Critical Review and Evaluation of the Literature on Listeners' Emotional Reactions

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Abstract .he listener's emotional reaction is significant for the performer, as well as for people who participate in musical activities. Research on the emotional response to music is hampered by the lack of a systematic and reliable approach for measuring emotional response. In this article, the researcher critically reviewed the literature on measuring the emotional reaction of music from several perspectives, including emotion-theoretical models, the application of models, the methods of collecting listeners' emotional reactions, selection of musical stimuli, and testing environment. To investigate the limitations of previous research, and promote academic awareness of the relevance of method collaboration in developing a more valid, uniform, and systematic approach to assessing emotional reactions.

Keywords :usic; listeners; emotional reactions

1 Introduction

This article reviewed the literature and study on measuring the emotional reaction of music. The listener's emotional reaction is reported to be critical for the performer[30], and it is also the primary reason for people to participate in musical activities[56]. However, the lack of a unified theory of emotion and inconsistency in the definition of emotion in music[28, 39], lead to the lack of a systematic and valid method for measuring emotional reaction therefore bringing a challenge in the emotional reaction to music research.

This article will first review the literature and study of emotion models, particularly, the discrete emotion models which are used frequently in research, and discuss the pros and cons. After this, I will focus on the methods of collecting emotional reactions in experiments, including self-report and biological methods. Furthermore, various types of musical stimulus materials will be reviewed. These include Western classical music, popular music, and natural and composite music since musical stimulus materials are the primary source of eliciting emotional reactions to music. Finally, emotion will be affected by different musical environments[29] thus I will discuss the advantages and limitations of conducting experiments in different musical environments such as studio, daily life and in concert. A critical review and evaluation of the research literature on

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measuring emotional reaction to music will be conducted because there is growing research on emphasis on emotional reaction which should be encouraged. Whilst the research is conducted in the field of emotional reaction in music, the more limitations of the lack of consistency in this field become apparent, but few researchers appear to consider this.

2 Proposal of Emotion-theoretical Models

2.1 Discrete Emotional Models

The existing literature has identified three primary types of emotional models: discrete emotional models, dimensional emotional models, and musical emotional models. The discrete models focus on basic emotions, although they can be somewhat limited in scope. The foundational basic emotions, as defined by Ekman et al. in 1972, consist of happiness, surprise, sadness, fear, anger, and disgust[14]. Similarly, Izard in 1977 proposed a set of fundamental negative emotions, encompassing sadness, anger, disgust, and fear[27]. Although these emotions might seem limited, this theory posits that all other emotions can be derived from these core categories. Beyond these, Ekman expanded the concept to include 16 positive emotions[13], and Harmon-Jones introduced the idea of emotional families[23], further broadening the emotional model landscape.

2.2 Dimensional Emotional Models

The dimensional models may be more accurate. Russell proposed a well-known circumplex model[53]. It can be said to be different to the discrete emotion model as the dimensional theory of emotion asserts that core affect is continuous in the brain, consisting of a mixture of Pleasure/Valence (pleasure-displeasure) and Arousal (activation-deactivation) dimensions[54]. However, Mather et al. argue that emotionally arousing stimuli are more accurately remembered in detail than non-arousing stimuli, regardless of their valence[38]. This also implies that arousal and valence may be related in terms of detailed memory accuracy for emotional items and that the two dimensions contribute relatively independently which may lead to an imbalance of contribution in the study.

2.3 Musical Emotional Models

The musical emotional models are uniquely designed for the emotional expression in music, aiming to categorize musical emotions with greater accuracy to align with the emotional intent of musical compositions. Hevner's circular ordering of emotions was one of the earliest models tailored specifically to music[24]. Following this, Gabrielsson identified seven core emotions in music, including happy, sad, angry, fearful, solemn, and tender[16]. Since then, researchers have identified a growing list of musical emotions: Juslin et al.[32] introduced 15 distinct musical emotions, and Zentner et al. proposed nine emotional factors[63]. However, Warrenburg noted that listeners might find it harder to recognize sound-based stimuli compared to the typical basic emotions, indicating that while these musical models offer more precise categorization, listeners might struggle to associate music with these specified emotions[60].

