare exceptions such as EDM, jazz, and classical performances, practically all music that people intentionally choose to listen contains lyrics. Based on surveys over 94% of peoples' favourite songs contain lyrics [46], and when participants are asked to select their own favourite music for brain imaging experiments on musical affect, they almost invariably select music with lyrics [47,48]. Lyrics connect music with our innate allure for storytelling [49], allowing music to connect with meaningful narratives leading to collective resonance of emotions, and many popular songs considered deeply emotional masterpieces such as Bob Dylan's "Like a Rolling Stone" or The Beatles's "Hey Jude" might carry much less emotional power if they had been released as instrumental versions.

Sentiment analysis has confirmed that a significant proportion of popular music lyrics is imbued with (primarily positive) emotion [50]. The semantic features of the lyrics are linked with the affective valence of music, complementing the emotional expression through the musical features so that combination of lyrics and musical features allows the most accurate prediction of resultant affect [51]. Large-scale analysis also suggests a close link between harmony and lyrics, that is, presence of major/minor chords and concurrent emotional semantics of the lyrics [52] suggesting that musical and semantic features both contribute to the mood of a musical piece. When the emotion conveyed by the melody and the lyrics are incongruent (e.g., a happy melody with sad lyrics), melody tends to dominate the perceived emotion, suggesting that musical features are the primary determinants of a song's emotional impact [53]. The contribution of lyrics to the net emotion resulting from a musical piece however depends on the emotional qualities of the music. Happy music without lyrics evokes stronger positive emotions than happy music with lyrics, and at the neural level happy music without (but not with) lyrics robustly engages the limbic emotion circuits, whereas the opposite is true for sad music [54]. Similarly, behavioural studies have found that sad music paired with sad lyrics boosts the negative emotion induced by a song whereas the same sad song played without lyrics was perceived as pleasant and had a positive effect on mood [55]. Other studies in turn have found evidence that lyrics are more fundamental in defining the affective qualities of sad versus happy music and even these results might be language-specific [53,56]. However, not all studies have been able to replicate these effects [57] and it is likely that lyrics and vocal expressions however have partially independent effects on the evoked emotion, yet the vocal and musical expressions tend to dominate over semantics [58].

Audiovisual integration and musical emotions

As a live artform, music is inherently a multi-modal experience, because listeners not only hear but also see the performers. During musical performance, visual cues such as facial expressions and gestures both complement the musical performance as well as direct the audience's attention and engage the engagement of the audience. The emotional qualities of music can be modulated by simultaneously occurring facial and bodily expressions of emotions, making it a particularly flexible tool for emotional communication. Audiovisual integration of emotions occurs across communicative channels such as facial expressions and the tone of voice [59], and these channels are also integrated for musical performances. Facial expressions that are congruent with the emotions expressed in the music amplify the resultant emotion in comparison with music-only condition [60], and musical expressive cues have larger impact on music-evoked emotions when the performance can be seen, indicating the additive effects of visual and acoustic channels in emotion elicitation [61]. Although some studies have failed to find evidence for such integration at subjective or psychophysiological levels [62], meta-analytic data supports the integration of visual and auditory signals in the evaluation of expressiveness and aesthetic appreciation of musical performance [63]. Compared to recorded music, live music also leads to stronger responses in amygdala and strengthens the coupling between listeners' brain activity, the acoustic features of the music, and their emotional experiences [64].

Performers' facial and other nonverbal expressions also complement music, influencing the interpretation of both musical and affective qualities of the performance [65]. Facial movements associated with emotions during speech are also retained during singing [66], and the visual expressive cues amplify the emotional content of the music [67]. Because the facial movements during singing extend beyond what would be acoustically necessary and are thus related to emotional expressivity. In line with this, observers can accurately infer the emotional meaning of visual and audiovisual but not from audio-only song recordings, indicating the importance of facial motion in communicating emotions through musical performance [68]. Expressive body movements during musical performance reflect a musician's internal states and serve as a channel for emotional communication. Observers rely heavily on visual cues to infer expressiveness, with non-musicians often identifying expressive intent more accurately through sight than sound (Davidson 1993). Specific emotions—such as happiness or anger—can be distinguished from musicians' body movements alone [69]. The kinematic features that convey expressive intent, including movement amplitude, speed, and smoothness, are particularly evident in body parts not directly involved in sound production, such as the head and upper torso [70]. Listeners can also perceive emotional dimensions—valence, activity, and power—from conductors' point-light gestures alone, further demonstrating that expressive movement communicates nuanced affective content even in the absence of sound [71].

