

Reciprocity Between Music and the Emotional State

By Karen Wang

Author Bio

Karen Wang is a senior at Phillips Academy in Andover, Massachusetts. She has played piano and violin from a young age, and music remains a core part of her life today, as she currently plays in orchestra and chamber music groups at school. Her interests include computer science and biochemistry, and she hopes to integrate the arts, specifically music, into those fields through interdisciplinary research.

Abstract

Music and the emotional state are two concepts that are commonly associated with each other, and many studies have been conducted about their relationship. Some have discovered how listening to music activates parts of the brain that control the emotional state, such as the limbic system. Others have explored how the emotional state may influence the music that someone chooses to listen to. As a literature review, this paper takes studies from those areas to highlight the reciprocal relationship between music and the emotional state. This paper presents findings on the physiological mechanisms of music-evoked emotions, as well as how music serves as a self-regulatory tool for emotions. These findings provide greater clarity about the connection between music and emotions, which can help lead to more effective forms of behavioral management and music therapy. Future research can look more specifically into how one emotion is related to music listening, or how one genre of music is related to the emotional state.

Keywords: Music, emotions, music-evoked emotions, music therapy, physiology of emotions, regulating emotions

Introduction

People interact with music every day, whether it is intentionally played on the radio or played in the background of a store. It is common to encounter people having an emotional response to music, and it is also ordinary for people to listen to music that reflects their own emotional state. When listening to music, the brain receives auditory information that influences the emotional state. Music expresses emotions through various amalgamations of musical features, such as tempo and loudness, and the listener has their own perception of the music-expressed emotion. In addition, music induces emotions, as music activates parts of the brain that regulate and control emotions, such as the amygdala and the hippocampus. Listening to music affects the endocrine and autonomic nervous systems as well, leading to hormonal and physiological changes. On the other hand, the listener's emotional state affects their choice of music due to self-regulatory goals. Music can fulfill various self-regulatory strategies and serve self-regulatory functions, and personal preference and association is especially important in the process of choosing music.

This literature review serves to explore the relationship between music and the emotional state and discuss the reciprocity between these two elements. Published literature was used for the discussion, and keywords such as, "music-evoked emotions," "physiology," "music and the brain," and "selecting music" were searched on Google Scholar, JSTOR, and ProQuest. Articles were sourced from scientific journals such as *Journal of New Music Research*, *Psychology of Music*, and *Frontiers in Neuroscience*.

Discussion

Definitions and Fundamental Physiology

The relationship between music and the affective state is a complex one. To understand this relationship, multiple terms must be defined. Firstly, Longe (2022) defines emotions as a physiological response to external stimuli. An emotional response is dependent on personal experiences, cognitive appraisal, and subsequent behavior (Longe, 2022; Van den Tol & Edwards, 2011). Feelings are an aspect of emotion (Scherer, 2004), as they are the conscious

awareness of emotions (Herbert et al., 2011). While emotions and feelings are closely related, emotions primarily describe physiological changes, while feelings are the mental experience of emotions. Finally, affect is a general term covering both emotion and mood, and moods are less intense than emotions and tend to last longer (Van den Tol & Edwards, 2011). All these psychological and physical changes ultimately serve to regulate and maintain homeostasis and to allow the body to respond appropriately to external disruptions (Scherer, 2004; Habibi & Damasio, 2014).

Physiology of Emotions

Emotion activity in the brain involves many parts of the limbic system, which is a collection of nerves and structures located near the cerebral cortex that control emotions and behavior (Longe, 2022). One of these structures is the amygdala, which is in the medial parts of the temporal lobe and plays a key role in controlling the status of emotions ("human nervous system"; Koelsch, 2014). PET (Positron emission tomography) studies, which reveal glucose metabolism during memory encoding, show that the amygdala helps with forming long-term emotional memories (Dalgleish, 2004). Also in the temporal lobe, the hippocampus plays a major role in emotional processing by consolidating long-term memory (Hale, 2020). It interacts with the amygdala in a strong two-way relationship, increasing the plasticity of these two structures and supporting long-term emotional storage. (Schaefer, 2017; Koelsch et al., 2006).

