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# How have music emotions been described in Google books? Historical trends and corpus differences

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Human records can assist us in understanding real descriptions and expected ideals of music. The present work examined how have music emotions been described in millions of Google books. In general, positive adjectives were more regularly used to describe music than negative adjectives, demonstrating a positivity bias in music. The emotional depiction of music has shifted over time, including a decrease in the frequency of emotional adjectives used in English books over the past two centuries, and a sudden surge in the usage of positive adjectives in simplified Chinese books during China's Cultural Revolution. Negative adjectives were substantially less employed to describe music in simplified Chinese books than in English books, reflecting cultural differences. Finally, a comparison of different corpora showed that emotion-related adjectives were more frequently used to describe music in fictional literature.

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## Introduction

Music moves us by conveying and evoking anything from arousal and basic emotions (e.g., happiness and sadness) to complex emotions (e.g., love and nostalgia). Thus, the perceived emotions (emotions expressed by music) and the felt emotions (emotions aroused by music) have attracted increasing academic attention in recent decades (e.g., Juslin et al., 2014; Kallinen and Ravaja, 2006; Schubert, 2013; Xu et al., 2021). Compared to the felt emotions of music, the perceived emotions are regarded as the “objective” aspects of music-elicited emotion (Gabrielsson, 2001). People may describe and share the emotional information of music that they listen to, and show a preference for music expressing specific emotions such as sadness (Xu et al., 2021; Yoon et al., 2020) and happiness (Schellenberg et al., 2008). Furthermore, the emotion information of music has been widely used in various application fields including music recommendation (Han et al., 2010), music therapy (Bernatzky et al., 2011), and music information retrieval (Downie, 2008).

Since music plays an important role in human life, how music was described by people has been recorded in different corpora, such as books (Michel et al., 2011), music reviews (Vannini, 2004), and texts in social media platforms (Dewan and Ramaprasad, 2014). By mining the music-related texts, researchers have investigated the meanings of a singer (Vannini, 2004), the contributions of music journalism (Fürsich and Avant-Mier, 2013), music-related metaphors (Šeškauskienė and Levandauskaitė, 2013), and so forth. However, the emotional description of music in texts has not been systematically investigated. As the soul of music, music’s emotional information often appears in various human records. Listeners may share their emotional states in music reviews after listening to music, the protagonists in books may describe the perceived emotions of music they heard, and people may recommend music that expresses specific emotions on social media. Thus, can we also obtain people’s attitudes towards music emotions from corpora? Similar to human description studies (Leising et al., 2014; Ye et al., 2018; Wen et al., 2023), we believe that the use of music descriptors can reflect either real descriptions (how music actually is) or expected ideals (how music should be). Therefore, mining the emotional description of music may help us know the emotional roles of music in human life.

In addition to the studies focusing on the short-term scale of corpora, examining the dynamics at longer time scales has attracted increasing academic attention. Berger and Luckmann (1991) noted that social change is interconnected with language. As a remarkably long-lived phenomenon, language containing a large number of common words has been passed down through multiple generations for centuries (Lieberman et al., 2007; Pagel et al., 2007). In fact, music, much like language, can also serve as a valuable research model to comprehend the evolution of cultural traits across time and space, thereby enriching our comprehension of cultural variation and transformation (Savage, 2019; Youngblood et al., 2023). In addition, by analyzing humanity’s written records, researchers have investigated the historical trends of personality description (Leising et al., 2014; Roivainen, 2013; Ye et al., 2018), emotion expression (Acerbi et al., 2013), women’s status (Twenge et al., 2012), cultural values (Greenfield, 2013; Zeng and Greenfield, 2015), morality (Kesebir and Kesebir, 2012), and so forth. For example, Roivainen’s series of works calculated the usage frequencies of personality adjectives in books to test the generational changes in personality (Roivainen, 2020), gender differences in personality (Motschenbacher and Roivainen, 2020), and the suitability of personality adjectives (Roivainen, 2015a). With reference to previous research methods, can we learn about the changes in the emotional description of music from books or other corpora? Studies have also indicated that the distribution of

word frequency can be influenced by social and historical events (Bochkarev et al., 2014). For instance, during World War II, the Great Depression, and the Baby Boom period (Acerbi et al., 2013; Bochkarev et al., 2014), there was an increase in the use of emotional vocabulary in literature, reflecting a trend toward more emotional expression. Considering that music is inseparable from human society, we believe that historical changes in music emotions (perceived or expected emotions) may have shifted themselves in music’s descriptions. Therefore, the present work would like to investigate how emotion-related words have been used to describe music in books, and how the description changes over time.

Cultural difference, reflected by language difference in texts, is an inevitable issue in text analysis. Music’s descriptions in books can be regarded as cultural artifacts whose meanings are “symbolically constructed, historically transmitted, and expressed by individuals in instances of situated communication” (Wilkins and Gareis, 2006). The study of music’s description is also a study of culture, investigating the anthropological knowledge about cultural values that are reproduced in the communication of music emotions. Cultural differences embodied in language have been observed in many fields. For example, the work of Besemeres (2004) found that the expression and description of emotion may differ in different languages; categorization, which organizes and classifies objects together, can be affected by different testing languages (Ji et al., 2004); by comparing English, French, and Dutch listeners’ speech segmentation, Tyler and Cutler (2009) found cross-language differences in cue use for continuous-speech segmentation; and previous studies have shown that “each written language has its own unique rhetorical patterns in terms of style, structure, and content” (Almuhailib, 2019; Leki, 1991). Therefore, it is necessary to compare musical emotion descriptions in different language corpora.

In fact, even with the same language, there may still be differences in different types of corpora. Roivainen (2015b) found that variation exists in adjectives’ usage across corpora (Twitter tweets and Google Books). Ye et al. (2018) noted that person-descriptive adjectives were more frequently used by fictional literature than by non-fictional literature. Underwood and Sellers (2012) conducted a study on literary diction and found that fictional literature uses more archaic words than non-fictional literature. Similarly, Heuser and Le-Khac (2011) examined the phrasing in 19th-century novels and found a decline in the usage of abstract vocabulary (such as integrity, modesty, sensitivity, and reason) and an increase in the usage of concrete vocabulary (such as action verbs, body parts, colors, and numbers) in literary language. By comparing Facebook, Twitter, Instagram, and WhatsApp, previous work found that the norms of expressing emotions on social media are different (Waterloo et al., 2018). The above findings reveal the differences in many aspects of different corpora of the same language, which reminds us to investigate the variation in music’s emotional descriptions across corpora. Thus, the corpus differences were also taken into account in this study.

