



HAL
open science

In Search of Sublime Music

Esteban Buch, Mario Lorenzo, Amélie Jacquot, Marco Sperduti, Jérôme Dokic

► **To cite this version:**

Esteban Buch, Mario Lorenzo, Amélie Jacquot, Marco Sperduti, Jérôme Dokic. In Search of Sublime Music. 2024. hal-04705041

HAL Id: hal-04705041

<https://hal.science/hal-04705041v1>

Preprint submitted on 23 Sep 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Copyright

Pre-print

Accepted for publication in *Music Perception*

20/08/2024

In Search of Sublime Music

Esteban Buch (CRAL/EHESS)
Mario Lorenzo (CRAL/EHESS)
Amélie Jacquot (Université Paris 8)
Marco Sperduti (Université Paris Cité)
Jérôme Dokic (IJN/EHESS)

Abstract

Since Burke and Kant, even subjectivist approaches to the experience of the sublime have claimed that some objects afford it more than others. In 2021, nearly all the participants in the ANR SublimAE questionnaire gave precise answers when asked to identify a piece of music that elicited in them an experience of the sublime. We analyzed this collection of 128 tracks through Music Information Retrieval (MIR) techniques, in order to determine what sonic traits, if any, distinguished these pieces of “sublime music” from those of a second collection, designated by a control group of respondents who answered a question about an experience of the beautiful.

The results did not identify a set of recurrent traits in these putatively sublime pieces, except for minor differences of timbre, like a brighter quality of the spectra. Rather, our study suggests that the topical opposition between sublime and beautiful objects is less adequate to understanding the listening experience, than a dynamic and continuous view of both the objective and the subjective aspects of these aesthetic categories.

Keywords

Sublime Music / Beautiful Music / music analysis / Music Information Retrieval / ANR SublimAE

Since Burke and Kant, it has been accepted that the sublime is a particular kind of aesthetic experience that human subjects might have, rather than the experience elicited in them by a particular kind of aesthetic object. While elaborating it in significant ways, recent contributions to the philosophical literature have stuck to this view (Brady 2013; Shapsay 2013). For instance, it has been suggested that the sublime implies a modification of the subject's sense of *self*, not unlike some non-aesthetic experiences, such as awe (Keltner and Haid 2003; Arcangeli, Dokic and Sperduti 2019). Psychologists found evidence of the sublime differing phenomenologically and neurologically from other experiences, such as the beautiful (Ishizu and Zeki 2014; Hur 2019; Hur e.a. 2020; Pelowski e.a. 2021; Hur e.a. 2022).

At the same time, there seems to be an agreement in that some objects afford the experience of the sublime more than others. Burke associated it with greatness and loudness, and Kant exemplified it with natural phenomena such as the ocean and high mountains. Recent studies showed that objects having colossal physical size are most likely to be perceived as sublime (Rickard 2004; Konecni 2005 and 2007; Baltes e.a. 2011; Cowena e.a. 2011; Ji e.a. 2019; Koumura 2020). Even if visual objects were privileged in the philosophical tradition, the same arguably applies to sonic ones. Burke observed that “the noise of vast cataracts, raging storms, thunder, or artillery, awakes a great and awful sensation in the mind” (Burke 1990, 75), and Kant evoked thunder and hurricanes.

Remarkably, both philosophers were reluctant to acknowledge some music being sublime per se. In this, however, they went somehow against the grain. When Burke published his *Philosophical Enquiry* in 1759, the description of Georg Friedrich Handel's oratorios as sublime was current in music criticism (Johnson 1986; Shapiro 1993; Gilman 2009; Buch 2020). Later on, instrumental works of the classical repertoire by Beethoven and Mahler were often described in these terms, as well as some pieces of music genres such as post-bebop jazz,

progressive rock, and others (Brillenburg Wurth 2009; Matthew 2009; Liddle 2017; Campbell 2018).

The willingness to associate the sublime with specific music persisted to this day. In 2021, nearly all the participants in a questionnaire-based study led by members of the ANR SublimAE project, an interdisciplinary project based in Paris¹, gave precise answers when asked for an example of music that elicited in them an experience corresponding to a standard description of the sublime. Thus, they showed that the association of these descriptions of the sublime with specific artworks made sense for them in the first place. Building on these findings, the current study analyzes the collection of 128 music pieces they mentioned through Music Information Retrieval (MIR) techniques. The aim of the analysis of the SublimAE music corpus was to explore the category of “sublime music” by determining what sonic traits, if any, distinguished these pieces from those designated by a control group of respondents who described a “positive” musical experience, taken as a neutral naming for listening to “beautiful music”. In this second group, mirroring how respondents answered a further question about the compatibility of the two experiences, we differentiated “beautiful music” and what we provisionally called “beausublime music”. While this third subset was excluded from the comparison through MIR analysis between the sublime and the beautiful collections, we return to it in the final discussion.

Adding to the detailed results of the fifty questions of the SublimAE questionnaire, discussed in a separated article (Jacquot, Sperduti e.a., forthcoming), the MIR analysis of the SublimAE music corpus presented here did not identify a set of recurrent sonic traits of putatively sublime music, except for minor differences of timbre, specifically a brighter quality of the spectra, and an arguably inconclusive difference in mode. Rather, our study suggests that

¹ The ANR SublimAE project, started in 2019 and funded by France’s Agence Nationale de la Recherche, was run by members of the Jean Nicod Institute (JNI), the Centre de Recherches sur les Arts et le Langage (CRAL) and the Laboratoire Mémoire, Cerveau & Cognition at the Ecole des Hautes Etudes en Sciences Sociales (EHESS), the Ecole Normale Supérieure (ENS) – PSL University, and Université Paris Cité.

the topical opposition between sublime and beautiful objects is less adequate to describing the listening experience of the subjects, than a dynamic and continuous view of both the subjective and the objective aspect of the sublime and the beautiful, interacting in complex ways in evolving musical and psychological contexts.

Thus, our findings did not really confirm the results of Young-Jin Hur's (2019) study on multimodal sublime experiences, which includes a section on "music only" that might count as a precedent to our research, despite its very different aims and methodologies. Hur found that music in the minor key was consistently perceived as "more sublime" than both music in the major key and atonal music; he also found that "fast music" elicited "more sublimity" than slow music (Hur 2019, 181). Based on the responses of 39 participants to piano pieces by Bach, Chopin, and Schoenberg, paired with a standardized characterization of the sublime and the beautiful, his methodology transposed to the sublime vs beautiful polarity the traditional association of the minor mode with sadness vs the major mode with happiness, atonal music being perceived, perhaps surprisingly, as closer to the last than to the first. In our study, though, we found that tempo differences were not significant at all in that respect, and also, that music in the major mode dominated both the sublime and the beautiful music collections. In fact, one of the MIR tools did find that the proportion of minor mode tracks was still significantly higher in the sublime than in the beautiful collections, but this was not confirmed by a second method for determining mode.

At another level, our results are consistent with Hur's observation that "the reported experience of sublimity and beauty are positively and moderately correlated", leading him to assert that "the experience of sublimity also assumes the experience of beauty, at least in judgements" (Hur 2019, 186). Interestingly, this last statement is also compatible with the historical record. The sublime was not always conceived as opposed to, or incompatible with, the beautiful, witness period descriptions of a work by Purcell as "this most beautiful, and

sublime representation” (Thomas Tudwell in Shapiro 1993, 231-232). Kant, for one, thought that in artworks such as oratorios and tragedies, the sublime was “united with beauty” (Kant 1922, 182). This continuity is mirrored in today’s natural language, where in both aesthetic and non-aesthetic contexts the adjective “sublime” is often used as a hyperbole of the adjective “beautiful”. Accordingly, our distinction of an intermediary, “beausublime” category helps seeing the beautiful vs sublime polarity as a spectrum of experiences. The possibility that a single piece, or very similar pieces, might inspire different experiences in different people, or in the same people at different moments, suggests that the difference between both categories is more dynamic, and less oppositional, than generally thought. This, together with the globally negative result of our search for sublime music, except for a small difference in the brightness of sound, might count as a main result of our study.

Methodology

The ANR SublimAE Questionnaire on Music and the Sublime, written in French, was meant to “determining the affective and cognitive characteristics of musical experiences of the sublime”. Adding to introductory questions on demographic data, it consisted of fifty Likert scales, subsequently reordered in eight dimensions or categories. Disseminated through the internet, it obtained 283 responses: 133 for the sublime version, 150 for the control version. Nearly two-thirds of the respondents in both categories (63,20% for the first, and 66% for the second) were women, the other third were men, with respectively 2,30% and 0,70% selecting the “other” genre category. Nearly half of the respondents declared to be non-musicians (46,60% and 52%), the other half acknowledging some degree of musical expertise, including 3% and 4% of professional musicians. A very significant amount of them -nearly two-thirds- had higher education degrees, namely, for the first group, 43,61% of Master’s degrees and

14,29% of Ph.D.s.; and for the second, 57,33% of Master's degrees, and 10,67% of Ph.D.s. No data on physical location was asked, but since the questionnaire was in French, we can assume a majority of French people in the sample. Thus, the sample was relatively homogenous from a sociological point of view.