Located in the brain stem, the hypothalamus lies below the thalamus and is the center for controlling the endocrine system, which manages hormones, emotions, and behavior ("human nervous system"), as well as the autonomic nervous system, which regulates involuntary physiological processes (Kriegbig, 2010; Longe, 2022). In addition, hypothalamus activity is influenced by information from cortical areas, such as the anterior cingulate and central nucleus of amygdala (Kriegbig, 2010). These limbic structures and systems in the body communicate and interact with each other to create an affective experience. Proposed in 1949, MacLean's limbic system model suggested how changes in the world resulted in bodily changes, and messages about these bodily changes would be sent to the brain and continually integrated with its current perception

of the outside world (Dalglish, 2004). Sensory information is received by the brain stem and then passed on to the limbic system. Subsequently, limbic system structures – specifically the hypothalamus, amygdala, and hippocampus, and parts of the thalamus – produce physiological changes that are carried out by the endocrine and autonomic nervous systems (Longe, 2022). For instance, after sensing danger, the brain sends a neural signal to the pituitary gland to release the ACTH hormone, causing the adrenal glands to produce cortisol – an anxiety hormone that induces the “fight-or-flight” response – which result in physiological changes, such as increased heart rate and respiration. (Longe, 2022).

Mechanisms of the Auditory System

Sensory activity begins in the ear, which is split into three divisions: external, middle, and inner. Sound waves from the external environment vibrate the eardrums, which are connected to ear bones that carry sound waves to the cochlea in the inner ear. The cochlear hair cells then turn the mechanical sound waves into neural signals that are sent to the brain by the auditory cortex in the temporal lobes (A. Bennet & D. Bennet, 2008; Schaefer, 2017). Boso et al. (2006) suggested that the processing of musical stimuli mainly occurs in right hemispheric structures, but a later study by A. Bennet and D. Bennet (2008) revealed how the whole brain is involved in musical processing. The temporal lobe in the right hemisphere detects musical elements such as pitch, harmony, and beat, while the temporal lobe in the left hemisphere evaluates lyrics and changes in rhythm and frequency. Finally, the frontal lobe connects the auditory information with thought and interacts with the limbic system to induce emotions (A. Bennet & D. Bennet, 2008).

Physiology of Music-Evoked Emotions

Music evokes responses in limbic structures, such as the amygdala and hippocampus (Koelsch, 2010; Koelsch, 2014; Schaefer, 2017). The amygdala receives information from the central auditory systems and processes emotions in response to the sensory information. The hippocampus plays a role in forming social attachments – music acts as a social function for creating and maintaining social connections – and long-term musical emotive memory (Schaefer, 2017). Certain musical features are associated with specific

physiological responses; consonance influences the paralimbic and cortical brain areas, musical tempo is related to cardiovascular dynamics, and loudness is associated with “psychoneuroendocrinological” responses to music (Schaefer, 2017). Furthermore, musical tension constructed through structural and tonal fluctuations contributes to physiological activity. The buildup of tension is perceived as unpleasant stimuli, and the resolution of tension is affiliated with relaxation and reward, which ultimately activates brain regions associated with reward such as the amygdala, hippocampus, and other structures in the limbic system. (Koelsch, 2014).

Along with activating parts of the brain, listening to music can also affect the autonomic nervous system, as shown through changes in heart and respiration rates, temperature fluctuations, and skin responses (Habibi & Damasio, 2014). Neuroendocrine changes (hormonal changes in the brain and body) also occur in response to music due to physiological processes. For instance, cortisol is a hormone that is associated with psychological and physiological stresses, and listening to classical choral, meditative, or folk music decreases the level of cortisol (Schaefer, 2017).

Pleasant vs Unpleasant Music

When listening to music is a pleasurable experience, the listener may experience physiological changes such as increased heart rate, respiration, and decrease in temperature. Pleasant music has also been shown to activate the dopaminergic reward system and lead to an increase in endogenous dopamine release (Habibi & Damasio, 2014). Additionally, pleasant music activates brain structures, including, but not limited to, the inferior frontal gyrus, the ventral striatum, and the anterior superior insula (Boso et al., 2006). On the other hand, when the listener perceives the music as unpleasant, the human sensory system is incapable of properly discerning dissonant stimuli, causing an irritating sensation (Habibi & Damasio, 2014). Consequently, Habibi and Damasio (2014) and Koelsch et al. (2006) found that unpleasant music activates the amygdala, hippocampus, parahippocampal cortex, and the temporal poles, whereas pleasant music leads to deactivations in those structures. Certain negative induced emotions, such as fear, result in an increased heart rate. Other emotions, such as non-crying sadness, result in a decreased heart

rate (Kriegbig, 2010).