In sum, with the accessibility of various online Big Data, we conducted an exploratory study to investigate the emotional descriptions of music in books. Our research question was three-fold. First, we sought to investigate the historical trends of music’s emotional descriptions. To this end, we utilized Google Books N-gram (GBN), the largest digital corpus of written records in human history (Michel et al., 2011), to analyze the frequency of different emotional words used to describe music over the past two centuries. Second, we aimed to examine whether the aforementioned trends were consistent across books in different languages. We achieved this by investigating the variation in music’s

emotional descriptions across books written in American English, British English, and Simplified Chinese. Lastly, we explored the variation in music's emotional descriptions across different corpora by comparing various types of books. By conducting these studies, we sought to understand how emotion-related words have been used to describe music in books, how these descriptions have evolved over time, and how they vary across different corpora.

## Methods

**Calculation and presentation of historical trends.** The present work used different corpora of the GBN database (available online at: <http://storage.googleapis.com/books/ngrams/books/datasetsv2.html>) to achieve our research goals. First, we used the English corpus from GBN database, which contains approximately 1,510,000 English-language books drawn from 100 sources (Lin et al., 2012; Michel et al., 2011), to examine the historical trends of music's emotional description. The time span of 1800–2000 was investigated because few books were published before 1800 and the books' selection criteria were changed after 2000 (Greenfield, 2013; Ye et al., 2018).

Leising et al. (2014) suggested that terms describing more significant things were more frequently used in a large corpus. Therefore, this study used the usage frequency, widely used in previous works (Moon, 2014; Roivainen, 2013; Ye et al., 2018), to evaluate the importance of music's emotional descriptions. Referring to the methods of Roivainen (2013), we first searched the usage frequencies of emotion-related adjectives when they were used to describe music, which formed the combinations of "adjective music". This study considered 320 emotion-related adjectives, which were mainly extracted from the "affect" category of the Linguistic Inquiry and Word Count (LIWC) dictionary (Pennebaker et al., 2015), and a small number of which were extracted from previous music emotion studies (Juslin et al., 2014; Kallinen and Ravaja, 2006; Zentner et al., 2008). The LIWC is a typical text mining tool that consists of a number of taxonomies of semantically affine words that are evaluated by human judges (Kahn et al., 2007; Schwartz et al., 2013). Notably, these 320 adjectives contained not only words that describe emotions (e.g., *happy*, *sad*, and *relaxing*), but also words associated with emotions (e.g., *sweet*, *terrible*, and *rude*). In addition, each word was classified into positive adjectives, negative adjectives, or others (neutral or be of different polarity in different contexts) referring to the category of LIWC (Pennebaker et al., 2015). The list of adjectives is presented in Supplemental Materials Table S1.

Second, since the usage frequencies of *music* may differ in different years, we calculated the adjusted frequencies of the combinations ("adjective" + "music") as follows:  $AF_i^{\text{combi}} = F_i^{\text{combi}} / F_i^{\text{music}}$ , where  $AF_i^{\text{combi}}$  is the adjusted frequency of each combination in year  $i$ , and  $F_i^{\text{combi}}$  and  $F_i^{\text{music}}$  are the usage frequencies of each combination and music in year  $i$ . The calculation of adjusted frequencies allowed us to get the usage of each combination in each year, which can be used to present the historical trend of each adjective when describing music. To show the time trends, we used the three-year smoothing method, a 7-year moving average; for instance, the adjusted frequency of 1950 is an average of 1947–1953. Third, we summed the adjusted frequencies of all adjectives for each polarity (positive or negative) as the adjusted frequencies of that category. Finally, the mean adjusted frequency and the historical trend of each adjective or each polarity were compared respectively.

**Comparison of books in different languages.** We then investigated the variation in music's emotional descriptions across different language books. In this study, American English (AE)

books, British English (BE) books, and Simplified Chinese (SC) books were compared. SC appeared in the 1950s (Zeng and Greenfield, 2015), so we compared the differences in books from 1960 to 2000.

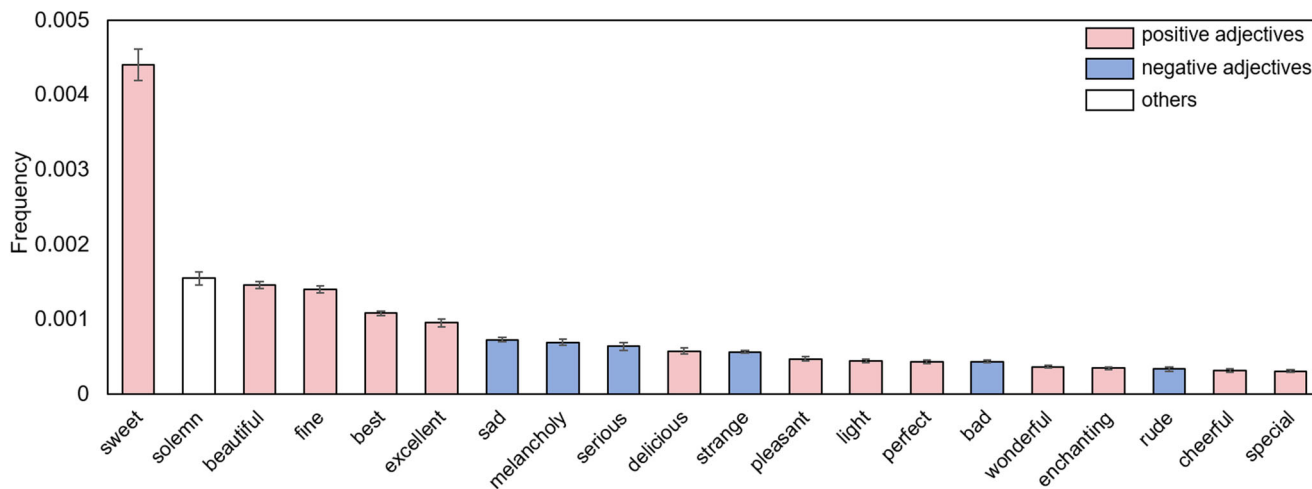
The corpora from the GBN database, including American English-language books (about 1,160,000 books), British English-language books (about 370,000 books), and Simplified Chinese-language books (about 300,000 books), were used here. For the analysis of AE and BE books, the same 320 emotion-related adjectives presented in the Supplemental Materials Table S1 were applied; while for the analysis of SC books, 585 emotion-related adjectives extracted from the "affect" category of Simplified Chinese LIWC dictionary (Huang et al., 2015) were used (see Supplemental Materials Table S2). Then, using the same method as in the section "Calculation and presentation of historical trends", the mean adjusted frequency and the historical trend of each adjective or each polarity in different language books were compared respectively.