People are also not merely passive listeners but move to music and attend to visual and bodily cues in musical performance which contribute to the communication of musical emotion. Emotional qualities of music are mirrored in bodily movement highlighting a close coupling of movement and musical emotion expression. Adult observers can recognize emotions like anger, fear, and joy above chance from movements of professional dances [72] while the spontaneous movements of untrained listeners dancing to music reflect its emotional qualities in systematic ways [73] and the motions induced by the music in the listeners can be predicted by rhythm, timbre and dynamics of the music [74]. The perceptual skills required to detect musical features closely tied to movement such as beat and tempo are present early in development, and children not only recognize but also spontaneously move to music from a young age [75].

Children as young as five can already decode at least some emotions from dance movements [76] suggesting bodily movement is an early-emerging channel for musical emotion communication. This early coupling of perception and action provides the foundation for later sensitivity rhythmic and dynamic properties of music that elicit an urge to move. Research on "groove" indicates that this urge is modulated by rhythmic complexity—typically strongest at moderate levels of syncopation—and that this appears robust across cultures [77]. Features that tend to be perceived as expressing positive emotions such as major mode tend to also boost the urge to move and the sense of groove and elicit bodily sensation in the limbs possibly related to the urge to move [78,79]. Thus the expression, perception, and induction of musical emotions are deeply intertwined with bodily movement from early development onwards providing a foundation to collective synchronization and social interaction that characterises much of human musical activities.

Social musical emotions

Finally, we turn to the question of what is the ultimate function of musical emotional communication? One prominent explanation is that music offers a unique way for promoting social connections by allowing the collective synchronization of emotions and moods of large groups on a scale far exceeding what would be possible via other expressive channels. For most human history, music making and listening have been fundamentally social, while solitary enjoyment of music made by others became possible only after analogue recording techniques were invented as late as 1877 by Thomas Edison. Cross-cultural studies have also revealed that musical universals are not limited to pitch- and rhythm-related musical features, but also encompass group performance in social contexts [80]. Similarly, a large-scale analysis of audio recordings from >1000 societies and ethnographic texts from over 60 corpora suggest that music making (singing) in groups is far more common than solitary musical expression [81]. Remarkably, listeners from diverse cultural backgrounds can reliably recognize dance songs, lullabies, and healing songs even without prior exposure [82]. This suggests that features like tempo, rhythmic and melodic complexity, and dynamics are systematically tied to these social functions and draw on broadly recognizable expressive cues.

Given that emotional engagement increases neural entrainment across individuals [83,84], musical emotion communication might harness this same mechanism to promote interpersonal synchronisation engagement in the social rituals. Anthropologists and psychologists alike have proposed synchronized action in rituals may enhance group cohesion, promoting cooperation and tightening social bonds, because they bring masses of people together in coordinated motions and minds [85,86]. Musical synchrony in ritual contexts may amplify these processes by inducing shared emotion, thereby strengthening group affiliation and credibly signaling cohesion to outsiders [12,13]. Increased neural coupling (as indexed by intersubject synchronization (ISC) across individuals) is observed particularly during affect-laden episodes of speech and cinema [83,84,87], and the degree of ISC is indicative of psychological attunement of the individuals [88]. When listening to affective music, such synchronisation peaks in the emotion circuits including amygdala, thalamus and caudate nucleus, highlighting the capacity of musical emotions to “tune in” different individuals [89].

This is supported by findings that body movement plays a central role in coordinating musical actions within ensembles [90] and may also shape the emotional expressiveness of music through interpersonal coordination among musicians [91]. Coordinated body sway among performers serves as a medium for greater information flow during expressive versus non-expressive performances, suggesting it reflects joint emotional expression. This coupling of body movement is associated with higher perceived emotional intensity by listeners, and during extremely energized music-evoked emotions such as excitement during heavy metal concert, the collective behaviour can self-organize from disordered gas-like states in the mosh pit into ordered vortexlike states of the circle pits [92], providing an effective means for mass synchronization.