Expressing and Perceiving Emotions

Music can express emotions. Features of music, which include but are not limited to, tempo, consonance, harmony, timbre, and rhythm, contribute to the expression of music (Juslin & Laukka, 2004; Schaefer, 2017). Different emotions are composed of different groups of features, and multiple emotional expressions may use the same feature in a similar manner. For instance, a slow tempo and soft dynamics are utilized in the expression of sadness (Habibi & Damasio, 2014), but the expression of tenderness often also involves a slow tempo (Juslin & Laukka, 2004).

While the composer or performer intends to express a certain emotion through the music, the listener forms their own perception of the musically expressed emotion. Emotional perception is a “cognitive process” that does not require emotional involvement of the listener because it is purely how the listener perceives, or discerns, the emotions that are being expressed by music (Juslin & Laukka, 2004). For instance, listeners may perceive sadness from a piece of music but do not personally experience sadness while listening to it (Corrigall & Schellenberg, 2013). Juslin and Laukka (2004) proposed that the perception of emotions has been investigated in two ways: “listener agreement” and “accuracy”. Listener agreement refers to a common agreement among listeners about the emotions the music expresses, and accuracy is the comparison between the listener’s emotional perception and an independent criterion, which is typically the emotion that performer or composer intended to express through the music.

Music-Induced Emotions

While perceiving emotions when listening to music does not require emotional activity, music can induce emotions in listeners (Scherer, 2004). Evidence of music-induced emotions primarily comes from self-report, behavior, and physiological changes. Self-report allows the listener to respond verbally (questionnaire, adjective checklist, etc.) or non-verbally (drawing a picture, moving a slider, etc.). However, self-report is not always the most reliable, so measuring behavior, or products of behavior, is used as another method. This involves tracking facial expression, body language, or less blatant reactions

such as purchase intentions (Juslin & Laukka, 2004). It is important to note that the intended expression of emotion in the music may not correspond with the emotions induced in the listener (Corrigall & Schellenberg, 2013). For instance, a musician may be trying to express sadness through their performance, but the listener may feel nostalgia, or even happiness, because the performance reminds them of a fond memory with a loved one. Understanding personal preference and context are vital for understanding music-evoked emotions.

Basic vs Aesthetic Emotions

Music can evoke a wide range of emotions for the listener, but many studies have focused their research on more basic emotions, such as happiness and sadness. Scherer (2004) uses the term “utilitarian” to describe these basic emotions that have been typically used in emotion research. These utilitarian emotions are crucial in adaptation and adjustment to external stimuli, and these are associated with fundamental life issues, like fear with danger, loss with sadness, and social cooperation with happiness (Juslin & Laukka, 2004; Scherer, 2004). However, listening to music may evoke emotions that are not linked to survival instincts, and oftentimes appreciating a piece of music is not relevant to personal needs at all. Scherer (2004) describes these emotions as an “aesthetic” experience, which “are not proactive but rather diffusely reactive” (p. 244). Aesthetic emotions are entirely based upon appraisal of auditory stimuli, and some common physiological responses include goosebumps and shivers (Scherer, 2004).

With basic and aesthetic emotions in mind, a study conducted by Juslin and Laukka (2003) revealed how basic emotions are more accurately expressed and perceived because their expression is dependent on musical features that are similar to elements of vocal expressions of emotion, such as loudness, rhythm, and timbre. Pereira et al. (2011) also suggests that “basic emotions are the immediate affective responses to music” (p. 1). Juslin and Laukka (2004) demonstrated how basic emotions like happiness and sadness were most commonly felt in listeners, while complex aesthetic emotions, such as jealousy and confusion, occurred much less often.

Emotional Modeling

Emotions are deeply subjective experiences, and it is difficult to conduct research on such a phenomenon. However, Scherer (2004) describes three major practices that have been used to measure emotions. The first one is a basic emotion model that focuses on discrete emotions. It assumes that an affective state induced by music is like the affective state in “real life”, and it suggests that there are between seven and 14 basic emotions that each have their own “eliciting conditions” and “specific physiological, expressive, and behavioral reaction patterns” (p. 246). However, this model is not fit to fully encapsulate the depth of music-evoked emotions. The second practice is the two-dimensional valence-activation model, which has become widely used in affective research. Valence, the pleasant-unpleasant scope, and activation, or arousal, are central to the emotional experience, and this model is more realistic in describing the emotional response to music. Unfortunately, representing a feeling in only two dimensions is limiting because many emotions may have similar valence-activation representations. The third practice is an eclectic approach that uses affect labels that the researcher deems relevant to their study. There is great flexibility for the labels that can be utilized, and this model best represents the complexity of emotional experiences from music. But this model may not be as reliable because the labels are uniquely chosen for each study, preventing any comparison of data with other studies (Scherer, 2004).