**Comparison of different corpora.** Finally, we investigated the variation in music's emotional descriptions across different corpora. We investigated the differences between music's emotional descriptions in English fictional books and in the overall English books of the GBN database. We utilized the Google English Fiction Corpus, which contains books mostly in the English language that a library or publisher recognized as fiction (Michel et al., 2011). The Google Ngram database does not divide fiction and nonfiction data to allow for direct comparisons, so we compared the Google English Fiction Corpus (including about 330,000 English fictional books) with the overall English Corpus. We used the same 320 emotion-related adjectives presented in the Supplemental Materials Table S1 here. Using the same method as in the section "Calculation and presentation of historical trends", we compared the mean adjusted frequency and the historical trend of each polarity in different corpora.

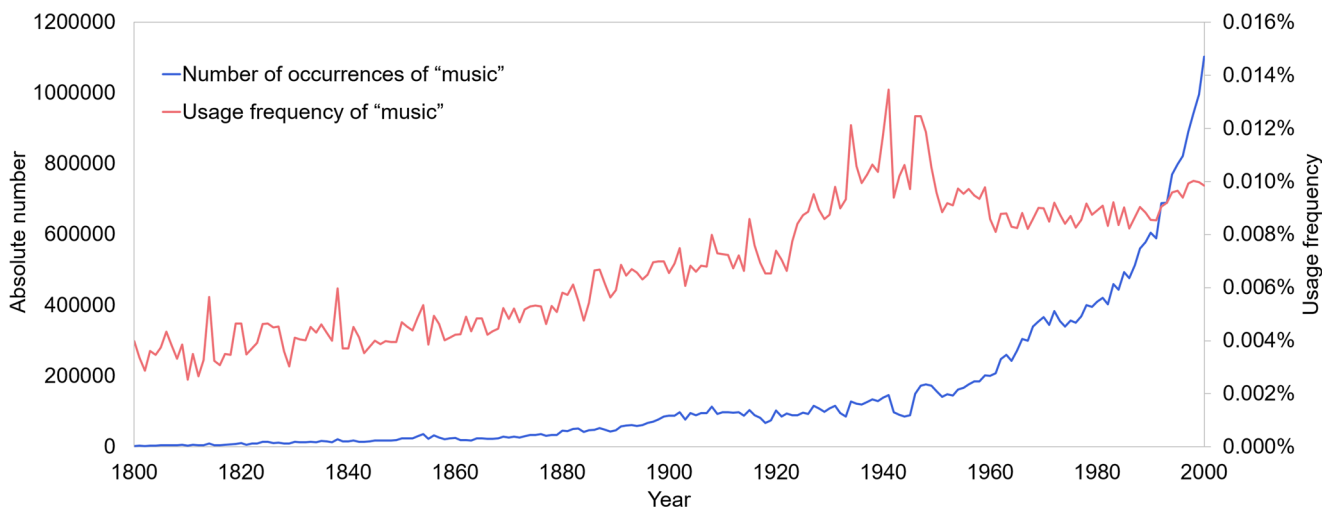
## Results

**Trend correlation check.** To begin our data exploration, we examined whether the patterns in adjective frequency we observed were unique to descriptions of *music*, or if they followed broader trends in the corpus and language over time. To accomplish this, we calculated the Pearson correlation between the usage frequency of each adjective and the frequency of its usage when describing *music* over the past two centuries. The results, shown in Supplemental Materials Table S3, revealed a mean Pearson correlation coefficient of  $0.172 \pm 0.316$  for all adjectives, indicating that the use of adjectives to describe music is not closely tied to general usage trends. While some words, such as *solemn*, *serious*, and *delicious*, displayed a strong positive correlation with overall frequency, most words did not exhibit such a trend. In fact, some words, including *beautiful*, *light*, and *soothing*, showed a negative correlation with overall frequency, meaning that as their frequency in the corpus increased, their frequency in descriptions of music decreased. Therefore, we believe that while some words may be influenced by general trends in language usage, most of the trend results we observed are specific to *music*.

**Historical trends in English books.** Figure 1 shows the mean adjusted frequency of emotion-related adjectives when describing *music* in English books from 1800 to 2000. We noticed that *sweet* was most frequently used to describe *music*, followed by *solemn*, *beautiful*, *fine*, *best*, *excellent*, *sad*, and *melancholy*. Comparing the mean adjusted frequencies of each emotion category, we found that, in general, positive adjectives were more frequently used to



**Fig. 1** The mean adjusted frequencies of the top 20 adjectives when describing music in Google English books from 1800 to 2000. Source: Own elaboration.



