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Emotional Effects Stimulated by Sad and Fearful Music: A Comparative Study Based on ERP and Behavioural Experiment

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Abstract: In recent two decades, human brain's response to the emotions of music has become a focus in both neuroscience and applied musicology. Rapid development in brain scanning such as ERP technique provides facilities to explore this fascinating field. How people respond to music emotionally has become a new area of study. This study is one of such explorations and aims to probe into the physical and mental effects of music with negative emotions on humans. Event-related potential (ERP) and behavioural experiment were conducted with 81 participants (20 to 28 years old) with ANOVA / t-test as the analytical tool to compare the effects of two kinds of negative emotional music, i.e., sad music and fearful music. The results showed that the participants had different neural mechanisms, willingness to listen, feelings and music preferences regarding the two types of music with negative emotions. Although fear and sadness are both negative music emotions, the emotional effects on the participants were significantly different based on brain processing. The participants did not reject sad music, but less than 5% of the participants were able to accept fearful music. There were also significant differences in the speed and intensity of the electroencephalography (EEG) responses as well as emotional stability when the participants processed these two music emotions. In sum, this study suggests that close attention people should be paid to the perception of negative emotional music to design music activities that contribute to a positive aesthetic perception.

Keywords: Fearful Music, Sad Music, Emotional Effects, Event Related Potentials

1. Introduction

The effect of music on human emotion is an interdisciplinary area of research that covers music cognition, music psychology and music neuroscience. Current studies in this field focus on how the behaviour and process of listening affect listeners' emotions, for example, in whether listening to music can change emotions, release emotions, relieve emotions and respond to emotions [1]. Additionally, some studies have addressed the influencing factors of music emotion, such as individual differences and personality traits, listener's cultural background, music preference, and the emotional content of music itself.

Although whether music emotion is an objective measure of itself or a subjective judgement of the music by the listener remains one of the academic debates, there is no denying that music can be divided into different types of emotional categories, such as the happy, the sad, the scary, the joyous, and the angry. The most common area of research is to explore the guiding effect of positive emotional music on human emotions. Indeed, the positive emotions dominate the musical experience in daily life [2]. People incline to enjoy music that produces positive emotions [3]. On the other hand, negative emotions have also been explored in the field of music psychology research, especially regarding the pleasurable sadness in music [4]. Eerola and Vuoskoski [5] compared negative and positive emotions, such as happiness and sadness, calmness, and anxiety, as well as seriousness and relaxation, which may limit the comparability of the results to some extent. However, few studies have focused on

the effect of negative emotional music on listeners and less so on the comparative research of the influence of two kinds of negative emotional music (the fear and the sad) on human emotions.

Negative emotions are the inevitable outcome of maintaining the balance of body function and self-protection of human in life [6]. It reflects the individual's subjective tension and displeasure, accompanied by certain specific behaviours. For instance, crying or being silent in times of distress, avoidance in times of fear, and aggression or catharsis in times of anger. How does the listener respond to negative emotional music? Will it trigger their negative emotions as well? Likewise, will listeners respond the same way to fearful music? Will it arouse actual feelings of fear? Moreover, when listening to sad or fearful music, does the listener's brain respond differentially? As stated by Gabrielsson, the listener can experience real emotions based on music [7]. In a research project entitled Strong Experience with Music (SEM), hundreds of participants were asked to describe "the strongest, most intense experience of music you have ever had" [8]. Afterwards, a content analysis of 1300 descriptions from participants was conducted. The results showed that participants experienced a strong emotional response to music including weeping, immersion, pleasure, ecstasy, sadness, and fear. Emotions and feelings were the most frequently words responded by participants. Furthermore, studies of emotion induced by music through behavioural experiments or brain imaging have indicated that audiences often respond to specific emotional tunes conveyed in music excerpts. Nevertheless, some studies have argued that whether a piece of music that expresses a particular emotion will induce the same emotion, a different emotion, or no emotion at all is not a simple issue. For instance, one study suggested that sad music does trigger feelings of sadness and that this negative effect can turn into a positive one [9]. Also, Juslin has argued that, as is the case with *Schadenfreude*, pleasurable sadness could be seen as a mixed emotion in which both negative and positive influences are concurrently experienced. This means that the relationship between the expressed and the induced emotion is extremely complex and needs to be further studied and confirmed by different research approaches.