Among the three primary emotional models—musical emotional models, discrete emotional models, and dimensional emotional models—the challenge lies in effectively systematizing musical emotions.[20] Discrete and dimensional models are often utilized to describe emotions more broadly. The discrete model suggests that emotions consist of basic elements such as happiness, sadness, and anger[28]. In contrast, the dimensional model views emotions as continuous, defined by two key dimensions: Valence and Arousal[53]. It is thought that a combination of these models could better capture the nuances of musical emotion[10]. However, there's a lack of research on the potential cooperative relationship between these three models. Further study in this area could be highly beneficial to better understand and measure musical emotions.

3 Application of models in experiments

3.1 Discrete Emotional Models

The empirical studies in the literature provide extensive evidence of the basic emotion which is related to discrete emotion models that can be identified accurately. Nusbaum et al. evidenced that people's physical or mental perceptions of emotional states in music are derived from basic emotions[43]. These emotions can be perceived by all kinds of populations, including children with hearing impairment[39], children suffering from traumatic brain injury[18] and both older and younger adults can recognise a variety of emotions[58]. However, discontinuities in basic emotion may present obstacles when attempting to measure emotions that exist between basic emotions or to measure the extent to which emotion perception is diminishing, for example, lower fear perception in brain injury children[18]; children with congenital hearing impairment have a lower perception of sadness and fear compared to happiness[39], besides, the all emotion perception of older adults is lower than the younger adults in the test[58]. To what extent were these participants' perceptual abilities diminished? Can the emotions of fear and sadness in brain-damaged children be properly identified? These situations may be difficult to explore through discrete models.

There were some shortcomings in these experiments, which may influence the persuasiveness of the study results. Although listeners were in a quiet room listening to the recording in Gosselin's and Mazaheryazdi's experiments, which may have reduced the influence of the outside world, this environment may have lower rates to arouse listeners' emotional reactions than their familiar surroundings, especially for some people who do not like to be in an unfamiliar quiet room[18, 39]. Sutcliffe's experiment used headphones; in this way, listeners can adjust the volume themselves[58], which can reduce the influence of different hearing levels[44]. Although, if the stimuli are only presented once, this can potentially shorten the reaction time of older adults.

3.2 Dimensional Emotional Models

Empirical studies in the literature demonstrate that discrete emotion models, focusing on basic emotions, can be used to accurately identify emotional states. Nusbaum et al.found that people's perceptions of emotional states in music, both physically and mentally, are linked to basic emotions[43]. These emotions can be recognized by various groups, including children with hearing impairments[39], children with traumatic brain injuries[18], and both older and younger adults[58]. However, discontinuities in basic emotions can create challenges in measuring emotions that exist between these basic categories, or in gauging diminished emotional perception. For instance, Gosselin noted reduced fear perception among brain-injured children[18], while Mazaheryazdi reported lower sadness and fear perception in children with congenital hearing impairments compared to happiness[39]. Additionally, Sutcliffe found that older adults displayed lower emotional perception compared to younger adults[58]. This raises questions about whether discrete models can effectively measure emotions in cases where basic emotions may be altered or impaired.

Experimental limitations may affect the reliability of study results. In Gosselin's and Mazaheryazdi's studies, listeners were in a quiet room while listening to recordings, potentially reducing outside interference[18, 39]. However, this controlled setting might not elicit the same emotional reactions as more familiar environments, especially for participants who are uncomfortable in quiet, unfamiliar settings. Sutcliffe's study used headphones, allowing listeners to adjust the volume, which could reduce the impact of varying hearing levels[58]. Nevertheless, if the stimuli are presented only once, this might reduce reaction time, especially for older adults.

Regarding dimensional emotional models, many studies ask participants to rate emotions on a bipolar scale of valence and arousal.[8] This approach appears straightforward for participants[34]. Vieillard et al.'s study with 59 randomly recruited students, who rated their emotions after listening to music on a CD, revealed that more students felt happy, suggesting arousal is more easily conveyed[59]. The results were presented as descriptive statistics, showing a general trend. However, using familiar music clips in the experiment could introduce additional variables, potentially affecting listeners' emotional responses. Replacing these with unfamiliar music clips might have improved the experiment's credibility. Other research supports Vieillard et al.'s findings, indicating that arousal contributes more to the dimensional model[19, 52], possibly due to the inherent nature of the musical experience. Music is often perceived as beneficial, and negative emotions in music are relatively rare[32, 47].