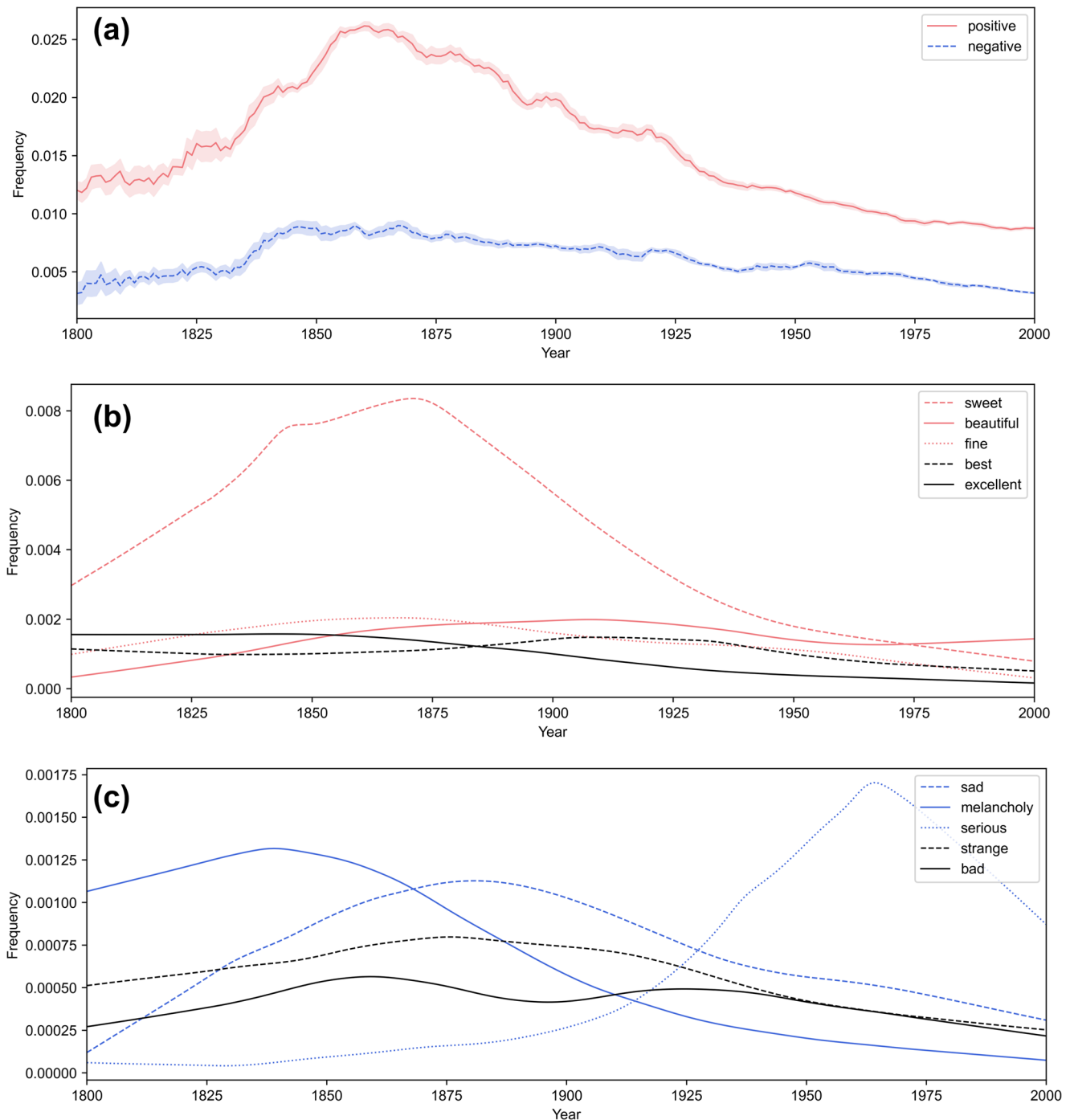
**Fig. 2** The number of occurrences and the usage frequency of music in Google English books from 1800 to 2000. Source: Own elaboration.

describe *music* than negative adjectives ( $Z = 12.293, p < 0.001$ , effect size  $r = 1.000$ ). This phenomenon conforms to the Pollyanna hypothesis that human language has a positivity bias (Boucher and Osgood, 1969). Positive words are used more frequently than negative words or words judged as less likeable (Dodds et al., 2015). For positive adjectives (see Supplemental Materials Table S3), words that express positive evaluation (e.g., *fine*, *best*, and *excellent*) were used more frequently to describe *music* than positive emotion words (e.g., *happy*, *joyful*, and *relaxing*). On the contrary, for negative adjectives, negative emotion adjectives (*sad* and *melancholy*) were the most frequently used to describe *music*. This reminds us that the difference between the usage of positive and negative adjectives mainly depends on the adjectives that express evaluation (e.g., *best*, *bad*, and *fine*), but not emotion words (e.g., *sad*, *happy*, and *relaxing*).

In our trend analysis, we began by examining the usage of the word *music*. As depicted in Fig. 2, the usage of the term *music* has consistently demonstrated an upward trend over the past two centuries, whether measured in terms of an absolute number of uses or frequency of use. Then, the historical trends of emotion-related adjectives when describing *music* are presented in Fig. 3. In general, positive adjectives were more frequently used to describe *music* than negative adjectives every year, but the difference exhibited a reduction from 1862 to 1975 (see Fig. 3a).

Since words may not be equally used in books (Roivainen, 2013), analyzing the top used words can help us better understand how the trends were formed. Figure 3b and c show the historical trends of the top five positive and negative adjectives, respectively. We noticed that the trend of *sweet* is very similar to the trend of the sum of positive adjectives, and Pearson correlation analysis shows that the adjusted frequency of *sweet* is positively correlated with the sum of the adjusted frequency of positive adjectives ( $r(200) = 0.945, p < 0.001$ ). The usage of other positive adjectives is relatively stable from 1800 to 2000. Therefore, is the dynamic of positive adjectives primarily driven by the most frequent adjective, *sweet*? To explore this question, we compared the overall trend in the use of positive words with and without the word *sweet* (see Supplemental Materials Fig. S3). Surprisingly, we found that although the overall frequency of positive word usage decreased, the trends in both cases remained similar, thus refuting the aforementioned speculation.

For negative adjectives, the trends of *sad*, *melancholy*, *strange*, and *bad* are similar, showing slight declines after 1900. While in the early 19th century, the usage frequency of *serious* suddenly increased, and declined in the late 19th century. In sum, the usage trend of many top words appears to be consistent with the overall trends of their respective categories (both positive and negative), which could be attributed to Zipf’s law for word frequencies



**Fig. 3** Historical periods of emotion-related adjectives when describing music in English books from 1800 to 2000. **a** the adjusted frequencies of positive and negative adjectives when describing music from 1800 to 2000. Error bands indicate the standard error (3-year smoothing). **b** and **c** are the adjusted frequencies of the top five positive and negative adjectives when describing music from 1800 to 2000 (loess smoothing). Source: Own elaboration.

(Ferrer-i-Cancho, 2016). According to this law, individual words make up a significant portion of the whole, and therefore the dynamics of these individual words can predict the overall dynamics. However, we also observed different trends for some words, and their underlying causes warrant further investigation and discussion.