Selecting Music and the Emotional State

Listening to music has been shown to affect the listener’s emotional state, but the inverse is also true, as one’s emotional state influences the music they choose to listen to. Research has shown how music can serve self-regulatory functions, especially with self-identified sad music (SISM), and many people use music as a tool to regulate their mood and emotions (Cook et al., 2019; Van den Tol & Edwards, 2014). Van den Tol and Edwards (2011) defines mood regulation as processes in which mood states can be managed, and self-regulation as handling all psychological processes related to the self. Specifically in times of crises, music listening can be a crucial self-regulatory tool, as listening to music was especially beneficial during the COVID-19 pandemic as a form of mood regulation (Gibbs & Eggermann, 2021).

Music Serving as Self-Regulatory Strategies and Functions

Van den Tol and Edwards (2011) suggests that regulation involves the use of strategies, which are “conscious and unconscious goal-directed activities aimed at achieving certain outcomes” (p. 3). Van den Tol and Edwards (2011) conducted a study on why people listen to SISM when experiencing emotional distress, and they discovered several emerging self-regulation strategies that music listening served, such as connection between their own affective state and the emotional expression of the music, memory triggers, high aesthetic value, and message communicated. With these strategies, music can serve various functions as a self-regulatory tool. These include experiencing affect, cognitive appraisal, retrieving memories, acting as a friend, providing distraction, and mood enhancement (Van Den Tol & Edwards, 2011). Furthermore, Juslin and Laukka (2004) found that people most commonly listen to music to “express, release, and influence emotions” (p. 232). All in all, the listener’s affective state influences the music they choose to listen to because the process is dependent on how they want to regulate their affective state. For instance, if one wants to enhance their current emotions and experience them more deeply, they may listen to music that they find an affective connection with.

Importance of Preference and Association

In the music-selection process, personal preference and context is a key factor. The listener’s past experiences influence how they perceive and choose music for their personal self-regulatory goals. For instance, slow music is often associated with relaxation, but someone may have a negative memory associated with a specific slow song because it reminds them of a lost loved one, so they would not choose to listen to that slow song for relaxation. The way that someone emotionally responds to music is greatly influenced by their personal associations to the piece of music (Walworth, 2003), ultimately affecting when and how they would choose to listen to that music again in the future. Consequently, little material was found regarding the relationship between the affective state and selecting music because this process is a greatly subjective experience, making it difficult to quantify this information and reliably collect data about this relationship.

Conclusion

This review explores how music and the emotional state exist in a reciprocal relationship; music expresses and induces an emotional state by activating the limbic system in the brain and evoking physiological changes, while the emotional state influences the listener's music choice through self-regulatory goals and personal preference. This close connection between music and the affective state could be utilized in strengthening the effectiveness of music therapy or behavioral management, perhaps in the classroom or in child developmental environments. Also, the concepts discussed in this review were generally broad, as minimal research has been specifically conducted in relation to emotions related to music listening. Future directions could include investigating behavioral changes in response to certain genres of music and examining the situational and subjective component of music-evoked emotions.