Based on relevant literature, the dominant approach in studies exploring music and emotion is self-report while other approaches, such as theoretical, biological, cross-cultural, and individual approaches as well as music analytic approach are not uncommon in studies of music and emotions. For example, one study measured neural responses recorded from areas involved in emotional processing by investigating music-induced emotions in healthy participants. Nonetheless, the use of mixed approaches within a single study is rare in the field of music and emotion, neither is the comparison between continuous self-reporting and physiological measurement. In fact, many of the individual components that make up emotions can only be satisfactorily studied by combining different approaches. As stated by Eerola and Vuoskoski [10]: "A valid and reliable understanding of music-induced emotions can only emerge when multiple approaches—such as self-reports, biological measures, and indirect measures of felt emotion—are simultaneously used to investigate a given problem". Along this line of thinking, this study intends to explore the brain mechanism and behavioural manifestations with characteristics of the sad and the fearful emotions induced by music through event-related potentials (ERP) and behavioural experiment to compare the similarities and differences between the two negative emotions. By exploring how the brain responds to music listening, aesthetic judgement and emotional processing, it is possible to shed light on whether music of the sad emotion and the fearful emotion would necessarily induce the same negative emotions in humans. An additional question was whether the brain mechanisms of the listener differed when they listen to the sad or fearful music.

2. Purpose of the Study

This research aims to explore the brain mechanisms and behaviour induced by sad music and fearful music through ERP and behavioural experiments to compare the similarities and differences between the two negative emotions. The following research questions guided the whole research:

1) Is there a difference in the brain mechanisms of the listener when they listen to sad music and fearful music?
2) How will listeners respond to music with negative emotions? Will it also trigger their negative emotions?
3) Do listeners respond in the same way to the sad and fearful music?

3. Method

This research consists of two parts and intends to answer the research questions by the convergent parallel design, a mixed methods design.

The first phase was the assessment of ERP in the participants when they listened to sad music and fearful music. The focuses were on the time, intensity, and stability of music-induced emotions. In the second phase of the behavioural experiment, the participants' behavioural responses to sad music and fearful music were observed with semi-structured interviews and emotional evaluation scale (self-report) to measure and analyse their emotional responses, music preferences and willingness to listen to the music.

Ethical issues were carefully considered before and after the execution of this study. Before the study, invitation letters were sent to all participants involved in the study to inform them of the purposes and content of the study. The names of the participants were all hidden to protect their privacy. In addition, they were guaranteed that they could withdraw the research for any reason at any time.

3.1. Participants

For the first part of this study (ERP), a total of 90

undergraduates and postgraduates of universities in Beijing were recruited as participants through online communication. Afterwards, the Chinese version of the Eysenck Personality Questionnaire [11] was used to select and classify the participants by gender and majors of study. Eighteen participants were finally identified (age range=20-28, standard deviation=1.88). Specifically, there were 10 music majors and 8 non-music majors; 10 female participants and 8 male participants; 10 participants had an extroverted personality, and 8 had an introverted personality according to the classification of personality types.

For the second part of this study (behaviour experiment). A total of 27 male and 36 female university students as participants were randomly selected, with a total of 63 (average age=23, standard deviation=2.49). All the participants had normal hearing.

3.2. Music Stimuli

According to the previous research literature, classical music accounts for more than half of the repertoire examples used as music stimuli in the research studies. Other music genres, such as mixed, pop and rock, ethic, film, and others were included. Western classical music was the main genre in the selecting the music stimuli, and various popular genres, such as R&B/soul and dance music, have increasingly appeared in studies of music and emotions [12].

For the present research, 300 western music excerpts were selected as the experimental materials, 150 of which were sad music and 150 fearful music. To adapt to the context of China, the authors had invited three professionals in ethnomusicology from China conservatory of music to provide 150 sad and 150 fearful Chinese music as stimuli materials. 600 music excerpts constitute the database. The genres of sad music mainly included Western classical music, Chinese folk music, pop music, film music, jazz music, light music, and dance music. The materials of fearful music are mainly selected from electronic music and film music.