In combining the results of the section “Trend correlation check”, we have also discovered some interesting phenomena related to the use of specific words in relation to music. For instance, we observed that the word *solemn* is used less frequently

than *beautiful* in books (see Supplemental Materials Fig. S1), yet the mean frequency of *beautiful music* and *solemn music* is similar (Fig. 1), indicating that the word *solemn* is more commonly used to describe music in literature. This finding aligns with the work of Knoop et al. (2016), who found that certain terms are more commonly associated with specific genres of literature (e.g., *funny* and *sad* for drama; *suspenseful*, *interesting*, and *romantic* for novels). Furthermore, we observed a significant decline in the frequency of *solemn* in describing music after 1854 (see Supplemental Materials Fig. S2). This trend



may be linked to the secularization of music, where the influence of religion on society gradually weakened due to industrialization and urbanization (Lombaard et al., 2019). This led to the emergence of new forms of music that may have been less associated with religious solemnity and more reflective of the changing societal values and beliefs.

**Language differences.** First, we identified similarities across the books in all three languages. As shown in Fig. 4a, whether in AE, BE, or SC books, the positive adjectives were more frequently used to describe *music* than negative adjectives from 1960 to 2000 (for each type of books,  $Z = 5.579$ ,  $p < 0.001$ , effect size  $r = 1.000$ ).

Then, to examine potential differences in language, we initially conducted a Friedman test to assess whether there were any significant differences among the three languages. Following this, we performed pairwise comparisons using the Post hoc Wilcoxon test. Friedman test showed that there is no difference in the use of positive adjectives in AE, BE, and SC books ( $\chi^2(2) = 0.146$ ,  $p = 0.929$ ), but indicated a significant effect for negative adjectives ( $\chi^2(2) = 58.390$ ,  $p < 0.001$ ). Post hoc Wilcoxon test showed that negative adjectives were less used to describe *music* in SC books than in AE and BE books (all  $p < 0.001$ , all effect size  $r = 1.000$ ).

In addition, the usage frequency of positive adjectives when describing *music* in SC books suddenly increased in about 1966 and then declined in about 1976. The above period seems to be closely related to China's Cultural Revolution (Yao, 2000), and positive adjectives were more frequently used to describe *music* in SC books than in AE and BE books in that period (see Table 1;  $\chi^2(2) = 7.091$ ,  $p = 0.029$ ; post hoc Wilcoxon test of SC and AE:  $p < 0.05$ , effect size  $r = 0.455$ ; SC and BE:  $p = 0.182$ ,  $r = 0.284$ ). As shown in Table 2, We also observed a decline in the usage of positive adjectives in BE language books ( $Z = 3.920$ ,  $p < 0.001$ ,  $r = 0.620$ ), and the decline in the usage of positive adjectives in AE language books is smaller ( $Z = 2.091$ ,  $p < 0.05$ ,  $r = 0.331$ ).

For negative adjectives, the usage frequencies of negative adjectives in AE and BE language books declined from 1960 to 2000 (AE:  $Z = 3.920$ ,  $p < 0.001$ ,  $r = 0.488$ ; BE:  $Z = 3.845$ ,  $p < 0.001$ ,  $r = 0.439$ ), but the usage frequency of negative adjectives in SC language books has not changed significantly over time ( $Z = 0.597$ ,  $p = 0.550$ ,  $r = 0.000$ ). Additionally, we computed the correlation between the adjusted frequency of adjectives in the AE and BE corpora (see Supplemental Materials Table S4). The results revealed that the average Pearson correlation coefficient is only  $0.141 \pm 0.225$ . Notably, words such as *sweet* ( $r = 0.839$ ), *fine* ( $r = 0.762$ ), and *solemn* ( $r = 0.750$ ) displayed higher correlation coefficients. However, several words exhibited negative correlations, including *beautiful* ( $r = -0.375$ ), *inspiring* ( $r = -0.296$ ), and *lost* ( $r = -0.295$ ).

The historical trends of top-used positive and negative adjectives when describing *music* in AE, BE, and SC language books are, respectively, presented in Fig. 4b–g. For positive adjectives in AE language books, the word *beautiful* was most frequently used to describe *music*, showing an upward trend; whereas the usage frequencies of the words *sweet*, *fine*, and *special* slightly declined from 1960 to 2000. For negative adjectives in AE language books, the word *serious* was more frequently used when describing *music* than the other top words ( $\chi^2(4) = 136.669$ ,  $p < 0.001$ ). The most frequently used adjectives when describing *music* in BE books were basically the same as those in AE books, including *beautiful*, *sweet*, *fine*, *special*, *serious*, *sad*, *strange*, *bad*, and *different*. For SC language books, the trends of the top-used positive adjectives are in line with the overall trend, that is, the usage frequency increased sharply from 1966 to 1976. We also observed that negative adjectives were rarely used to describe *music* in SC books, although the most frequently used negative

adjectives were similar to the previous two types of languages, such as *serious*, *sad*, and *strange*. However, it is important to note that the results obtained from Chinese corpora, especially prior to 1978, may be unreliable due to the limited number of simplified Chinese books included in Google Books during that time (see Supplemental Materials Figs. S4 and S5), resulting in highly unstable results.