Since, as stated above, the responses to the questionnaire are discussed in detail elsewhere, we do not address them here. Suffice it to say that the study proposed a description of a musical experience of the sublime and, in the second, control questionnaire, a description of a musical experience of the beautiful. Based on these short texts, each subject chose a musical example. Both questionnaires purposely avoided using the words *sublime* and *beau* (beautiful), in order to focus on the psychological experiences described in natural conversation, rather than on the language games implying these terms. Indeed, the meaning of these words in non-specialized contexts often diverges from their definition in the philosophical tradition, the latter being our starting point for penning the questions. We also took advantage of studies that associated some strong listening experiences with somatic reactions, such as chills and goosebumps (Panksepp 1995; Bannister 2020). Also, it is worth noting that the French language is unlikely to induce a significant difference with the same questions in English, as the lexical fields are similar in the two languages.

The Sublime questionnaire invited participants to react to the description of an idealtypical experience of the sublime, shown below, and to illustrate it with one music piece:

La musique produit en moi des sentiments mêlés. D'une part, elle m'émeut, touche ou transporte bien plus intensément que d'autres musiques que j'apprécie aussi. En l'écouter, il m'est arrivé d'avoir la gorge nouée ou les larmes aux yeux. Il y a dans la musique quelque chose d'édifiant et d'exaltant. C'est comme si d'autres horizons se révélaient à moi. D'autre part, je me sens submergé par la musique, qui me perturbe et me remet en question. Je pourrais facilement avoir des frissons ou la chair de poule. J'ai le sentiment d'être confronté à quelque chose qui me dépasse, d'être bien peu de choses.

The music inspires me mixed feelings. On one side, it touches me and transports me, in a much more intense manner than other music pieces I also like. By

listening to it, I sometimes have a lump in my throat, and tears might flow from my eyes. The music has an edifying and exalting quality, as if I discovered new horizons. On the other side, I feel submerged by the music, it moves me and challenges me. I could easily feel chills or goosebumps. I have the feeling of being confronted to something bigger than me, the feeling of being very small.

The corresponding question of the Control questionnaire, intended to elicit an example of “beautiful” music, was:

La musique me procure du plaisir ou des sentiments de bien-être. Je suis bercé par l’harmonie, l’ordre et la sérénité que la musique dégage, et qui me conforte ou m’apaise.

Music gives me pleasure or feelings of wellbeing. I am surrounded by the harmony, order, and serenity that the music irradiates, thus comforting and calming me down.

The Control questionnaire included a supplementary question, namely whether the music piece corresponding to the respondent’s experience of “beautiful music” *also* matched the description we submitted to respondents of the Sublime questionnaire. (Since the project was designed to focus on the sublime only, the ANR SublimAE questionnaire did not include the symmetrical question of whether the description of the experience of the sublime also applied to the experience of the beautiful). Such was the case in 83 responses out of the total 283, that is, 30% of the total number of respondents, and 55% of the 150 respondents to the Control questionnaire. Consequently, these 83 responses were excluded from the control collection to which we compared the pieces mentioned in the Sublime questionnaire, although we did take them into consideration for our final discussion of the loose boundaries between the sublime and the beautiful.

The constitution of the SublimAE music corpus implied several other decisions, adapted to the computational tools selected to analyze this set of recorded tracks of music works. Of the 283 responses obtained for the SublimAE questionnaire, 4 did not mention any work or composer, and were discarded for the making of the corpus (for example: “none”, “a sweet

music”). Also discarded were 4 answers giving only the name of a composer (“Beethoven”, “any music by Bach”, “Chopin”, “Mozart”). The remaining 275 respondents gave one, and only one, answer, namely the title of a music piece.

We also had to reduce the heterogeneity of the works’ duration, especially when the respondents’ answer was a classical music work such as a symphony or an opera. For one thing, including many very long works in the corpus would have stressed our computational capabilities to the limit. Moreover, since many classical works are multi-movement, they appear in standard listening devices -streaming platforms, mp3 players, CDs- as a set of distinct tracks, each corresponding to a movement, or number. To compare multi-track with one-track pieces would have introduced a fatal asymmetry in the material operation of the corpus. Merging several movements into one single track for each work was not a good solution either, as the new wav files would not have been on Spotify, a condition detailed below.

A further reason for reducing temporal heterogeneity was the hypothesis that pieces of very different durations -say, a three-minutes song and a three-hours opera- correspond to very different listening experiences. Assuming that the expression “Mahler’s *Second*” in the written recollection of an experience designates the whole work is as hard to ascertain as the opposite conjecture, which admits that in some cases at least the name of a work is a synecdoche for one or more unidentified *moments* of it. This is why long, multi-movement classical works are represented in the corpus by one single track, namely the most popular one, according to Spotify data. This method was followed in 42 responses out of the total 275. For example, Beethoven’s *Symphony n°6 ‘Pastoral’* was replaced by its *Allegro ma non troppo*, Bach’s *Goldberg Variations* by the *Aria*, Bizet’s *Carmen* by the *Habanera*, Wagner’s *Valkyrie* by the *Ride of the Valkyries*, Keith Jarrett’s *Köln Konzert* by its *Part 1*, and so on.

The participants who mentioned classical music works did not specify the performer and/or the version they preferred (except for two of them, who answered “Peer Gynt, *In the*

Hall of the Mountain King, Grieg-Karajan”, and “*Concerto pour piano n°20*, Mozart par Clara Haskil”). For this reason, the constitution of the corpus implied selecting the performer of each classical piece, something we did by choosing the most popular version available on Spotify.

Now, performances can significantly impact the listening experience, as different versions of a music work are never identical. We addressed this issue by selecting not one, but two versions of each piece of classical music. Some non-classical works are in that position too, given that some popular songs are presented in both a studio recording and a live recording, when available. As a result of these operations, there are two versions of the corpus. The first, Corpus 1, included the most popular performances of all pieces, always according to Spotify, whenever the distinction among versions is pertinent; the second, Corpus 2, included the second most popular versions.

Whenever a significant difference was detected in Corpus 1, with a value of $p < 0.05$, we double-checked it with Corpus 2, and discarded all differences that were not confirmed in the second version of the corpus. Conversely, in the discussion of the results we considered only significant differences that were detected in both Corpus 1 and Corpus 2. Still, measurements for both corpora systematically appear in the tables that recapitulate the results for each musical parameter.

Now, MIR tools designed by Spotify can only be operated through Spotify playlists. For that reason, we also discarded 5 titles which were not available on Spotify. Without that limitation, we should have renounced using Spotify resources altogether. We also used Spotify to measure the tracks’ popularity, and we operated the corpus mostly as Spotify playlists. This is a consequence of this company’s dominant position in music streaming, a complicated ethical and practical issue which we do not address here, as it does not have clear implications for our results (Vondereau 2017; Prey 2018). All the tracks listed in Spotify were converted through corresponding Youtube mp4 files into mp3 files, in order to analyze them with MATLAB’s

MIRtoolbox resources. The alteration of the signal through this process, where all records were reduced to the standard quality of a mp3 file, is a limitation of the present study. On the other hand, the participants were not asked to specify the technical and acoustical conditions in which they listened to the music in the first place.

These are the four collections of the SublimAE corpus (see Appendix I for the lists of music works):

Sublime 1 (128 tracks)

<https://open.spotify.com/playlist/3EZme5Rql5vATVxzGVDDJt?si=e412ac7f692c4711>

Beautiful 1 (63 tracks)

<https://open.spotify.com/playlist/65fz36uQn2UfGltdeV3Qhw?si=06baf2faec54432e>

Sublime 2

<https://open.spotify.com/playlist/5G2g846q2JsgADe551XZLD?si=5b7e809a8bdd4d9a>

Beautiful 2

<https://open.spotify.com/playlist/1Ajm6tiLGVjWGo7tVeQHcs?si=ff2510c0b7c34ded>

While in recent years MIR procedures have become increasingly important in scholarly research on music perception and music studies at large, there is no stabilized toolbox for MIR-analysis inside the scholarly communities of musicologists and psychologists of music. For one thing, MIR resources have different conditions of accessibility. Some of them are dependent on streaming companies, some are part of computational packages only available on a financial basis, and some are available in open access through languages such as Python. Also, providers have different policies concerning the transparency of their algorithms. While open access resources generally include information on the functions' design, streaming platforms are well-known for the opacity, and even the secrecy, of the algorithms that orient their customers' preferences and behaviors.

In the following we present results obtained with Spotify Web API and MATLAB's MIRtoolbox (version 1.8.1) (Lartillot e.a. 2008a). To get access to the data provided by Spotify,

we used the Python library Spotipy, designed by Paul Lamere. First, the distribution of music genres is discussed on the basis of Spotify metadata, specifically the “parent genre” of the artist associated to each track. After that preliminary step on genre, which extends to a short discussion of the identity of the artists/composers, we present the results obtained with several Spotify API and MIRtoolbox functions, regrouped by us into the broader categories of Dynamics, Rhythm, Timbre, and Tonality. (See Appendix II for recapitulative tables of differences found in Corpus 1 and Corpus 2, and Appendix III for a detailed presentation of the results).