To avoid the emotional hints from the meaning of song lyrics, all Chinese and foreign excerpts were composed of pure music without words. To ensure the reliability and validity of musical stimulus, the authors first conducted a pilot study in which 80 university students were recruited from Beijing and used the 5-point Likert scale to classify the emotion types and evaluate the emotional intensity of the music materials. Finally, the top 100 excerpts with music emotional type tendency rate of over 95% and high intensity score were selected as the stimuli materials for the ERP experiment. A total of 363 music excerpts were selected for the behavioural experiments.

3.3. Procedures

For the ERP experiment, the main purpose was to monitor the natural responses of the participants to the emotions in the music, ensuring the subjective judgement of the emotions in music minimized. However, there was no classic experimental paradigm for music emotion with ERP research. Therefore, a virtual task was designed for our experiment, that is, the participants were asked to choose whether they "like" the music they heard. During the whole experiment, the participants were required to sit quietly and fully experience the music and then judge their preference of music in this virtual task. In the digital reaction box of 1-5, depending on the degree of like or dislike, participants provided a rating by selecting keys 1 to 5, where 1 is "did not like it at all", and 5 is "like it very much". In the experiment, 100 musical stimuli were presented in a random manner, of which 50 were sad and 50 were fearful. The interval between each stimulus was 2000 ms. Between each block, participants could rest for a while they chose for themselves. The volume of music was controlled at approximately 60 decibels to ensure the smooth and comfortable auditory experience of the participants. The experimental procedure is shown in Table 1.

Table 1. *Procedure for Event-Related Potential Assessment.*

Experimental Procedure	I ⟶	II ⟶	III ⟶	IV
	+ Fixation point	Stimulus Music presented, approximately 4500 ms	Black screen Make a choice	Interval 2000 ms

For behavioural experiments, the results of the existing research on the influence of emotional background on subsequent tasks show that whether the antecedent emotional background was in very positive or negative, it had a significant influence on subsequent tasks, including emotional perception, working memory and trustful behaviour. Therefore, to ensure the universality of the results, the authors asked the participants to complete the Scale of Current Mood States before the experiment. This scale was adapted from the Profile of Mood States (POMS), which was designed by Dr. Haythornthwaite from the Department of Psychiatry and Behavioural Sciences at Johns Hopkins University [13]. The purpose of completing this scale was to capture the emotional state of the participants in the process of performing experiment, so that in the final statistical analysis, the data of participants who had normal, stable emotions without fluctuations before the experiment could be collected. In the main experiment, 20 music excerpts of the two negative emotions were randomly played. Music samples were taken from the music material database created in the earlier stage of the study. All samples had distinct emotional types and high emotional intensity scores, and each session lasted no more than four minutes. At the end of each music session, participants were asked to complete the emotional evaluation scale and questionnaire.

3.4. Data Processing and Statistical Methods

In ERPs experiment, the electrophysiological data detection system produced by German company (Brain Products) was used to collect auditory ERPs, and the EEG

was recorded continuously in real time through 64 potentials embedded in the electrode cap. The sampling rate was 500 Hz/conductance, the electrical impedance was less than 5 kΩ; Cz was the reference electrode point, and FPz was the ground electrode. The horizontal electrooculogram (HEOG) on the outside of the two eyes and the vertical electrooculogram (VEOG) on the above and below of the left eye were recorded simultaneously. The input signal was amplified by BrainAmp amplifier with a bandwidth of 0.15 ~ 200 Hz.

The EEG of each subject was superimposed and processed off-line with Brain Vision Analyzer produced by German company, Brain Products. Time history analysis was 4500ms, the first 500ms of the musical stimulation was used as the baseline, and this baseline was corrected with the mean before stimulation. The 30Hz high-frequency filter was used to automatically correct blinks and other artifacts, and to eliminate EEG segments with amplitudes greater than ±100μV. According to the purpose of this experiment and the characteristics of the overall average amplitude, the differences in ERPs induced by the two musical conditions (sad music and fearful music) were mainly as follows:

1) The positive component P2 (the maximum peak value in the window of 150 to 260 ms) that reaches the maximum peak value was different around 200 ms, and the laterality of the left and right hemispheres of the brain was different under sad music and fearful music.
2) Due to the dynamic characteristics of music stimulation, this experiment also analyzed the average amplitude of overall time history.
3) Considering the relatively long music stimulus time in this experiment, the 4500ms music stimulus was divided into 5 time-segments: 600-1400 ms, 1400-2200 ms, 2200-3000 ms, 3000-3800 ms, and 3800-4500 ms.