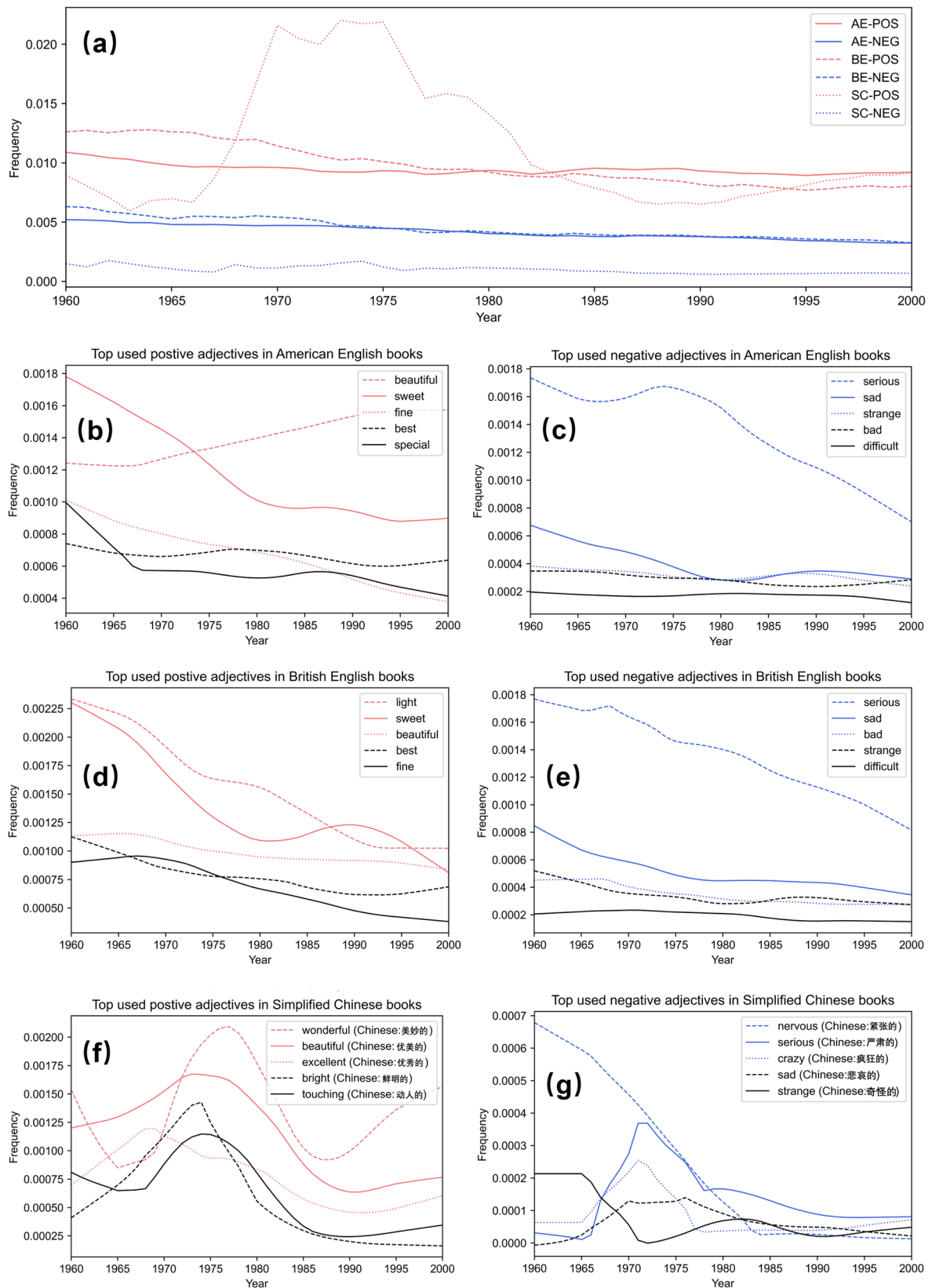
**English fictional corpus vs. the overall English corpus.** As shown in Fig. 5, we observed that the positive adjectives were more frequently used to describe *music* than negative adjectives in English Fictional books ( $Z = 13.394$ ,  $p < 0.001$ , effect size  $r = 0.940$ ). Both positive and negative adjectives were more frequently used to describe *music* in English fictional books than in the overall English books (positive words:  $Z = 11.003$ ,  $p < 0.001$ , effect size  $r = 0.781$ ; negative words:  $Z = 10.862$ ,  $p < 0.001$ , effect size  $r = 0.771$ ). These results indicated that emotion-related adjectives were more frequently used in fictional literature.

## Discussion

The present work examined how have music emotions been described by analyzing the usage frequencies of emotion-related adjectives in Google books. We observed similarities and differences in the usage frequencies of emotion-related adjectives when describing *music* across histories, languages, and corpora. In terms of similarities, we found that positive adjectives were more frequently used to describe music than negative adjectives, based on the Google English Books Ngram database, the Google American English Books Ngram database, the Google British English Books Ngram database, the Google Simplified Chinese Books Ngram database, the Google English fiction Books Ngram database. This finding supports the Pollyanna hypothesis that human language has a positivity bias (Boucher and Osgood, 1969; Dodds et al., 2015), which is also reflected in people's descriptions of music. This result is predictable because positive events have been proven to be more prevalent than negative events in daily life (Rozin et al., 2010). In addition, words describing more significant items were employed more frequently in a vast corpus (Leising et al., 2014). Thus, our finding of the similarity may also indirectly reflect that people generally prefer positive music, which has been concluded by a study using a different methodology (Xu et al., 2021).

Of course, not all research supports the aforementioned positive bias. Brand et al. (2019) study of popular music lyrics in the past 50 years found that the use of negative words in lyrics is increasing while that of positive words is decreasing. This may reflect a negative bias in the dissemination of social information, meaning that negative language information is more frequently shared by society. Therefore, there is still a lack of accurate conclusions regarding whether language information is more positive or negative. Furthermore, the words in LIWC are not exhaustive, meaning that they cannot represent all the vocabulary used in human languages. Therefore, we still need more research to interpret the observed positive preference for music description.

In terms of the time trends in English books, we observed that, for both positive and negative adjectives, the usage frequency started high in the middle of the 18th century and then showed a steady decline when describing *music*. Previous work has found that the use of words related to positive emotions decreased in song lyrics over time (DeWall et al., 2011), and it is consistent with part of our findings. DeWall et al. (2011) explained their findings by the rise of psychopathology (Twenge et al., 2010), but they did not evaluate the words related to negative emotions. Our findings revealed a general decrease in the emotional description



**Fig. 4 Historical periods of emotion-related adjectives when describing music in AE, BE, and SC books from 1960 to 2000.** **a** The adjusted frequencies of positive and negative adjectives when describing music from 1960 to 2000 (3-year smoothing). AE indicates American English, BE indicates British English, SC indicates Simplified Chinese, POS indicates positive adjectives, and NEG indicates negative adjectives. **b** and **c** are the adjusted frequencies of the top five positive and negative adjectives when describing music in AE books. **d** and **e** are the results of BE books, and **f** and **g** are the results of SC books (loess smoothing). Source: Own elaboration.

of music over time, regardless of emotional polarity. In fact, a genuine decrease in the literary expression of emotion has been found in the work of Acerbi et al. (2013). We think these trends may be explained by the cultural shift from collectivism towards individualism (Greenfield, 2013). Previous research has shown that music arousing specific emotions, including happiness, surprise, interest, nostalgia, anxiety, love, and spirituality, was more frequent in collectivist cultures than in individualist cultures (Juslin et al., 2016). Decreased pursuit of in-group emotional experience may lead to a reduction in the emotional description of the music. Another possibility could be that emotional words' usage has altered over the century, rather than decreased. However, this appears unlikely to explain the observed decline because we utilized contemporary word lists.