The selection of the MIR tools was made in order to cover these standard parameters of sound signal and music, while avoiding whenever required the redundancies of highly correlated variables. We included in the Dynamics data results obtained with Spotify API’s Energy and Loudness functions, as well as with MIRtoolbox’s Root Mean Square (RMS) and Low Energy functions. Concerning Energy, it is worth noting that this measure from 0 to 1 implies more than amplitude data, for it represents a perceptual measure of intensity and activity. “Typically, energetic tracks feel fast, loud, and noisy”, according to Spotify API. Also, while the RMS function measures the energy of the signal by taking the root average of the square of the amplitude, the Low Energy function identifies the percentage of frames showing less-than-average energy, thus giving some insight into the temporal distribution of energy and its degree of contrast (Tzanetakis and Cook, 2002).

Under the Rhythm label, we present results of Spotify API’s Time Signature, BPM and Danceability functions, as well as MIRtoolbox’s Pulse clarity, Event density, and Tempo. In particular, Pulse clarity indicates the strength of the beats estimated by the Tempo function, which in turn detects periodicities from the event detection curve (Lartillot e.a. 2008b). Also, Danceability estimation -where 0 is least danceable and 1 is most danceable- is based on a

combination of musical elements including tempo, rhythm stability, beat strength, and overall regularity.

We put under the Timbre category Spotify API's Instrumentalness and Acousticness metadata, together with several of MIRtoolbox's descriptors of spectral activity, namely Brightness, Roughness, Irregularity, and Zero-Crossing Rate. Concerning Instrumentalness, "ooh" and "aah" sounds are treated as instrumental, while rap or spoken word tracks are clearly vocal. Also, tracks with high Acousticness will mostly have natural sounds such as acoustic guitar, piano, orchestra, or the unprocessed human voice, while those with low rates will mostly consist of electric sounds, including drum machines and auto-tuned vocals. As for the MIRtoolbox functions for Timbre, the Zero-Crossing Rate counts the times the signal crosses the X-axis, while Irregularity measures the degree of variation between successive peaks of a spectrum. Concerning the Roughness function, it derives from Plomp and Levelt (1965) proposing an estimation of the sensory dissonance related to the beating phenomenon, whenever a pair of sinusoids are close in frequency. Their definition of roughness was elaborated by Sethares (1998), by computing the peaks of the spectrum, and taking the average of all the dissonances between all possible pairs of peaks.

Finally, under the title Tonality we present data obtained with MIRtoolbox's Inharmonicity algorithm, and with both Spotify API's and MIRtoolbox's Key and Mode functions. The key is described through standard Pitch Class notation, e.g. 0 = C, 1 = C#/D \flat , 2 = D, and so on, while the estimation of Mode is returned as a numerical value between -1 for the minor and +1 for the major mode.

The statistical description of the data showed that in large part, the distribution was not normal, and the tests of equality of variances also had problems of heteroskedasticity. In a number of cases, there was also the issue of outliers. This heterogeneity in the data raised the question of which tests to use. Generally speaking, in the case of quantitative data we used the

Levene test for equality of variances, and the Shapiro-Wilks test for the analysis of distributions. Whenever possible, we performed data normalization with a logarithmic function. We compared the means with the Student's test, but in some cases we had to use the medians, hence the Mann-Whitney test. For qualitative data, we used the Chi-square test.

Results

A first, important result of our study is that music genre does not appear to be a pertinent variable for distinguishing sublime music and beautiful music. It is true that music genre categorizations are often too dependent on opaque algorithmic decisions to be counted as trustworthy indication of the respondents' taste and listening practice. Still, it is remarkable that classical music dominates both the Sublime and the Beautiful collections, in roughly the same proportions (respectively 38% and 40%). This similarity is an indication against the possibility of classical music being to some extent, for historical reasons, a prototype of sublime music, capable of influencing some participants independently of their actual familiarity with the genre.

Rock music and pop music are the second and third most important genre subsets, although in quite different proportions: while in the Sublime collection rock music amounts to 21% and pop music to 14% of the whole, these figures are only 11% and 8% respectively in the Beautiful collection. On the other hand, tracks identified with the "metal" music genre represent 8% of the Beautiful, and only 2% of the Sublime; metal music being arguably a variant of rock music, this leaves us with roughly similar proportions in that account too. The same can be said of the "electronic" genre, with 7% of the Sublime and 6% of the Beautiful.

Now, the two collections differ not only in the proportion of pop music, but also in that "easy listening" pieces represent 6% of the Sublime, and only 3% of the Beautiful. Also, jazz

pieces are 3% of the Sublime collection, against 9% of the Beautiful; “world/traditional” tracks are 2% of the Sublime, and 5% of the Beautiful. Some genres are present in only one collection: “chanson” tracks are 4% of the Sublime, and 0% of the Beautiful; “new age” tracks are absent from the Sublime collection, while they are 5% of the Beautiful. The other generic categories mentioned in the results -latin, hip hop, blues- show still lesser differences, if any.

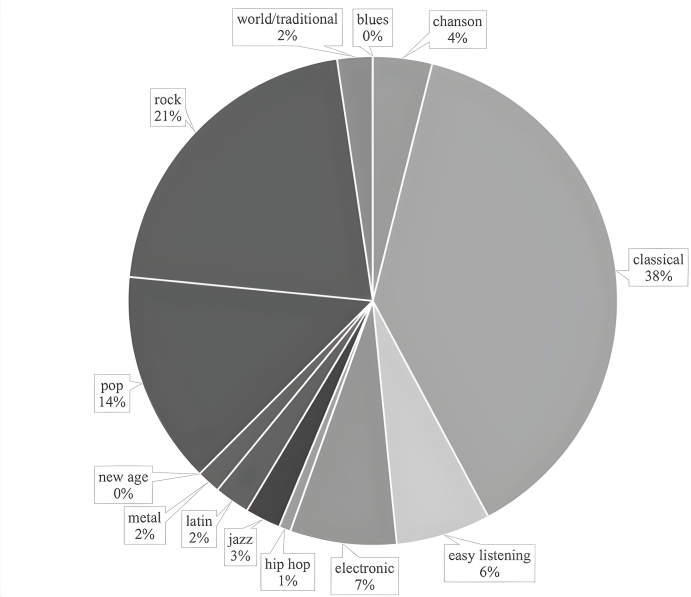


Fig.1: Music Genres (Sublime)

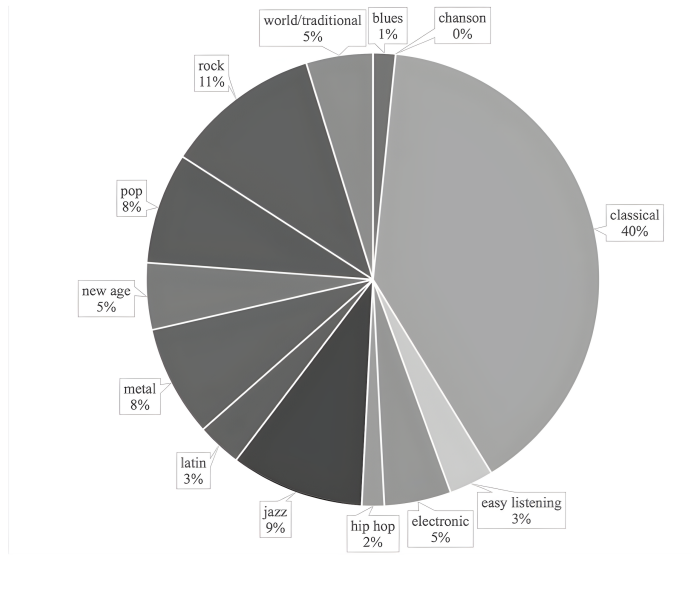


Fig.2: Music Genres (Beautiful)

Thus, as we see in Fig. 1, except for the higher proportion of pop music in the Sublime collection, differences in music genre are not very significant. A similar observation can be made about artists: in the two collections, music by Johann Sebastian Bach appears first in the list of the number of occurrences by composer, arguably confirming Bach’s canonic status in history as “the father of music” (Hennion & Fauquet, 2000). The Sublime collection’s list also includes Antonin Dvorak, Ludwig van Beethoven, Wolfgang Amadeus Mozart, and Johann Strauss, whereas in the same positions of the Beautiful collection we find, after Bach, the names of Keith Jarrett, Antonio Vivaldi, Gabriel Fauré, and Maurice Ravel. The statistical importance of classical music is balanced with the fact that no composer is quoted more than 5 times in any collection, while most are mentioned just once, thus suggesting a strong influence of personal taste and idiosyncratic choice.