To avoid the loss of statistical effectiveness, repeated measurement of variance analysis is used to quantify the data of multiple leads and multiple time windows [14]. At the same time, to investigate the difference in emotional processing of the music between the anterior and posterior brain regions and the left and right hemispheres, the combined analysis method of scalp electrodes was used to analyse the piecewise time history of experimental stimulation [15, 16]. Specifically, the brain was divided into 10 regions of interest (ROIs): ROIs1 (F7/F5), ROIs2 (F1/Fz/F2), ROIs3 (F6/F8), ROIs4 (FT7/FC5/T7), ROIs5 (FC1/FCz/FC2/C1/Cz/C2), ROIs6 (FC6/FT8/T8), ROIs7 (TP7/CP5/P7/P5), ROIs8 (CP1/CPz/CP2/P1/PZ/P2), ROIs9 (CP8/TP8/P6/P8), ROIs10 (PO3/POz/PO4/O1/Oz/O2).

The division rules of the 10 regions of interest were as follows: the dimension of anterior-postorior was divided into 4 levels, and the dimension of left-right was divided into 3 levels; The 10 scalp regions of interest were listed in numerical order as follows: left prefrontal region (ROIs1), middle prefrontal region (ROIs2), right prefrontal region (ROIs3), left frontotemporal region and temporal region (ROIs4), frontal central region and central region (ROIs5), right frontotemporal region and temporal region (ROIs6), left temporoparietal region and parietal region (ROIs7), central parietal region and parietal region (ROIs8), right temporoparietal region and parietal region (ROIs9), and parietal occipital region and occipital region (ROIs10).

In the analysis of P2 peak value and latent period, the average peak value and average latent period of each encephalic region were calculated as dependent variables. When observing the grand mean map, it was found that the electrode P0 contained in ROIs10 and the P2 induced by P region were not obvious. Therefore, only 9 interest regions were selected for statistical analysis, and repeated measurement ANOVA was conducted with two emotion types, three anterior and posterior scalp positions, three left and right scalp positions as independent variables.

For the average amplitude of piecewise time history, PASW18.0 was used to calculate the average amplitude of each encephalic region in each time window and used it as the dependent variable. Two emotional types, five-time segments and ten encephalic regions were used as independent variables for repeated measurement ANOVA. Finally, the overall amplitude was analyzed to determine the whole-segment amplitude of each encephalic region as the dependent variable. Ten regions of interest were also analyzed, and two emotional types and ten encephalic regions were used as independent variables for repeated measurement analysis of variance. Greenhouse-Geisser method was used to correct P value.

4. Results

For the ERP experiment, according to the overall amplitude figure showing the experimental results, there were differences in the laterality of activation across the left and right hemispheres of the brain under the conditions of the sad and fearful music. In addition, the evoked speed, duration, and activation intensity of the amplitude were also different. In the subsequent analyses of the experimental results, the music stimulus materials of 4500 ms were divided into five-time segments, namely, 600-1400 ms, 1400-2200 ms, 2200-3000 ms, 3000-3800 ms, and 3800-4500 ms, and the analysis was conducted with each of these music fragments.

First, according to the overall distribution map and amplitude intensity across brain regions under the two emotional conditions, the main processing areas for music emotion were the frontal, temporal, and central regions (see figure 1 and figure 2).

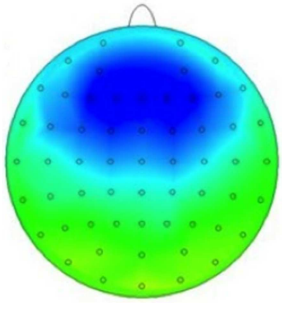

Figure 1. *Overall map of the neural mechanisms processing sad music.*

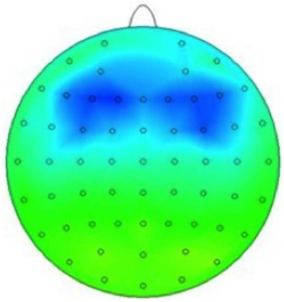

Figure 2. *Overall map of the neural mechanisms processing fearful music.*

Further analysis and comparison showed that when the human brain processes fearful music, the amplitudes in the prefrontal region and middle region were significantly stronger.