3.3 Musical Emotional Models

Studies using music models supplemented the area that discrete and dimensional models neglect, which brings challenges to listeners in recognising music models as well.[9] In Vieillard's experiment, he added musical emotions to the basic emotions, such as peaceful and ambivalent but discovered that ambivalent emotions were only recognised at a rate of 12%[59]. Furthermore, Xing et al. used an entire set of musical emotion models in which they found that listeners were defining musical emotions such as 'dignified', resulting in a majority value of 0 in the dignified emotion in most of the listeners' reports[62]. Interestingly, Gabrielsson reported that the recognition rate of the music emotion such as solemn was higher than some basic emotions in his studies, and despite the ambiguity of the emotion, it can still be recognizable[16]. Since there is complexity and precision of musical emotions, it is reported to lack widespread understanding and recognition[26]. The lack of recognition may impact the quality of the experiment due to the unevenness of the data.

Based on this article, musical emotion experiments mainly use discrete and dimensional emotional models which may lead to the neglect of some special emotions conveyed by music. Although increasing experiments use music emotion models, the conceptual framework of music emotions is not consistent and there are not clear emotion definitions which increases the listener's challenges in recognizing music emotions. As a result, additional experiments that utilise music models are needed, and pre-experiment explanations to listeners may be necessary as well.

4 The Methods of Collecting Listeners' Emotional Reaction

4.1 Self-report

Regardless of which model is used, self-report is the majority method for collecting emotional reactions in the research literature although this method may be limited by an individual's level of perception of their own emotions.[4] This method requires that listeners report their personal feelings about the music to which they are experiencing via a questionnaire or an electronic device. Mazaheryazdi required students to choose sadness, happiness, and fear after listening to music[39], and Song et al. asked listeners to complete a questionnaire[57]. However, in the Song et al. experiment, almost all of the listeners were musically trained and 88% of them played at least one instrument[57]. Although these experiments were designed to be simple in terms of emotion options, in some cases, a different level of emotion perception may affect the reported results, such as people with brain damage or the experiment listeners who had learned and others who had not learned music. Because musical training specifically trains the expression and perception of emotion, it is perhaps easier for those with musical training to accurately identify their perceived emotions, whereas those without musical training may face challenges in certain situations, especially when there are words that more accurately describe music, such as tender. The mental activity and associated patterns of brain activation are distinct in these two populations[64]. Self-reporting may be unreliable[29], particularly when children or children with brain damage are questioned. as they may have difficulties correctly identifying the emotions they perceive.

4.2 Biological methods

With the advancement of technology, increasing studies have emerged using biological methods, which test the human brain's reactions that identify an individual's emotional reaction by examining the activity of various brain areas through technological devices, although the devices may miss reactions when the emotions are not strong enough. According to Blood and Zatorre, music induces a highly pleasurable sensation of "shivers-down-the-spine" or "chills" and the more intense the emotion, the greater the change in blood flow to the brain[5]. Furthermore, Alfredson et al found that pleasurable music activated the right temporal lobe more[1]. The two experiments above revealed that most of the obvious emotions could be measured, but that the changes were inconsistent but it could be explained by the different emotional reactions elicited by the different materials used for the musical stimuli. In general, not all emotional reactions will induce physiological changes that are detectable by machines. As a result, it has been suggested that not every emotion is associated with a physiological "fingerprint"[3].

There is, however, literature that combines self-reporting and physiological reporting, such as Egermann et al.'s experiment which allowed listeners to self-report via iPod while simultaneously collecting biological data via sensors[12]. Combining the two approaches can be seen as a positive trend. To sum up, the existing literature illustrates that either self-report or biological methods can measure emotions, but the accuracy of feedback on musical emotions is still a challenge. [17]Thus, combining the two methods and then refining them may facilitate accurate feedback on musical emotions and it is worthwhile to be explored further.