In addition, we still agree with the opinion of DeWall et al. (2011) that “shifts in song lyrics reflect cultural changes.” Therefore, cultural shifts may also be reflected in changes in music’s emotional description. Indirectly supporting the above viewpoint is the co-occurrence phenomena in simplified Chinese books. We observed that the usage frequency of positive adjectives when describing *music* in simplified Chinese books suddenly

increased in about 1966, and then declined in about 1976. This time period is consistent with China’s Cultural Revolution (Donnithorne, 1972). During the above time period, many Chinese people were actively seeking out “positive” objects, which had a noticeable impact on the emotional descriptions of music in Simplified Chinese books. We believe that this phenomenon aligns with the broader perspective on cultural evolution in music (Savage, 2019; Youngblood et al., 2023). By exploring the relationship between musical characteristics and specific cultural environments, music can serve as an important research tool to understand how cultural features change over time and across different geographic locations.

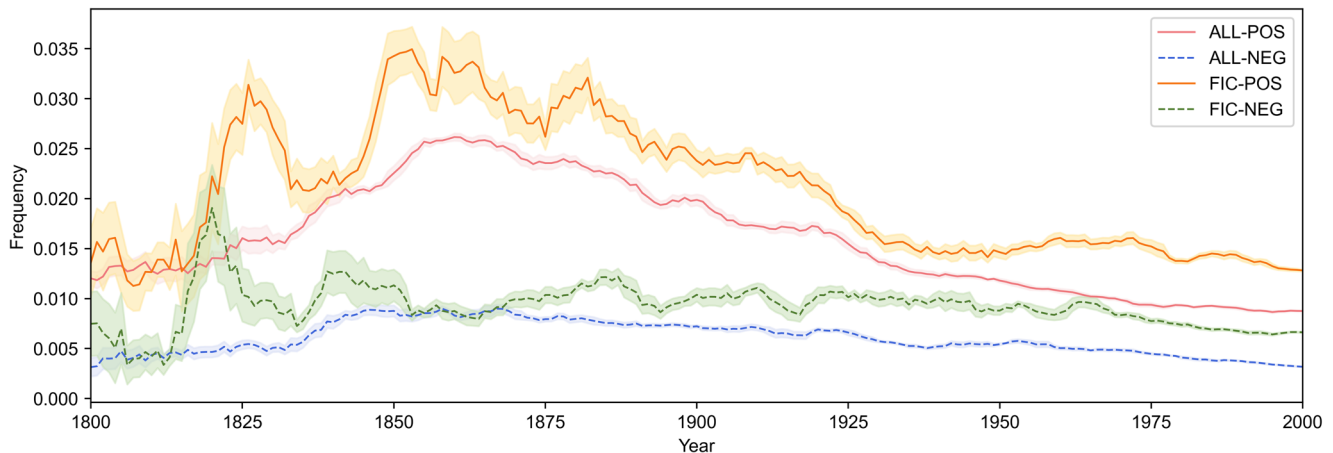
Changes in the emotional description of music can also be linked to significant social and historical events. Bochkarev et al. (2014) have argued that the distribution of word frequencies is sensitive to social and historical changes. From 1820 to 1850, we observed that both positive and negative adjectives were used with greater frequency. This suggests an increase in emotional expression during this period, with the upward trend being more pronounced for positive words, which began around 1800 and ended around 1860 (see Fig. 3b). In the history of music, the early 19th century marked a significant shift from classical music to the early romantic period (Erfurth and Hoff, 2000). By 1820, the romantic period was officially underway (Hansen et al., 2016). Artistic works from this period were distinguished by their romanticism, which was characterized by a strong subjective flavor, a focus on the expression of personal emotions, and the use of passionate language to convey those emotions. This style may not only impact the form of music but also influence literary works. However, the increase in emotional expression during the romantic period was followed by a prolonged period of decline after 1860. This trend is particularly evident in the long-term and significant decrease in the use of positive emotional words. Morin and Acerbi (2017) suggest that following the excessive emotional expression of the romantic period, emotional expression returned to average levels. Furthermore, Fig. 3c reveals that the frequency of the negative word *serious* shows relatively inconsistent changes compared to other negative words. Its usage frequency began to rise rapidly after 1925 and remained at a high level until around 1980 when it started to decline. This period of high usage frequency coincides with World War II, the Great Depression, and the Baby Boom, which were significant historical events (Bochkarev et al., 2014). These changes in vocabulary usage appear to be driven by specific major historical events (Acerbi et al., 2013).

**Table 1 Frequency comparison of positive adjectives used to describe music among the books written in AE, BE, and SC from 1966 to 1976 (post hoc Wilcoxon test).**

	Z	p	Effect size r
AE vs. SC	2.134	0.033	0.455
BE vs. SC	1.334	0.182	0.284
AE vs. BE	2.845	0.004	0.607

**Table 2 Frequency comparison of positive adjectives used to describe music between year 1960–1979 and year 1981–2000 in different language books (post hoc Wilcoxon test).**

	Z	p	Effect size r
AE	2.091	0.037	0.331
BE	3.920	<0.001	0.620
SC	2.389	0.017	0.378



**Fig. 5 Historical periods of emotion-related adjectives when describing *music* in English books and in English fictional books from 1800 to 2000 (3-year smoothing).** ALL indicates English books, FIC indicates English fictional books, POS indicates positive adjectives, and NEG indicates negative adjectives. Error bands indicate the standard errors. Source: Own elaboration.