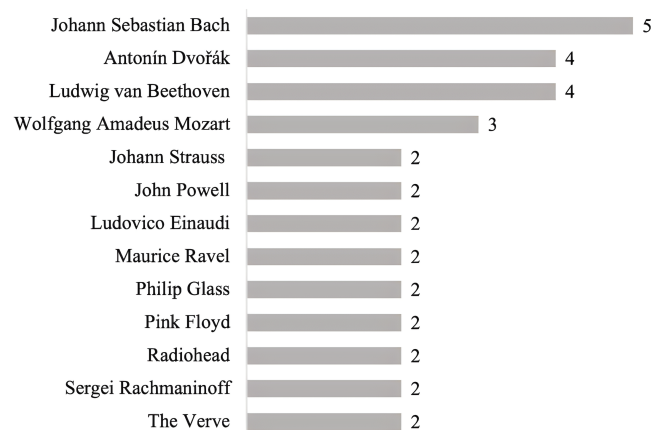


Fig 3. Artists (Sublime) (mentioned more than once)

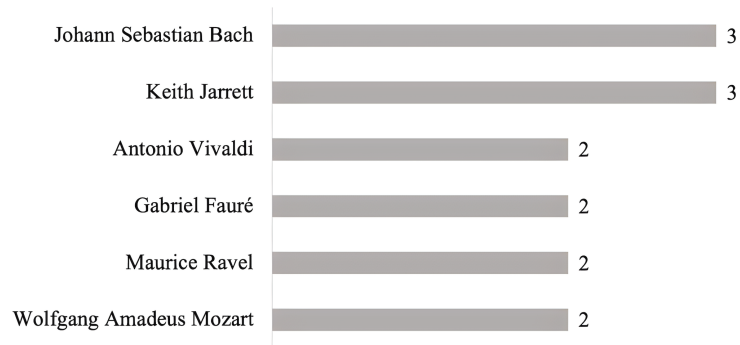


Fig. 4: Artists (Beautiful) (mentioned more than once)

Let us now compare the Sublime and the Beautiful collections with MIR tools for Dynamics, starting with Spotify API's **Energy** function. As the data showed a significant deviation from normality, with $p < 0.001$ for both the Sublime and the Beautiful collections, we performed a Shapiro-Wilk test. The result of the comparison using medians by way of a Mann-Whitney test was a non-significant $p = 0.060$.

Concerning **Loudness**, the values obtained through Spotify API were submitted to a Levene's test that revealed that the homogeneity of variance was respected, with $p = 0.611$. Yet, a Shapiro-Wilk test showed that the data were not normally distributed, namely Sublime 1 with $p = < 0.001$ and Beautiful 1 with $p = 0.031$. After trying various transformations (logarithmic, square, inversion) without obtaining homogenization, we opted again for the non-parametric Mann-Whitney test. These results show a significant difference between Beautiful 1 (median -16db) and Sublime 1 (median -15db) with $p = 0.041$, implying that Loudness is likely to be a little higher in sublime tracks.

To confirm our results on Loudness, we turned to the second version of the corpus, and compared the Sublime 2 and Beautiful 2 collections. Since the homogeneity of the variance by the Levene's test was respected with $p = 0.923$, we carried out the Shapiro-Wilk test which showed again a poor distribution to pass the Student's test, namely Sublime 2 with $p = <.001$ and Beautiful 2 with $p = 0.029$. We performed again a Mann-Whitney test, and this time the

difference was not significant, $p = 0.224$. Hence, given that the results for Corpus 1 were not confirmed for Corpus 2, we do not retain Loudness among significant differences characterizing sublime music.

Now, Levene’s test for the **Root Mean Square (RMS)** values of Sublime 1 and Beautiful 1 was significant, $p = 0.024$. A logarithmic transformation allowed us to pass this test with $p = 0.448$, but in both cases, the results of the normality tests did not allow us to perform a Student’s test. The non-parametric Mann-Whitney test gave $p = 0.107$, hence a non-significant result. Finally, we used the **Low energy** MIRtoolbox function. Since the results followed the normal distribution, Student’s test gave the result $p = 0.177$, also non-significant.

Here Is a synthesis of the results for Dynamics, including systematic comparisons with Corpus 2. Significant results ($p < 0.05$) are highlighted:

		S1/B1		S2/B2	
	Features	p-value	Test	p-value	Test
Spotify	Energy	0.060	Mann-Whitney	0.301	Mann-Whitney
Spotify	Loudness	0.041	Mann-Whitney	0.225	Mann-Whitney
MIRtoolbox	RMS	0.107	Mann-Whitney	0.328	Mann-Whitney
MIRtoolbox	Lowenergy	0.177	Student	0.363	Student

Table 1: Dynamics

We now consider several functions listed under the category of Rhythm, starting with MIRtoolbox’s **Pulse clarity**. Levene’s test showed that the variability of the means of Sublime 1 and Beautiful 1 was not significant ($p = 0.310$), but since the distribution did not follow a normal distribution, we performed a Shapiro-Wilk test, obtaining $p < 0.001$ for both collections. A logarithmic transformation allowed us to do the Student’s test, confirming the null hypothesis with $p = 0.718$.

We also compared the **Event density** with MIRtoolbox’s mireventdensity. For Sublime 1 and Beautiful 1, the Levene’s test revealed that the assumption of homogeneity of variance

was not respected ($p = 0.003$), and the Shapiro-Wilk test showed that the distribution was not normal. Since no transformation allowed us to correct this problem, we performed a Mann-Whitney test with $p = 0.152$, a non-significant result.

Concerning the **Time signature**, as identified by Spotify API's function, the comparison through the Chi-square test showed no significant difference between Sublime 1 and Beautiful 2, with $p = 0.213$. Indeed, both collections are dominated by 4/4 measures, as compared to ternary rhythms:

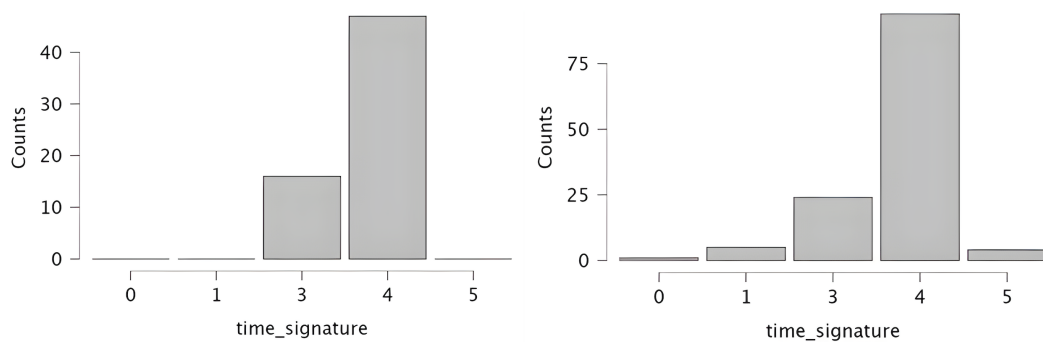


Fig. 5: Time signature (Corpus 1)

Significant differences for **Tempo** were looked for with MIRtoolbox's function and Spotify API's BPM extractor. Let's start with this last. Levene's test showed a significant difference with $p = 0.016$, but the heteroscedasticity led to a Welch correction, giving now $p = 0.416$, thus comforting the null hypothesis. What about MIRtoolbox's Tempo function? For one thing, there were many outliers, of which it was hard to tell if they were real or resulted from imperfections of the measurement device, which tend to double or quadruple the actual tempi. Now, if we retire manually the nine outliers from the collections, we obtain through a Student's test a non-significant value, namely $p = 0.192$. If, instead, we keep the outliers in, with medians at 123 BPM for Sublime 1 and 121 BPM for Beautiful 1, a Mann-Whitney test gives $p = 0.267$. The conclusion is that tempo difference is non-significant with both Spotify API and MIRtoolbox.

Finally, our Rhythm section included Spotify API’s **Danceability** function. The tests of equality of variances as well as that of normality did not give a significant difference, thus allowing us to obtain a Student’s test with a non-significant result, $p = 0.818$.

Here is a synthesis of the results for Rhythm, including again systematic comparisons with Corpus 2:

	Features	S1/B1		S2/B2	
		p-value	Test	p-value	Test
MIRtoolbox	Pulseclarity_Log	0.718	Student	0.114	Student
MIRtoolbox	Eventdensity	0.152	Mann-Whitney	0.420	Mann-Whitney
Spotify	Time Signature	0.213	χ^2	0.465	χ^2
Spotify	BPM	0.416	Welch	0.038	Mann-Whitney
MIRtoolbox	Tempo (outliers)	0.192	Student	0.465	Student
MIRtoolbox	Tempo	0.267	Mann-Whitney	0.459	Mann-Whitney
Spotify	Danceability	0.818	Student	0.993	Student

Table 2: Rhythm

Now, let us present the results for **Timbre**. As explained above, our analysis included levels of instrumentality and acousticity proposed by Spotify API, as well as MIRtoolbox measurements of Brightness, Roughness, Spectral Centroid, Zero-Crossing Rate, and Irregularity. It is worth reminding that timbre is “a complex auditory attribute” which relates to “abstract spectral, temporal, and spectrotemporal properties of the audio signal, although previous knowledge of the sound source itself also plays a role” (McAdams 2019, 23). Functions such as Zero-Crossing Rate are time-domain descriptors, often used to describe the “noisiness” of the sound, as resulting among others from percussion instruments (Hanna e.a. 2004; Gouyon e.a. 2000; Bayle, Hanna & Robine 2016). Also, Spectral Centroid is useful for instrument recognition, music genre classification, and voice activity detection (Murthy e.a. 1999; Essid e.a. 2006; Li & Ogihara 2005; Zhang, Guo & Zhang 2009; Ahrendt e.a. 2004). In

other words, although the functions we used here are associated with timbre, they also provide information on tonality, rhythm, and other musical categories.