5 Selection of Musical Stimuli

5.1 Music Genres

Although Western classical music appears to be easier in eliciting emotional reactions, at least in Western listeners, its use as stimulus material may have limitations. The majority of studies have made use of Western classical music[11]. Although listening to Western classical music can stimulate the striatum ventral, the left striatum dorsal, the hippocampus, and the amygdala[41], everyone has a preference for different types of music, and simply focusing on Western classical music may overlook the emotional reactions of listeners who prefer other styles. [46]Extroverts, for example, prefer more aggressive music, such as pop or rock[9, 50], whereas more conservative individuals are reported to tend to not prefer genres such as heavy metal and rap[36]. Utilising a large amount of Western classical music as stimulus material may not benefit data collection, especially if the large proportion of listeners who prefer non-classical music is greater. There have been additional experiments utilising popular music as a stimulus material which have emerged in recent years[57].

5.2 Natural and Composite Music

Two types of musical stimuli are frequently used in experiments as musical stimuli: natural music, which is pre-recorded music performed by musicians and played back to participants via video or audio recordings; and composite music, which is music synthesised using computer technology. [42]Music can display the natural music to listeners but it may be influenced by the performer's subjective expression and may have a lack of acoustic parameters. [49]Hunter et al. used an iMac to present videos to listeners, whereas Mazaheryazdi et al. used audio[25, 39]. This may reduce some of the emotional expression issues associated with composite music, but it may lack persuasive parameters. Additionally, Repp recorded 115 pianists performing the same piece, but with varying illustrations by, such as different starting beats and different representations of expressive notation[51]. In the 115 versions, the difference between the maximum and minimum speed can be up to twice as great. This also implies that the emotional expression of the music may be influenced by the performer's subjective factors. Although these distinctions can enhance the attractiveness of natural music[30] and provide the listener with a real expression of emotion, it may not reflect the emotion that the material was originally intended to convey due to subjective expression, and influence the emotional recognitions.

The prevalence of technological composition increases the likelihood of using composite music as a stimulus in experiments, the complexity of composite music may cause difficulties in expressing musical emotions.[2] Scirea evidenced that computer systems can reliably generate emotional music, in the sense that creating an adaptive and dynamic soundtrack with a search-based melody generator[55]. Interestingly, Quinto, Thompson and Taylor observed that fear was more perceptible in computer-generated music than in music performed by professional musicians[48]. Additionally, evidenced that providing listeners with both the extracted audio (composite music) and standard audio (natural music) can improve emotional recognition[45]. Although these experiments were successful in composite music examples and increasing listeners' emotion recognition, Eerola and Vuoskoski suggested that only a few researchers have been able to employ complex techniques that accurately express emotions[11]. As not every parameter of emotions can be offered and measured, it still relies on the composer's experience and aesthetics, thus this presents a challenge to the composer of composite music.[54]

5.3 Cultural Background Affects Listeners' Emotions

The experiments reviewed in this paper mainly utilised music with a Western cultural context and made few cultural background requirements of the participants[15, 59]. Although emotional reactions share significant acoustic characteristics with speech and music[30], for example, music worldwide is reported to be faster in tempo and louder in anger, and slower in tempo and quieter in tenderness, there are similarities in human speech expression[6, 7, 35, 61], it is more likely to elicit an emotional response when the cultural context of the music is similar to that of the listener. Fritz observed that Western listeners were more likely to recognise the emotions expressed in Western background music by comparing their emotional responses to music than Mafa (native African population) listeners[15]. However, Mafa may find it easier to react to the music of its own country. Notably, it is possible that participants from other countries may have inadvertently listened to Western music, which could have had a small effect on the experiment's results. Generally, the music of the world shares similarities, but a familiar cultural context may elicit a stronger emotional response from listeners.[22]

The existing studies showed several challenges in the selection of musical materials, including a possible mismatch between the listeners' culture and the cultural context of the music, the use of Western classical music in the majority of experiments, which limits data collection, and the difference between natural music and composite music shows potential factors to influence the emotional expression and recognition during the experiments. Little research investigated the selection of music stimuli for emotional reaction studies, and this gap needs to be filled.