References

- Bennet, A., & Bennet, D. (2008). The human knowledge system: Music and brain coherence. *VINE*, 38(3), 277-295. <https://doi.org/10.1108/03055720810904817>
- Boso, M., Politi, P., Barale, F., & Emanuele, E. (2006). Neurophysiology and neurobiology of the musical experience. *Functional Neurology*, 21(4), 187-191. https://www.researchgate.net/profile/Pierluigi-Politi/publication/6439036_Neurophysiology_and_neurobiology_of_the_musical_experience/links/540714480cf23d9765a8358c/Neurophysiology-and-neurobiology-of-the-musical-experience.pdf
- Cook, T., Roy, A. R. K., & Welker, K. M. (2019). Music as an emotion regulation strategy: An examination of genres of music and their roles in emotion regulation. *Psychology of Music*, 47(1), 144-154. <https://doi.org/10.1177/0305735617734627>
- Corrigall, K. A., & Schellenberg, E. G. (2013). Music: The language of emotion. *Handbook of Psychology of Emotions*, 299-325. <https://www.utm.utoronto.ca/~w3psygs/CorrigallSchellenberg2013.pdf>
- Dalgleish, T. (2004). The emotional brain. *Nature Reviews Neuroscience*, 5, 582-589. <https://doi.org/10.1038/nrn1432>
- Emotion. (2022). In J. L. Longe (Ed.), *The Gale Encyclopedia of Psychology* (4th ed., Vol. 1, pp. 381-384). Gale in Context: Science. https://link.gale.com/apps/doc/CX8273700263/SCIC?u=mlyn_n_phillips&sid=bookmark-SCIC&xid=a23dc260
- Gibbs, H., & Egermann, H. (2021). Music-evoked nostalgia and wellbeing during the United Kingdom COVID-19 pandemic: Content, subjective effects, and function. *Frontiers in Psychology*, 12, 1-16. <https://doi.org/10.3389/fpsyg.2021.647891>
- Habibi, A., & Damasio, A. (2014). Music, feelings, and the human brain. *Psychomusicology: Music, Mind, and Brain*, 24(1), 92-102. <https://doi.org/10.1037/pmu0000033>
- Hale, G. R. (2020). The biological basis of memory. *Gale Science Online Collection*. Gale in Context: Science. https://link.gale.com/apps/doc/GJBZUF577882439/SCIC?u=mlyn_n_phillips&sid=bookmark-SCIC&xid=80f7cd31
- Herbert, C., Herbert, B., & Pauli, P. (2011). Emotional self-reference: Brain structures involved in the processing of words describing one's own emotions. *Neuropsychologia*, 49(10), 2947-2956. <https://doi.org/10.1016/j.neuropsychologia.2011.06.026>
- Human nervous system. (n.d.). *Encyclopaedia Britannica*. Retrieved July 18, 2023, from <https://academic-eb-com.proxy5.noblenet.org/levels/collegiate/article/human-nervous-system/110704>
- Juslin, P. N., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: Different channels, same code? *Psychological Bulletin*, 129(5), 770-814. <https://doi.org/10.1037/0033-2909.129.5.770>
- Juslin, P. N., & Laukka, P. (2004). Expression, perception, and induction of musical emotions: A review and a questionnaire study of everyday listening. *Journal of New Music Research*, 33(3), 217-238. <https://doi.org/10.1080/0929821042000317813>
- Koelsch, S. (2010). Towards a neural basis of music-evoked emotions. *Trends in Cognitive Sciences*, 14(3), 131-137. <https://doi.org/10.1016/j.tics.2010.01.002>

Koelsch, S. (2014). Brain correlates of music-evoked emotions. *Nature Reviews Neuroscience*, 15, 170-180. <https://doi.org/10.1038/nrn3666>

Koelsch, S., Fritz, T., & Cramon, D. Y. V. (2006). Investigating emotion with music: An fMRI study. *Human Brain Mapping*, 27(3), 239-250. <https://doi.org/10.1002/hbm.20180>

Kreibig, S. D. (2010). Autonomic nervous system activity in emotion: A review. *Biological Psychology*, 84(3), 394-421.

Pereira, C. S., Teixeira, J., Figueiredo, P., Xavier, J., Castro, S. L., & Brattico, E. (2011). Music and emotions in the brain: Familiarity matters. *PLoS ONE*, 6(11), e27241. <https://doi.org/10.1371/journal.pone.0027241>

Schaefer, H. (2017). Music-evoked emotions—Current studies. *Frontiers in Neuroscience*, 11, 1-27. <https://doi.org/10.3389/fnins.2017.00600>

Scherer, K. R. (2004). Which emotions can be induced by music? What are the underlying mechanisms? And how can we measure them? *Journal of New Music Research*, 33(3), 239-251. <https://doi.org/10.1080/0929821042000317822>

Van den Tol, A. J.M., & Edwards, J. (2011). Exploring a rationale for choosing to listen to sad music when feeling sad. *Psychology of Music*, 41(4), 1-26.

Van den Tol, A. J.M., & Edwards, J. (2014). Listening to sad music in adverse situations: How music selection strategies relate to self-regulatory goals, listening effects, and mood enhancement. *Psychology of Music*, 43(4), 1-22. <https://doi.org/10.1177/0305735613517410>

Walworth, D. D. (2003). The effect of preferred music genre selection versus preferred song selection on experimentally induced anxiety levels. *Journal of Music Therapy*, 40(1), 2-14.