Concerning **Instrumentalness**, a Mann-Whitney test gave $p = 0.118$, a non-significant result. On the other hand, the measurement for **Acousticness** with the same method did show a significant difference for Corpus 1, with $p = 0.002$. This was confirmed by the analysis of Corpus 2, where $p = 0.017$. Hence, we include as a result of our study the observation that Sublime pieces are less often acoustic than Beautiful ones, or conversely, that Sublime pieces are more likely to use electronic instruments. It is worth noting that classical music has no impact here, since its levels of acousticness are much higher than other music genres.

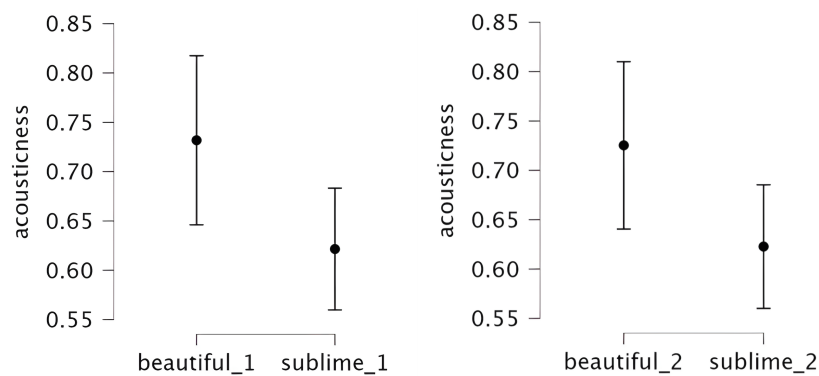


Fig 6: Acousticness

We studied **Brightness** with MIRtoolbox's corresponding function. Given a normal distribution and a non-significant measure of variances according to Levene's test, with $p = 0.488$, a Student's test showed that we should reject the null hypothesis for Corpus 1, with $p = 0.006$. Once double-checked with Corpus 2, a Shapiro-Wilk test indicated that the distribution of Beautiful 2 data was not normal, leading us to perform the Mann-Whitney test, with again a resulting $p = 0.006$. Thus, in both cases we found a significant difference in the brightness of the music, Sublime tracks being globally a little brighter than Beautiful tracks.

We could rephrase this by saying that the Sublime and the Beautiful collections have different spectral centers. Indeed, analysis with MIRtoolbox’s **Spectralcentroid** extractor confirmed this point. Since the distribution was not normal, a logarithmic transformation was needed for performing the Student’s test on Corpus 1, with the result $p = 0.011$. Once double-checked with Corpus 2, the result was still $p = 0.016$, thus confirming that Sublime pieces are likely to have a higher spectral center than Beautiful ones.

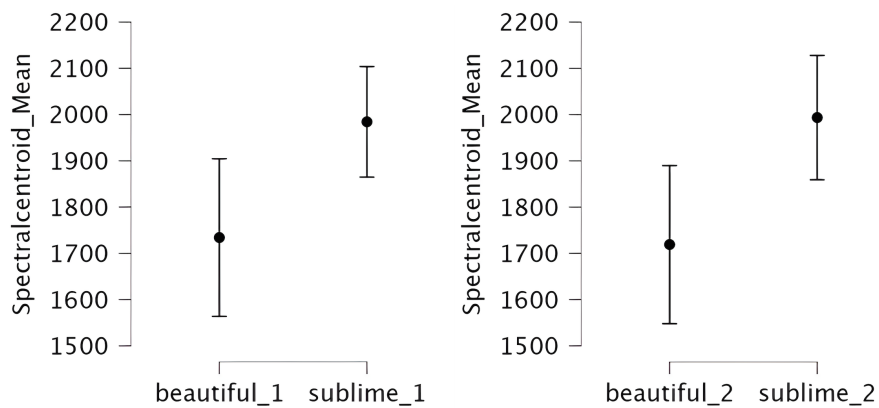


Fig. 7: Spectral centroid

Now, **Roughness** was defined by Plomp and Levelt (1965) to describe the spectral dissonance, i.e the beating phenomenon that occurs when two sinusoids are brought together. The data obtained with the corresponding MIRtoolbox extractor was very heterogeneous, with a significant quantity of outliers. After a logarithmic transformation and the application of the Mann-Whitney test, the comparison between Sublime 1 and Beautiful 1 gave $p = 0.070$, hence non-significant.

The situation was different with **Irregularity**, a MIRtoolbox function that indicates the degree of variation of the successive spectral peaks. The comparison through a Student’s test displayed a significant difference, namely $p = 0.017$. This difference in Corpus 1 was confirmed with Corpus 2; this time the result, $p = 0.004$, was obtained with a Mann-Whitney test. Thus, we can retain this parameter for a discussion of the singularities of Sublime music, while

observing that the stronger irregularity of the Beautiful collection seems to contradict other measurements of spectra such as Zero-Crossing Rate, which is higher for the Sublime collection.

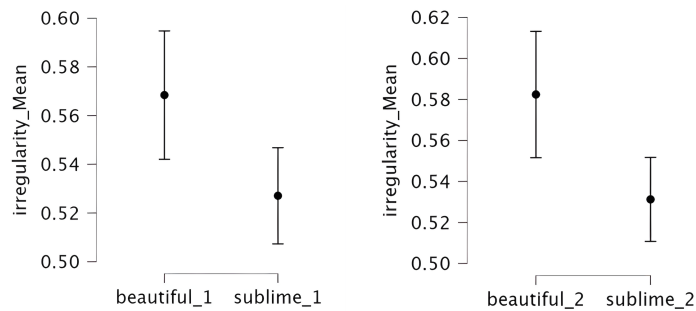


Fig. 8: Irregularity

By using MIRtoolbox's **Zero-Crossing Rate** function, we performed Levene's and Shapiro-Wilk tests, and found a significant difference between the Sublime and the Beautiful collections both in Corpus 1 and Corpus 2, respectively $p = 0.018$ and $p = 0.011$. Thus, the higher frequency of zero-crossing rate was an indication of a possible noisier quality of Sublime music tracks.

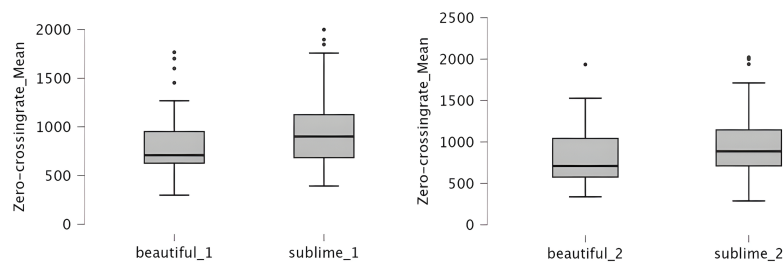


Fig. 9: Zero-Crossing Rate

Here is a synthesis of the results for Timbre, with highlighted significant differences:

		S1/B1		S2/B2	
	Features	p-value	Test	p-value	Test
Spotify API	Instrumentalness	0.118	Mann-Whitney	0.039	Mann-Whitney
Spotify API	Acousticness	0.002	Mann-Whitney	0.017	Mann-Whitney
MIRtoolbox	Brightness	0.006	Mann-Whitney	0.006	Mann-Whitney
MIRtoolbox	Spectralcentroid	0.011	Student	0.016	Student
MIRtoolbox	Roughness	0.070	Mann-Whitney	0.085	Mann-Whitney
MIRtoolbox	Zero-crossing	0.018	Student	0.011	Student
MIRtoolbox	Irregularity	0.017	Student	0.004	Mann-Whitney

Table 3: Timbre

The last grouping is Tonality, in which we include estimates of the tonal center, predominance of major or minor modes, and measurement of the degree of harmonicity of the spectrum. MIRtoolbox’s **Inharmonicity** function estimates the amount of energy outside the harmonic series on a scale of 0 to 1. The comparison between Sublime 1 and Beautiful 1, once effected a Shapiro-Wilk test and a Brown-Forsythe test of equality of variances, obtained $p = 0.757$, hence non-significant.