6 Testing Environment

6.1 Experimental Studios

Because our perceptual system is constantly scanning our immediate environment[29], the environment in which we listen to music can influence our brain processing, and although studios may exclude the external influencing factors, a familiarity environment may be more conducive to emotional arousal.[65] The majority of existing studies were conducted in quiet studios, and these can avoid distraction by other factors[18, 37, 58]. However, what attracts us to the experience of musical emotions is their similarity to daily emotions[30], thus it is encouraged to research emotional reactions in other environments instead of confining environments to the studio only. Listeners in Hargreaves et al. experiment were tested in a daily life environment, he sent listeners music by mobile devices, although it may be easier to arouse listeners' emotions in familiar settings, listeners stated that there will have many effects that will disturb their emotions recognition[21]. Juslin's listeners also mentioned this, particularly when listening to music (stimulus material) in a space with other music playing[32]. This interference is commonly present in everyday environments, and avoiding it is difficult. However, experiments have shown that listeners prefer to listen to music during pleasurable times [21], and that listening to music in a pleasurable environment is more likely to be emotionally stimulating for listeners. Furthermore, for some listeners who were fearful of staying in a quiet room, particularly when tested with frightening music, may add extra mental stress that can affect emotional perceptions and thus affect test results.

6.2 Concerts

Except for the two environments above, some studies set the test environment in concerts; however, the musical experience may be influenced by doing the self-report.[31] Both Egermann et al. and McAdams involve listeners in emotional self-reporting throughout a concert[12, 40]. Egermann et al. observed listeners' emotional reactions during concerts and evidenced that emotional expectations could be tested[12]. McAdams's experiment required listeners to complete self-reports throughout the concert; the process took several minutes to accomplish which may affect the audience's musical experience, thereby affecting emotional reactions[40]. However, in an experiment conducted by Egermann et al., it was demonstrated that emotional expectations can be tested, and listeners stated that the test had no negative effect on their experience[12]. This difference could be explained by different methods of reporting the emotions, listeners in Egermann et al's experiment were required to swipe with their fingers through an iPod and could complete it in seconds[12], whereas listeners in McAdams's experiment took several minutes to complete the feedback, increasing the likelihood of being emotionally interrupted[40].

The music studio is frequently used as a testing context in the literature on musical emotions, which reduces the impact of external influences on emotions for the majority of people. However, familiar environments are more likely to stimulate emotional reactions, and being in a living environment may allow listeners to show their most realistic emotional reactions, but it is still necessary for the researcher to provide some advice on avoiding distractions, such as trying to avoid having other music present at the same time while listening to the musical stimulus material. The concert setting provides a more enjoyable environment for listeners and is a likely benefit to arouse emotions. However, it is critical that the process is appropriately simplified so that there is an avoidance in interrupting listeners' emotional reactions.[33] There are few studies conducted by researchers outside of the studio environment, and further investigation is necessary.

7 Conclusion

In conclusion, this paper reviews the literature and experimental studies on listeners' emotional responses to music, revealing that discrete and dimensional emotion models are predominantly used.[18] Despite some studies utilizing musical emotion models[16, 59], the measurement of musical emotions lacks precision. This is partly due to a conceptual framework gap in musical models. Traditional methods for collecting emotional data, such as self-reports and biological measures, have limitations—self-reports can be prone to inaccuracy, while biological methods might miss subtle emotional cues. A combined approach could yield better results.

Additionally, the use of traditional Western music as stimulus material might not account for cultural differences or individual listener preferences, potentially skewing experimental outcomes[11]. The subjective emotions of performers in natural music could introduce variables that affect the consistency of emotional expression. To address these issues, combining natural and synthetic music could offer a more comprehensive perspective.

Experimental settings in quiet studios might dampen emotional responses due to reduced external stimuli. Conducting studies in more familiar and comfortable environments could better elicit listener emotions. Understanding audience reactions to music can be useful for performers, guiding them to tailor their performances and improve audience engagement. This paper suggests that researchers and scholars should consider integrating various methods to develop a more robust and consistent approach for measuring emotional reactions to music. By doing so, they can create a more effective framework that enhances the validity and reliability of future studies.

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