A large bulk of evidence suggests that interpersonal synchrony is an important means for social boding and signifying alliances, a process which is thought to be mediated through the endogenous opioid system [93–95]. Pleasurable music is capable of engaging not only the dopamine system central for reward and incentive motivation [96] but also the endogenous opioid system [47] which has been implicated in both positive and negative emotions as well as affiliative behavior and social bonding [97].

MORs are also expressed in the vestibular afferent neurons [98,99] and in humans, nodding head while listening to music increases pain threshold - an indirect proxy for endogenous opioid release. Accordingly, shared rhythmicity and entrainment of actions, breathing and autonomic activation while singing or playing can provide a rhythmic framework facilitating synchrony [100], leading to subsequent opioid release promoting social bonding. Such bonding functions may subsequently operate independently of the actual mutual music making. Merely listening to music can reduce the feelings of loneliness and it has been proposed that music might act as a “social surrogate”, thus music may not only be used for establishing social bonds but may simulate social contact perhaps because it is perceived as expressing the emotions and intentions of another mind [101]

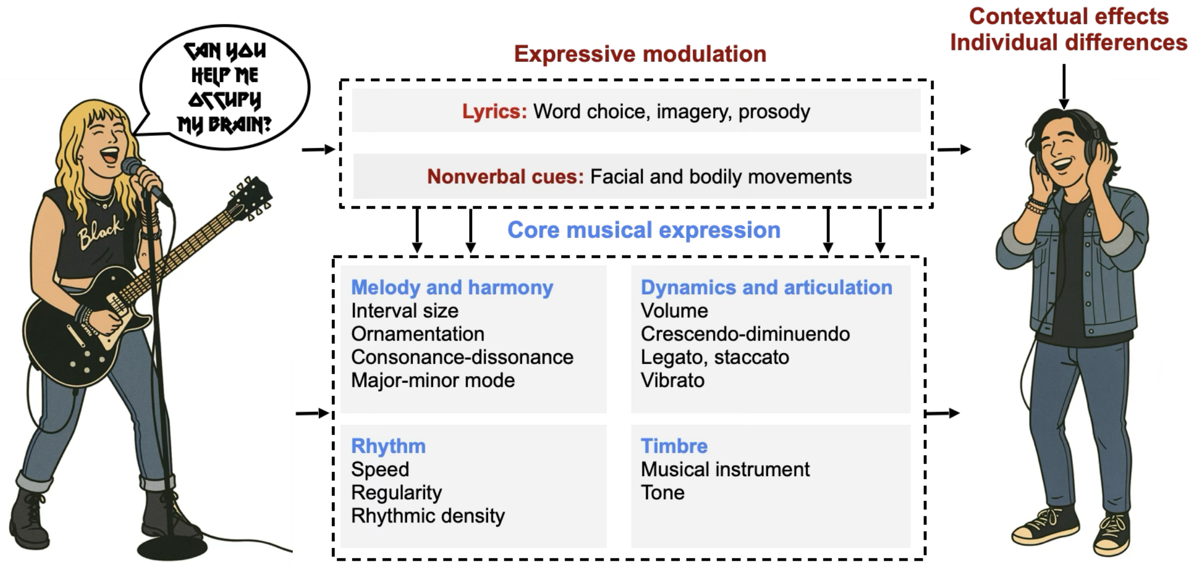

Figure 3 Emotional communication channels in music. The emotional tone of the music is primarily determined by the core musical features which can be however altered by concomitant nonverbal and verbal expressive channels.

Conclusions

Although laboratory music production tasks do not consistently engage emotion circuits, emotional qualities are inherently embedded into music, and musical communication is a powerful way of communicating emotion for establishing and maintaining social bonds (**Fig 3**). This is accomplished by a set of core musical features that generate the overall affective tone of the music, based on shared acoustic code between musical and vocal expressions [6], which is complemented by learned associations between musical emotions and features such as musical expressive cues and harmony [26–28]. This core musical expression can be further complemented by lyrical and nonverbal cues presented simultaneously with the musical performance, albeit the effects of such expressive modulation is modest in comparison with the core musical expression. Due to this multichannel nature of emotional communication, music offers an unique and rich means for transmitting affect and connecting minds with far greater cultural and situational flexibility than other means for expressing emotions.

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