As for **Key**, we used both Spotify’s and MIRtoolbox’s tools. In the first case, the result after a Chi-Square test was $p = 0.587$. With MIRtoolbox’s function for Key, once effectuated a Shapiro-Wilk test and a Brown-Forsythe test, the result was $p = 0.240$. It might be worth showing the results for the Spotify API function:

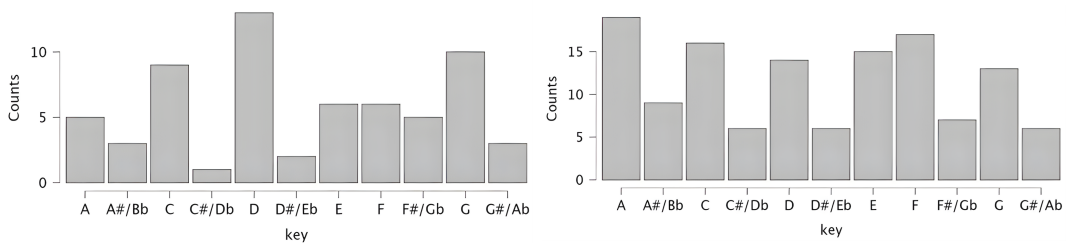


Fig. 10: Key, Sublime 1 and Beautiful 1

As with Key, the observation of **Mode** implied using both Spotify API's and MIRtoolbox's functions. In the first case, a Chi-square test indicated a significant difference between the Sublime 1 and the Beautiful 1 collections, with $p = 0.015$. A significant difference also appears in Corpus 2, with $p = 0.002$. The distribution shows in all cases a majority of tracks in the major mode, yet comparatively more minor mode tracks in the Sublime collection, here in Corpus 1:

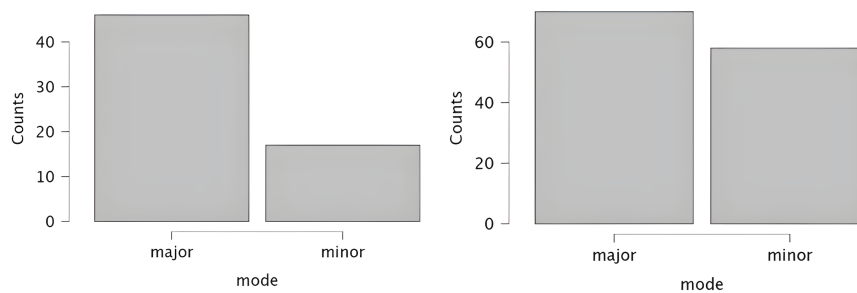


Fig 11: Mode (Spotify), Sublime 1 and Beautiful 1

Now, the difference found with Spotify API's Mode extractor was not confirmed with the corresponding MIRtoolbox algorithm. Here, a Mann-Whitney test for Corpus 1 gave $p = 0.805$, and for Corpus 2 the result was also non-significant, namely $p = 0.690$. The reasons for this divergence between results are not easy to ascertain, given the impossibility of comparing the corresponding algorithms.

Here is the synthesis of our results for Tonality:

		B1/S1		B2/S2	
	Features	p-value	Test	p-value	Test
MIRtoolbox	Inharmonicity	0.757	Student	0.204	Mann-Whitney
Spotify API	Key	0.587	χ^2	0.399	χ^2
MIRtoolbox	Key	0.240	Student	0.878	Student
Spotify API	Mode	0.015	χ^2	0.002	χ^2
MIRtoolbox	Mode	0.805	Mann-Whitney	0.690	Mann-Whitney

Table 4: Tonality

Discussion and conclusion

The analysis of the SublimAE corpus through Music Information Retrieval techniques did not show significant differences ($p < 0.05$) between Sublime and Beautiful music in any parameter related to music genre, dynamics, rhythm, and tonality. A relative exception was the difference in mode detected with Spotify API's device, but this was not reproduced with the corresponding MIRtoolbox function. On the other hand, our analysis did show some significant differences related to timbre, namely Spotify's metadata for acousticness, and MIRtoolbox's measurements of brightness, zero-crossing rate, spectral centroid, and irregularity.

This article is entitled "In search of sublime music" because it presents research aimed at knowing if, and how, the music designated by the respondents of the SublimAE questionnaire as the object of their experiences of the sublime differed from the music they designated as the object of their experiences of the beautiful. Our MIR analysis of the SublimAE corpus does not afford a strong positive answer to the question of "sublime music" possessing shared musical characteristics, that "beautiful music" would not. On the contrary, our results suggest that the two collections are quite similar, to say the least. To the extent that the expression "sublime music" is meaningful independently from the experience it affords, the works that it designates are not likely to be louder, faster, or slower, more often in ternary or in binary rhythm, more melodic or more inharmonic, or favoring any particular set of tonalities, than other kinds of music. Sublime music is not likely either to belong to a particular music genre, nor to have been written by specific composers, nor to be sung rather than being instrumental music. It is also not likely to be more danceable, nor to have more "energy", nor to elicit more negative emotions than positive ones.

This overall negative characterization has some blind spots, starting with the fact that margins of error are consubstantial to any MIR tool (Pachet and Aucouturier 2004; Casey e.a. 2008), especially when analyzing such a heterogeneous corpus, sometimes by taking mean values, others by taking medians. Also, we did not analyze the lyrics of any piece of music, even if their verbal content is likely to impact their reception and categorization. For example, one respondent describing as sublime Georges Brassens's song *La non demande en mariage*, which exalts free love as compared to marriage, or another doing the same for Booba's *Ma définition*, a rap piece chanting the artist's strong political experiences, hardly make sense without paying attention to the verbal content. This is clearly a limitation of the present study.

On the other hand, our results do show *some* differences that might associate sublime music with a certain quality of brightness, measured by convergent means. Indeed, some of the functions we used to analyze timbre are strongly correlated: the Pearson correlations we calculated for Sublime 1 were +0.942 for Brightness and Zero-Crossing Rate, +0.916 for Brightness and Spectral Centroid, and +0.909 for Spectral Centroid and Zero-Crossing Rate. Even if we cannot rule out that differences were a consequence of contingent factors in the constitution of the corpus, as further suggested by the seemingly contradictory results for Irregularity, this difference in timbre is a positive result of our search. Yet this feature is not easily explained, nor accounted for. At this stage, we should perhaps say that the brighter timbre of sublime music is nothing but a fragile, almost imperceptible *je ne sais quoi*.

Now, we have seen that generally speaking, the results obtained when comparing the Sublime 1 and Beautiful 1 collections were very similar to those obtained with Sublime 2 and Beautiful 2. In other words, versions of classical music works do not appear to determine whether they afford an experience of the sublime, or not. Of course, this could still be put to the test by varying the versions again (as a Sublime 3 and Beautiful 3, etc.), but there is no reason to believe that the results would be different.

The evidence can also be interpreted as suggesting that similar musical objects, or the same for that matter, can alternatively inspire an experience of the sublime, and/or an experience of the beautiful, according to varying contexts defined by subjective, environmental, and technical conditions. This would tend to comfort the popular notion that the sublime and the beautiful are in the eye -or rather in the ear- of the beholder, against the competing popular assumption that there is such a thing as “sublime music”, different from “beautiful music”.

Saying this implies to return to an important step we took while constituting the SublimAE corpus, namely the exclusion of all the respondents to the Control questionnaire who answered *yes* to the question of whether the music that corresponded for them to the standard description of an experience of the beautiful also afforded the standard description of the sublime. As stated in the introduction, this applied to 83 respondents, that is, 30% of the total of 283, and 55% of the 150 who answered the Control questionnaire. As we see, this part of the corpus was all but quantitatively negligible. We might address its intermediary status between the sublime and the beautiful by calling it a collection of “beausublime music”. These are the two “beausublime” collections of the SublimAE corpus:

Beausublime 1 (75 tracks)

<https://open.spotify.com/playlist/5udsArxsNUOrltSzxSMitM?si=33181e3d46434adf>

Beausublime 2

<https://open.spotify.com/playlist/1XjblkMvIwwsbAOjLDiIrb?si=6850a6a144774278>

This fancy neologism, “beausublime”, does not imply replacing the classical binary opposition of sublime vs beautiful by a ternary categorization. In fact, it is hard to tell whether a ternary typology would fare better than a binary one as a basis for pertinent, heuristic descriptions of the multifarious reality of human listening experiences. Rather, the neologism invites to revise the traditional opposition between the beautiful and the sublime, in favor of a more dynamic model of the aesthetic experiences elicited by music, and perhaps by other kinds of objects, be they artistic or natural. The fact is that many respondents to the SublimAE

questionnaire were ready to accept both verbal prototypes as meaningful descriptions of their experiences. This is a reminder of the utterly complicated relationship between language and reality, a fundamental philosophical issue that plays a crucial role in any exploration of aesthetic experiences based on verbal descriptions of the respondents' introspection.

At the same time, it can also remind us that all listening experiences have a temporality of their own. While listening to a piece of music, our inner state changes in ways which might very well include the transformation of an experience of the sublime into an experience of the beautiful, and vice versa. It can also be an experience of the beautiful which, from time to time, turns also into an experience of the sublime, and so on. Indeed, even if we have been unable to find relevant literature on that topic, we can assume that a listening experience that does *not* change from beginning to end is more likely to be an exception than an example of the norm.