In addition to the middle region, the prefrontal middle region, frontal central and central regions, central parietal region, and parietal region also played important roles in the early periods of the negative music emotional task.

Second, for the frontal region that played an important role in processing music emotions, the authors compared the left prefrontal region with the right prefrontal region and compared the P2 amplitude in the left lateral region with the right lateral region. It was found that the P2 amplitude in the right lateral region was stronger than in the left lateral region when processing music of negative emotions. This result was consistent with previous research conclusions; that is, positive emotions were correlated with left-lateralized activities of the brain, while negative emotions were correlated with right-lateralized activities of the brain. However, based on the results of this experiment, while fearful music primarily activated the right side of the brain, it also correlated with activity on the left side of the brain. In fact, each brain region was more active in processing fearful music than sad music, especially in the bilateral frontotemporal regions, and the degree of activation was more significant. Based on these experimental results, the authors suggest that the arousal of fear enhances the mobilization and allocation of attention resources in the brain. Likewise, Xiang [17] found that compared with light music, fearful music mainly activated lateral parts of the bilateral prefrontal cortex, bilateral frontal orbitofrontal cortex, bilateral medial frontal gyrus and anterior cingulate gyrus, and bilateral amygdala complex. However, due to the limitations of the ERP research method (low spatial resolution, etc.), further verification is needed to explore the issue regarding fearful music activating more extensive brain regions than other types of music.

It can be seen from the results of the amplitude analysis of the segmented durations that as the music progressed, the intensity of human perception of music emotions also changed. For the whole piece of music, the participant's emotional perception of fearful music was always the strongest. By contrast, the perception for intensity of sad music was relatively weak at the beginning of the music excerpt, but the overall response was more lasting (see figure 3 and figure 4).

Third, the authors analysed the latency values under the conditions of the two types of emotional music (sad music: 190.28 ms; fearful music: 183.36 ms). The comparison showed that when music was just started, the listeners already had an initial perceptual difference between the two kinds of music. The latent period of the emotional perception for fearful music was shorter than that for sad music. In other words, the emotions evoked by fearful music were more sensitive and the response time was faster. The authors speculate that it may be that the participants initiated a self-protection mechanism in the listening process. Some studies have shown that negative emotions are the inevitable result of maintaining a functional balance and self-protection in life. Fearful music makes listeners more aware of the danger of their surroundings. Thus, the participant is more sensitive to the emotions generated by fearful music, and the speed of the emotion getting induced was faster. Previous studies using facial expressions and pictures to induce emotions have also shown that people have a special sensitivity to negative stimuli and prioritize their processing [18]. Compared with positive events, negative events can cause more extreme reactions and can quickly activate combat/flight behaviours. In addition, there may be another possibility that sad music did not necessarily induce actual negative emotions. Studies have found that even music full of sadness and sorrow brings positive emotions to listeners if they like it [19].