The main discovery in terms of the language difference is the usage frequency of negative adjectives. We noticed that negative adjectives were significantly less used to describe *music* in simplified Chinese books than in English books. This may be explained by the differences in display rules between Western and Eastern cultures. Eastern cultures usually place a lower value on the display of an individual's emotions (Matsumoto et al., 2008), particularly anger and grief expressions (Matsumoto, 1990; Safdar et al., 2009; Song et al., 2021), and encourage hiding the negative emotions (Gross, 2001; Rychlowska et al., 2017); whereas western cultures are more focused on the development of the self (Markus and Kitayama, 1991) and the expression of emotion (Butler et al., 2007). In a representative oriental country, Chinese people may express fewer negative feelings and describe music with fewer negative words. In fact, except during China's Cultural Revolution, there are also fewer positive adjectives used to describe music in simplified Chinese books than in English books (see Fig. 4a). This also emphasizes how Chinese culture is more reserved when it comes to expressing and describing emotions.

Of course, the observed language differences may also stem from the ideology of music. Sorce Keller (2007) argues that the narrative content of music inevitably carries ideology, and these underlying ideologies can elicit responses from people and achieve a certain purpose by shaping and conveying the ideology. Therefore, there may be differences in the words used to describe musical emotions under different ideologies. Additionally, the author's literary style is also influenced by the cultural era in which they live, and this influence is often reflected in the words they use (Knight and Tabrizi, 2016). Hence, distinct cultural backgrounds may result in differences in the vocabulary used to describe music. Unfortunately, this study only compares the differences between the three languages, which makes it challenging to determine whether the observed variations are due to cultural differences between the East and West, the impact of the ideology of the country and society, or other reasons (e.g., the differences between the original LIWC lexicon and the SC-LIWC lexicon).

Corpora differences were also observed. We found that emotion-related adjectives were more frequently used to describe *music* in the fictional English books than the overall English books. Previous research has shown that, in comparison to non-fictional literature, fictional writing tends to utilize more person-descriptive adjectives (Ye et al., 2018), and fiction books were more biased toward intuition words (Scheffer et al., 2021). Thus, stronger emotive descriptions of music in fictional books are to be expected. These findings support the substantial disparities in words used in various corpora, which affect people's descriptions of musical emotions.

Notably, this study has several limitations. First, the current study solely examined bigrams composed of an adjective and a target word (e.g., sad music). Other ways of describing music are not covered: for example, single nouns (music is art) and single verbs (the music moved me). Our results also excluded expressions such as "that music is so sad". Second, this study initially focused on the word "music" as our sole target. However, it's worth noting that there are other semantically related concepts that could be considered, such as *song*, *melody*, and *fantasia*. While concentrating on a single seed word can help us avoid bias introduced by extraneous concepts, it also limits the scope of our results. Additionally, by only examining a subset of the corpus, we may have encountered unforeseen deviations. Thus, in future research, if we can remove the noise caused by additional seed words, more adjacent concepts should be integrated. Third, the corpora employed in this study were primarily from the previous two centuries, so they can only be used for historical analysis and cannot reflect the current state of society. More corpora,

expressions, and languages should be investigated in future studies to better understand people's attitudes toward music.

Furthermore, we must acknowledge the limitations of the Google Books corpus. First, while GBN is a free database that provides vast amounts of data, there are concerns regarding its reliability and representativeness (Solovyev et al., 2020). For instance, recognition errors may occur due to book printing quality and scanning problems, and there is a lack of metadata which makes it difficult to determine whether the content in the database truly belongs to the category it is labeled as. Studies have shown that even datasets labeled as fiction are heavily populated with scientific literature (Pechenick et al., 2015). Second, although the number of books included is substantial, it only represents digital scan samples of 6% of the world's published books and does not encompass all languages, genres, and types of text data (Solovyev et al., 2020), therefore it cannot fully represent all published books. Our research is based on text content obtained from this database, and as such, incomplete samples are an inevitable issue. Third, another issue with GBN is the unstable composition of the corpus over time, which introduces bias in diachronic comparisons. GBN encompasses a mixture of different genres, with fluctuating proportions over time. The uncontrolled composition of the GBN corpus leads to an apparent increase in cognitive distortions (Schmidt et al., 2021). Therefore, if Google books were constructed using a representative sample of existing books, it would significantly improve its reliability.

It should also be noted that even though google books provide some insight into the possible impact of key historical events on vocabulary use, we have only examined material from a single database and therefore cannot be considered to demonstrate historical evolution. The use of text in published books is likely to be influenced by the censorship system and the willingness of authors, editors, and publishing houses to produce and distribute certain types of content (Pechenick et al., 2015; Salganik et al., 2006). Therefore, the materials analyzed in this study may not necessarily reflect true cultural evolution. Furthermore, the language used in books tends to be more conservative than spoken language (Bochkarev et al., 2014), meaning that our findings only reflect trends in published materials and may not fully represent changes in human language. Despite these limitations, we believe that the Google Books corpus can still serve as an important basis for scientific research, helping us identify connections between the use of literary terms and social events or behaviors (Müller-Spitzer et al., 2015).

## Conclusion

The present work examined how have music emotions been described in books and music reviews by analyzing the usage frequencies of emotion-related adjectives when describing *music*. Positive adjectives were more commonly employed to describe music than negative terms in all corpora studied, indicating a positivity bias in music. Historical changes shifted in the emotional description of the music. For example, fewer and fewer emotion-related adjectives were used to describe music in English books over the past two centuries (1800–2000), and the usage frequency of positive adjectives suddenly increased in simplified Chinese books during China's Cultural Revolution. Language differences were also observed. For instance, negative adjectives were significantly less used to describe music in simplified Chinese books than in English books, reflecting cultural differences. Finally, we discovered significant disparities in the music's emotional descriptions between English Fictional Corpus and the Overall English

Corpus. Of course, more research is needed in order to understand the reasons behind the historical changes and cultural differences.

### Data availability

The data is accessible at <http://storage.googleapis.com/books/ngrams/books/datasetsv2.html>.

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## Author contributions

LX: conceive and design the experiment; methodology; analyzed and interpreted the data; writing-original draft preparation; contributed analysis tools and data. MX: formal analysis; writing-original draft preparation. ZJ: writing-original draft preparation. XW: conceive and design the experiment; analyzed and interpreted the data. YL: analyzed and interpreted the data; validation. ZS: resources; writing-review and editing. HL: supervision; writing-review and editing. XQ: supervision; writing-review and editing.

## Competing interests

The authors declare no competing interests.

## Ethical approval

Ethical approval did not apply in this study as the research did not include any human or animal participants.

## Informed consent

This article does not contain any studies with human participants performed by any of the authors.

## Additional information

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