Thus, an important limitation of this study is the fact that our MIR tools do not allow comparing the temporality of the music pieces of the corpus. Take the climax, a notion perhaps more attuned to standard descriptions of the sublime than of the beautiful (Meyer 1980; Patty 2009; Osborn 2013; Buch 2019). Are climaxes in a piece of music correlated to climactic points in the listener's experience? And if that is the case, does this correlation play a role in the subject's distinguishing an experience of the sublime from an experience of the beautiful? Conversely, does a piece of music which remains substantially the same from beginning to end correspond to a more homogeneous and, as it were, monotone experience, hence more likely to be described as beautiful? In short, can we have highs and lows in the music without having highs and lows in the feelings we get from it? (Kim 2013)

Some indication in favor of the hypothesis of a correlation appears in studies of the phenomenon of chills during the listening experience, which point out that these often appear during climaxes of the music (Panksepp 1995; Bannister 2020). Yet, to address further questions about temporal processes would require an analytical protocol able to study musical

form and other micro-level temporalities, rather than functioning on the basis of mean values and standard deviations. Also, the fact that the place where we listen to a piece of music affects the ways in which we perceive it is a common-sense observation, that was historically crucial in composition, since Renaissance site-specific music to twentieth-century electroacoustic music, and beyond. Accordingly, a program for future research on sublime music in realistic ecological conditions might seek to describe time processes in connection with space configurations.

References

- AHRENDT, P., A. MENG AND J. LARSEN. 2004. "Decision time horizon for music genre classification using short time features," 12th European Signal Processing Conference, Vienna, Austria, 1293-1296.
- ARCANGELI, MARGHERITA, JÉRÔME DOKIC AND MARCO SPERDUTI. 2019. "The Beautiful, the Sublime, and the Self". *Advances in Experimental Philosophy of Aesthetics*, Fl. Cova and S. Réhault eds., London, Bloomsbury.
- BALTES, FELICIA R., JULIA AVRAM, MIRCEA MICLEA, ANDREI C. MIU. 2011. "Emotions induced by operatic music: Psychophysiological effects of music, plot, and acting A scientist's tribute to Maria Callas". *Brain and Cognition*, 76(1), 146-157.
- BANNISTER, SCOTT. 2020. "A survey into the experience of musically induced chills: Emotions, situations and music". *Psychology of Music* 48(2), 297-314.
- BAYLE, YANN, PIERRE HANNA, MATTHIAS ROBINE. 2016. "Classification à grande échelle de morceaux de musique en fonction de la présence de chant". Journées d'Informatique Musicale, Albi (France), 144-152.
- BRADY, EMILY. 2013. *The Sublime in Modern Philosophy. Aesthetics, Ethics, and Nature*. Cambridge and New York: Cambridge University Press.
- BRILLENBURG WURTH, KIENE. 2009. *Musically Sublime: Indeterminacy, Infinity, Irresolvability*. New York: Fordham University Press.
- BUCH, ESTEBAN. 2019. "Climax as Orgasm: On Debussy's 'L'isle joyeuse'", *Music and Letters* 100/1, 24-60.
- BUCH, ESTEBAN. 2020. "The Sound of the Sublime: Notes on Burke as Time Goes By", *SubStance: A Review of Theory and Literary Criticism*, Issue 152 *Listening to Sound Studies*, Eric Méchoulan & David F. Bell eds., Vol. 49/2, 44-59.
- BURKE, EDMUND. 1990. *A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and the Beautiful*. Oxford: Oxford University Press.
- CAMPBELL, EDWARD. 2018. "Musical Modernity, the Beautiful and the Sublime", *The Routledge Research Companion to Modernism in Music*, Björn Heile and Charles Wilson eds., London, Routledge, chap. 5.
- CASEY, M. A., VELTKAMP, R., GOTO, M., LEMAN, M., RHODES, C., & SLANEY, M. 2008. "Content-based music information retrieval: Current directions and future challenges". *Proceedings of the IEEE*, 96/4, 668-696.

COWENA, ALAN S., XIA FANG, DISA SAUTERB, AND DACHER KELTNER. 2020. “What music makes us feel: At least 13 dimensions organize subjective experiences associated with music across different cultures”, *PNAS* 117 (4), 1924-1934.

ESSID, S., G. RICHARD, AND B. DAVID. 2006. “Instrument Recognition in Polyphonic Music Based on Automatic Taxonomies.” *IEEE Transactions on Audio, Speech and Language Processing*, Vol 14/1, 68–80.

GILMAN, TODD. 2009. “Arne, Handel, the Beautiful, and the Sublime”, *Eighteenth-Century Studies*, Vol. 42, No. 4, 529-555.

GOUYON, F, F. PACHET, O. DELERUE. 2000. “On the use of zero-crossing rate for an application of classification of percussive sounds”, *Proceedings of the COST G-6 conference on Digital Audio Effects*.

HANNA, PIERRE, NICOLAS LOUIS, MYRIAM DESAINTE-CATHERINE, AND JENNY BENOIS-PINEAU. 2004. “Audio Features for Noisy Sound Segmentation.” *5th International Conference on Music Information Retrieval (ISMIR04)*, 120—124.

HENNION, ANTOINE AND JOËL-MARIE FAUQUET. 2000. *La grandeur de Bach. L’amour de la musique en France au XIXe siècle*. Paris: Fayard.

HUR, YOUNG-JIN. 2019. *An Empirical Aesthetics of the Sublime and Beautiful*. PhD. dissertation, University College London.

HUR, Y.-J., GERGER, G., LEDER, H., & MCMANUS, I. C. 2020. “Facing the sublime: Physiological correlates of the relationship between fear and the sublime”. *Psychology of Aesthetics, Creativity, and the Arts*, 14(3), 253–263.

HUR, Y.-J., HALLAM-EVANS, C., GARFEN, Y., BAIZA, A., BACKHOUSE SPRIGGS, T., MIRCEA, M.-T., NAGY, O., PYE, E., & MCMANUS, I. C. 2022. “Differentiating the Visual Aesthetics of the Sublime and the Beautiful: Selective Effects of Stimulus Size, Height, and Color on Sublimity and Beauty Ratings in Photographs”. *Psychology of Aesthetics, Creativity, and the Arts*.

JANATA, PETR, JOSHUA PETERSON, CLINTON NGAN, BOKYOUNG KEUM, HANNAH WHITESIDE AND SONIA RAN. 2018. “Psychological and Musical Factors Underlying Engagement with Unfamiliar Music”, *Music Perception: An Interdisciplinary Journal*, Vol. 36/2, 175-200.

JI, QIHAO, SOPHIE H. JANICKE-BOWLES, REBECCA N. H. DE LEEUW AND MARY BETH OLIVER. 2019. “The melody to inspiration: The effects of awe-eliciting music on approach motivation and positive well-being”, *Media Psychology* 24(3), 305-331.

JOHNSON, CLAUDIA L. 1986. “‘Giant HANDEL’ and the Musical Sublime”, *Eighteenth-Century Studies*, Vol. 19/4, 515-533.

KANT, IMMANUEL. 1922. *Kritik der Urteilskraft*, 5th ed., Karl Vorländer ed., Leipzig: Felix Meiner.

- KELTNER, DACHER, AND JONATHAN HAIDT. 2003. "Approaching awe, a moral, spiritual, and aesthetic emotion". *Cognition and Emotion*, Vol. 17/2, 297–314.
- KIM, JIN HYUN. 2013. "Shaping and Co-Shaping Forms of Vitality in Music: Beyond Cognitivist and Emotivist Approaches to Musical Expressiveness". *Empirical Musicology Review*, Vol. 8/3-4, 162-73.
- KONEČNI, VLADIMIR J. 2011. "Aesthetic Trinity Theory and the Sublime", *Philosophy Today*, vol. 55, 64-73.
- KONEČNI, VLADIMIR J. 2020. "Requiem: Psychological, Philosophical, and Aesthetic Notes on the Music of the Mass for the Dead". *Art and Design Review* 8, 114-126.
- KONEČNI, VLADIMIR J., REBEKAH A. WANIC, AND AMBER BROWN. 2007. "Emotional and aesthetic antecedents and consequences of music-induced thrills", *American Journal of Psychology*, Vol. 120/4, 619–643.
- KOUMURA, TAKUYA, MASASHI NAKATANI, HSIN-I LIAO AND HIROHITO M. KONDO. 2021. "Dark, loud, compact sounds induce frisson". *Quarterly Journal of Experimental Psychology* 74(6), 1140-1152.
- LARTILLOT, OLIVIER, PETRI TOIVIAINEN, AND TUOMAS EEROLA. 2008a. "A Matlab Toolbox for Music Information Retrieval", in *Data Analysis, Machine Learning and Applications, Studies in Classification, Data Analysis, and Knowledge Organization*, C. Preisach, H. Burkhardt, L. Schmidt-Thieme, R. Decker (eds.). Berlin: Springer-Verlag.
- LARTILLOT, OLIVIER, TUOMAS EEROLA, PETRI TOIVIAINEN, JOSE FORNARI. 2008b. "Multi-feature modeling of pulse clarity: Design, validation, and optimization", *International Conference on Music Information Retrieval*, Philadelphia.
- LI, TAO, AND M. OGIHARA. 2005. "Music Genre Classification with Taxonomy". IEEE International Conference on Acoustics, Speech, and Signal Processing.
- LIDDLE, JAMIE. 2017. "The Sublime as a *Topos* in Nineteenth-Century Piano Music", *Israel Studies in Musicology Online*, Vol. 14.
- MCADAMS, STEVEN. 2019. "The Perceptual Representation of Timbre". Siedenburg, K., Saitis, C., McAdams, S., Popper, A. N., & Fay, R. R. (Eds.). *Timbre: Acoustics, perception, and cognition* (Vol. 69). New York: Springer.
- MCFEE, BRIAN, COLIN RAFFEL, DAWEN LIANG, DANIEL PW ELLIS, MATT MCVICAR, ERIC BATTENBERG, AND ORIOL NIETO. 2015. "Librosa: Audio and music signal analysis in python." Proceedings of the 14th Python Science Conference, 18-25.
- MEYER, LEONARD B. 1980. "Exploiting Limits: Creation, Archetypes, and Style Change", *Daedalus*, Vol. 109/2, *Intellect and Imagination: The Limits and Presuppositions of Intellectual Inquiry*, 177-205.