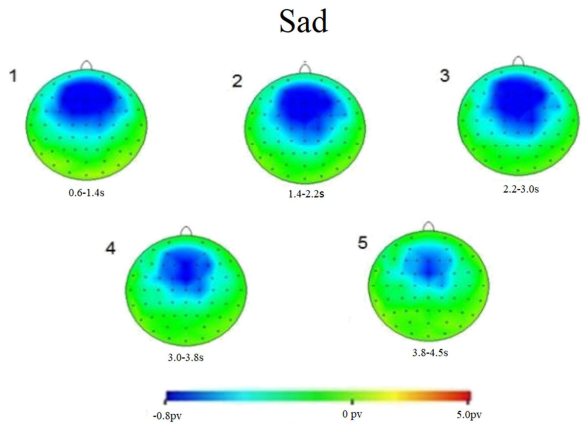

Figure 3. *Neural processing of sad emotional music over time.*

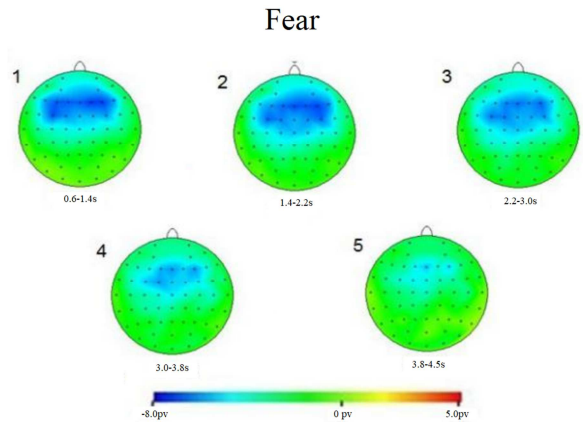

Figure 4. *Neural processing of fearful emotional music over time.*

Fourth, the intensity, time and stability of the emotion induced by the two kinds of negative emotional music were interactively analysed with gender, personality, and professional background. The results showed that the female group had a stronger brain wave amplitude than the male group when dealing with negative emotional music, especially in the processing of sadness, the activation of the brain in women was more intense. The participants with introverted personalities had a stronger perception of the music emotion than those with extroverted personalities, and this was especially observed as a stronger emotional perception of fearful music. Not surprisingly, all participants with introverted personalities were music majors, which is consistent with Kemp's research to some extent. He insisted that all musicians share a common core of traits related to musicianship, such as introversion, sensitivity, independence, anxiety, and psychological androgyny [20]. Additionally, in a study of the brain mechanisms underlying the personality dimensions in the Eysenck model, Rusting and his colleagues [21] found that the reticular cortical circuit was the neural basis of the extroversion and introversion, and its activation in the extroverted individual was lower than that of the introverted individual. This may also be the reason why extroverted individuals seek behavioural compensatory activation, such as sociability, and enthusiasm for thrills, novelty, and change [22]. This conclusion is consistent with the results of the present experiment, which also proves the difference in brain mechanisms between introverted and extroverted groups [23].

For the behavioural experiment, the experimental hypothesis of this research was that listeners' preference, feelings and listening willingness of sad and fearful music would be different, although both belong to negative emotions. For the statistical analysis, the authors conducted a chi-square test on the correlation between music emotion types and listening willingness, and the results showed a significant correlation (r=0.62, $p < 0.001$). The distribution of listening willingness is shown in Table 2.

Table 2. *Emotional Types and Willingness to Listen.*

		Listening Willingness	
		Be willing to listen	**Not willing to listen**
Emotional types	Sad	51.3%	48.7%
	Fear	3%	97%
Total		33%	67%

In terms of negative emotional music, the participants preferred to listen to sad music rather than fearful music. A total of 117 excerpts of sad music were deemed the type "Be willing to listen", accounting for 51% of the total. While only four excerpts of fearful music were deemed the type "Be willing to listen", they accounted for 3% of the total. However, the participants' willingness to listen to these two kinds of negative emotional music was not high. A total of 121 pieces of the sad and fearful music were regarded as "Be willing to listen", accounting for 33% of the total.

Meanwhile, the authors measured the degree of correlation between emotional types and listening willingness by measurement of the phi correlation coefficient. The result was 0.496 (greater than 0.3) which means that there was a large degree of correlation between the two, indicating that emotional types had a significant influence on listening willingness. Afterward, the authors conducted a gamma analysis on the correlation between music emotion types and music preferences, and the results showed that the correlation between the two was significant (r=0.70, $p < 0.001$). The correlation between music emotion types and music preferences is shown in Table 3.

Table 3. *Emotional Types and Music Preference.*

		Degree of Preference (Higher value means higher preference)					Total
		1	**2**	**3**	**4**	**5**	
Emotional types	Sad	12.7%	27.6%	29.0%	21.5%	9.2%	228
	Fear	79.2%	17.8	1.5%	1.5%	0.0%	135

Notes: 1=Dislike it very much, 2=Dislike it, 3=Neither like nor dislike (acceptable), 4=Like it, 5=Like it very much

As shown in Table 3, participants' preferences for the sad and fearful music with negative emotions are quite different. There were 107 excerpts of fearful music that participants rated as "dislike it very much", accounting for 79.2% of the total. None of fearful music (0%) was rated as "like it very much". Conversely, participants rated only 12.7% excerpts of sad music as "dislike it very much", and 27.6% excerpts of sad music were rated as "dislike it"; both categories accounted for 40.3% of the total. In addition, 115 excerpts of sad music were rated as "acceptable" or "like it", accounting for 50.5% of the total. Interestingly, 21 excerpts of sad music were rated as "like it very much", accounting for 9.2% of the total.

5. Discussion

From the perspective of different emotion types, although sadness and fear are both negative emotions, the ERP experiment results of this research showed that the neural mechanisms in the human brain that process the two kinds of music emotions are different. The participant's processing of fearful music was more like the handling of threatening emergencies. For example, the neural mechanisms respond faster, the mobilized area is larger, and the activation level is greater than control conditions. By contrast, there was no evasive attitude towards the processing of sad music. For instance, the state of the participant was stable, which means that they remained steady for a long time while experiencing the emotions elicited by sad music.

In terms of behavioural outcomes, the participants' preferences and listening willingness of the two kinds of music were also quite different. The participants were more repulsive to fearful music, and clearly stated that they did not like to listen to such music. The proportion of "acceptable" rating for fearful music was less than 0.5%. Moreover, in the process of listening, the participants even showed discomfort in their facial expressions and disgusted in behavioural reactions. In contrast, with sad music, according to individual music preferences, some participants expressed dislike for the timbre of the instruments, and some expressed dislike for heavy emotions, but there was no rejection, and the acceptability of listening reached 60%.

In sum, music is a non-verbal emotion carrier that can arouse people's implicit emotions and tends to guide emotions, even more intensely than language. However, emotions are extremely complex and have the characteristics of a process, including the perception of the source of emotional stimuli, the cognitive judgement of the overall event and the subsequent behavioural response, which depend on changes in emotional types and intensity. Music is also an art that focuses on this process. Generally, the larger the structure of the musical work, the richer the emotional expression contained therein and the deeper the corresponding level of emotion. Based on the present study, the authors believe that there are two aspects deserving attention and consideration.

First, does sad music necessarily guide the listener to a negative emotion? Negative emotions are usually accompanied by some disgusting feelings, such as anger, fear, anxiety, or depression, while different negative emotions will be associated with different coping behaviours. From this point of view, however, the stimulus of sad music does not have this characteristic. In real life, many musical pieces are full of sadness, desolation, or sorrow, but people do not choose to stay away from them. Instead, in a certain state of mind, they will actively choose to listen to sad music to release their emotions through resonance with the intrinsic mood of the music, thus obtaining another kind of pleasant and comfortable experience. For example, people prefer to listen to sad music when they are alone or when they feel depressed or lonely when they are in introspective moods. Another research has indicated that sad music can activate specific memories, and thereby taking people away from current problems [24]. Furthermore, one study has shown that sadness caused by music is pleasant 1) when it is perceived as non-threatening; 2) when it is aesthetically pleasing; and 3) when it produces psychological benefits such as mood regulation, and empathic feelings, caused, for example, by recollection of and reflection on past events. Additionally, as physiological responses to specific external stimuli, negative emotions can be conducive to re-establishing a homeostatic equilibrium [25]. As stated by Liao [26], positive and negative emotions in human emotional experience should be a balanced state. Hence, in the complete emotional experience, negative emotions are indispensable; otherwise, people will fall into another kind of morbid emotional imbalance. Overall, on the one hand, it is necessary to reduce or eliminate negative emotions to attenuate their negative effects on individuals physiologically and mentally.

Sad music is perfectly equipped with this special property. Listeners can not only experience negative emotions but also obtain emotional release and the satisfaction of aesthetic pleasure from these music experiences. When an individual is in the vortex of negative emotions, positive and lively music with distinct emotional characteristics may not bring positive effects and may in fact result in a worse experience for the individual. What is needed more at this time is synchronization and resonance with the individual's emotions. Through music with sad tunes, emotional tension is gradually transferred to the music leading to an individual feeling full of power and an uplifted spirit. In other words, listening to sad music would gradually correct the imbalance induced by emotional suffering, and the experience would be enjoyable in the end [27]. Therefore, it is not possible to categorize positive or negative emotional stimuli in a dichotomous manner according to the emotions in the music. Instead, individual differences, cultural background, music preference, and listening mood should be considered. Some studies have revealed influencing factors on music emotion, such as individual differences and personality traits, listener's cultural background [28], music preference [29], and the emotional content of the music itself [30].

Second, one might question whether the aesthetic perception of music is overstated? Not all music plays a positive role in regulating human emotions. During the behavioural experiment in this study, the authors observed the expressions of the participants when they listened to fearful music and found that some were frowning, their mouths were slightly open, and some were shrugging their shoulders. In the ERP experiment, there were two screaming reactions in the laboratory, which led to the termination of the experiment. These explicit stress expressions and behaviours further confirmed the real experience of the participants. In other words, fearful music makes the listeners truly feel a sense of fear and danger. Hence, the music itself does not have the aesthetic character as the belief people usually hold. It might be affirmed that the necessity of negative emotional experiences, and as Kant's said, fear is a natural aversion to danger, and it is an inevitable and unavoidable part of human life.

Appropriate fear is one of the necessary experiences to realize human self-protection, and sensitivity to injurious signals can promote survival in dangerous situations to some extent. For example, some researchers have studied fear responses to children's picture books and then proposed that it was beneficial for children to properly experience such emotions as worry and fear during their growth [31]. In other words, if negative emotions are controlled within children's psychological tolerance, such emotions may promote their emotional balance and coping ability towards adversity. By contrast, children who have not experienced negative emotions are more likely to suffer from emotional disorders.

Further, one study indicates that negative emotions contribute to better cognitive processing [32]. Individuals engaged in more thinking and reasoning about the bad than the good events, dedicating more energy and consideration to those goals that were "blocked" than to those that were easily achieved. This is because the negative emotions will urge them to make new plans or goals; in the face of the fear of failure, they will develop better cognitive tools to overcome its negative effects. These studies further suggest that people learn from bad things faster than they learn from good things, supporting the idea that negative emotions can be useful and may create meaningful learning opportunities.

On the other hand, there is no doubt that living in constant and excessive fear can have a detrimental effect on physical and mental development at any age. Music can indeed provide the listener with negative emotional experience, as well as the tension and excitement accompanying the emotional experience. Hence, how to grasp the "degree" of music emotions may lead to the next problem to be solved. In other words, music listeners should not only experience tension, fear, worry, and excitement in music but also maintain the balance of internal emotions simultaneously.

6. Conclusion

Summarized from the above report, significant conclusions may be gained for several perspectives related to this research study. Viewed from the methodologies applied in the study, ERP scanning with behavioural experiment enables the researchers to collect data richer than from the process using only one technique of brain scanning. The behavioural experiment, as well as the questionnaire used as an aid to the researchers, provides more valid information coming overtly from the subjects' performance that could be observed and judged closely by the researchers. Based on the data and analyses, the overall results implied meaningful hints which might become starting points for further studies and applications in the areas of music psychology, music therapy, music aesthetics, and music education. Most interestingly among them, unlike the myths as it is generally believed by laymen that happy music makes one happy and sad music must be bad for one to feel sorrow. On the contrary, this research revealed that it was very possible that, when properly conceived and designed, sad music may well serve to soothe those who are in the depressed mood. Of course, it is by no means to advocate ordinary people to enjoy those alleged sad music and get enchanted in such music with negative emotions. That would be not ethically good. The implication here is for music therapists to consider possibilities to use thoughtfully designed procedures in treating emotionally bothered people. For instance, to help someone step out of the negative emotions to the positive, music therapist, music teacher, or even parents might first apply music with accordant mood, induce and release a similar mood, and gradually lead him to listen to music with more positive or happier feelings. In addition to possible application in music therapy, the result of this research might be applied in the field of music education. As all known to the teachers and parents, children experience various emotions daily. It is the same with all human beings. One cannot escape from fear and this specific emotion is indeed felt by all human as one the "colorful" feelings. In the case of teaching and learning, fearful music enriches human feelings for teachers and students without actual hurts physically and mentally because they know this is music after all and music, no matter what kind of emotion a piece of musical work possesses, does not really hurt. At the worst situation, the listeners feel a mild startle as in the case of the *Symphony in G major No. 94* by Franz Joseph Haydn who did surprise the audience on a joyful purpose.

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