- MURTHY, H.A., F. BEAUFAYS, L.P. HECK, AND M. WEINTRAUB. 1999. "Robust Text-Independent Speaker Identification over Telephone Channels". *IEEE Transactions on Speech and Audio Processing*. Vol. 7/5, 554–568.
- OSBORN, BRAD. 2013. "Subverting the Verse–Chorus Paradigm: Terminally Climactic Forms in Recent Rock Music", *Music Theory Spectrum*, Vol. 35/1, 23-47.
- PACHET, FRANÇOIS AND JEAN-JULIEN AUCOUTURIER. 2004. "Improving timbre similarity: How high is the sky?". *Journal of negative results in speech and audio sciences*, 1/1, 1-13.
- PANKSEPP, JAAK. 1995. "The Emotional Sources of 'Chills' Induced by Music". *Music Perception* 13/2, 171–207.
- PATTY, AUSTIN T. 2009. "Pacing Scenarios: How Harmonic Rhythm and Melodic Pacing Influence Our Experience of Musical Climax", *Music Theory Spectrum*, Vol. 31/2, 325-367.
- PEETERS, GEOFFROY. 2004. *A large set of audio features for sound description (similarity and classification) in the CUIDADO project*, http://recherche.ircam.fr/anasyn/peeters/ARTICLES/Peeters_2003_cuidadoaudiofeatures.pdf.
- PELOWSKI, M., HUR, Y. J., COTTER, K. N., ISHIZU, T., CHRISTENSEN, A. P., LEDER, H., & MCMANUS, I. C. 2021. "Quantifying the if, the when, and the what of the sublime: A survey and latent class analysis of incidence, emotions, and distinct varieties of personal sublime experiences". *Psychology of Aesthetics, Creativity, and the Arts*, Vol. 15/2, 216-240.
- PLOMP, R. AND LEVELT, W.J.M. 1965. "Tonal Consonance and Critical Bandwidth", *The Journal of the Acoustical Society of America* Vol. 38, 548-560.
- PREY, ROBERT. 2018. "Knowing Me, Knowing You: Datafication on Music Streaming Platforms", Ahlers, M., Grünewald-Schukalla, L., Lücke, M. & Rauch, M. (Eds.), *Musik und Big Data* (Jahrbuch der Gesellschaft für Musikwirtschafts- und Musikkulturforschung, JGMM). Wiesbaden: Springer.
- RASMUSSEN, JAMES. 2010. "Language and the Most Sublime in Kant's Third Critique", *The Journal of Aesthetics and Art Criticism*, Vol 68/2, 155-166.
- RICKARD, NIKKI. 2004. "Intense emotional responses to music: a test of the physiological arousal hypothesis". *Psychology of Music*, Vol 43/4, 371-388.
- RYAN, VANESSA L. 2001. "The Physiological Sublime: Burke's Critique of Reason". *Journal of the History of Ideas*, Vol. 62/2, 265-279.
- SHAPIRO, ALEXANDER H. 1993. "Drama of an Infinitely Superior Nature': Handel's Early English Oratorios and the Religious Sublime", *Music & Letters* Vol. 74/2, 215-245.
- SHAPSAY, SANDRA. 2013. "Contemporary Environmental Aesthetics and the Neglect of the Sublime". *British Journal of Aesthetics*, Vol. 53/2, 181-198.
- SACHS, MATTHEW, DAMASIO ANTONIO AND HABIBI ASSAL. 2015. "The pleasures of sad music: a systematic review". *Frontiers in Human Neuroscience* Vol. 9/404.

SETHARES, WILLIAM A. 1998. *Tuning, Timbre, Spectrum, Scale*. London: Springer-Verlag.

VONDEREAU, PATRICK. 2017. “The Spotify Effect: Digital Distribution and Financial Growth”, *Television & New Media*, 1–17.

ZHANG, S., Y. GUO, AND Q. ZHANG. 2009. “Robust Voice Activity Detection Feature Design Based on Spectral Kurtosis.” First International Workshop on Education Technology and Computer Science, 269–272.

Appendix I: The SublimAE music corpus

Table 1: The Sublime 1 Collection (128 tracks)

artist	name	album
Albinoni, Tomaso	Adagio for Strings and Organ in G Minor	Albinoni: Adagio in G minor / Pachelbel: Canon, Leon Spierer, David Bell, Berliner Philharmoniker, Herbert von Karajan
Allie X	Old Habits Die Hard	CollXtion II
Arnalds, Öilafur	a2	Stare, Nils Frahm
Avril, Fred	Close To Me	Plan Cœur (Musique Officielle De La Série Originale Netflix)
Aznavour, Charles	La bohème	La Bohème (Remastered 2014)
Bach, Johann Sebastian	Brandenburg Concerto No. 5 In D Major, BWV 1050: 1. Allegro	Bach - Concertos brandebourgeois n° 1 à 5, Musica Antiqua Köln, Reinhard Goebel
Bach, Johann Sebastian	Cantata, BWV 147: Jesus bleibet meine Freude	Yo-Yo Ma Plays Bach, Yo-Yo Ma, Amsterdam Baroque Orchestra
Bach, Johann Sebastian	Cello Suite No. 1 in G Major, BWV 1007: I. Prélude	Bach: Cello Suites Nos. 1, 5 & 6, Yo-Yo Ma
Bach, Johann Sebastian	Keyboard Concerto No. 7 in G Minor, BWV 1058: III. Allegro assai	Glenn Gould plays Bach: Piano Concertos Nos. 1 - 5 BWV 1052-1056 & No. 7 BWV 1058, Glenn Gould, Columbia Symphony Orchestra, Vladimir Golschmann
Bach, Johann Sebastian	Matthäus Passion, BWV 244, Pt. 1: Kommt, ihr Töchter helft mir klagen (Chorus)	J. S. Bach La Passion selon Saint-Matthieu, Arnold Schönberg Choir, Vienna Boys' Choir, Nikolaus Harnoncourt, Concentus Musicus Wien
Bach, Johann Sebastian	Stanza BWV 855a The Children's Room	And the Things that Remain
Balavoine, Daniel	S.O.S. d'un terrien en détresse	Starmania (2009 Remaster)
Barber, Samuel	Adagio for Strings	Barber: Adagio for Strings & Violin Concerto - Schuman: To Thee Old Cause & In Praise of Shahn, Leonard Bernstein, New York Philharmonic
Bastard, Mat	Stand As One	LOOV
Beethoven, Ludwig van	Piano Sonata No. 8 in C Minor, Op. 13 'Pathétique': II. Adagio cantabile	Beethoven La Sonate No. 8 "Pathétique", Stephen Kovacevich
Beethoven, Ludwig van	Symphony No. 6 in F Major, Op. 68 Pastoral : I. Erwachen heiterer Empfindungen bei der Ankunft auf dem Lande. Allegro ma non troppo	Beethoven: Symphony No. 6 "Pastoral", Philadelphia Orchestra, Riccardo Muti
Beethoven, Ludwig van	Symphony No. 6 in F Major, Op. 68 Pastoral : IV. Gewitter. Sturm. Allegro -	Beethoven: Symphony No. 6 "Pastoral", Philadelphia Orchestra, Riccardo Muti
Beethoven, Ludwig van	Violin Sonata No. 5 in F Major, Op. 24 Spring : I. Allegro	Beethoven: Violin Sonatas Nos.4 & 5 "Spring", Gidon Kremer, Martha Argerich
Bénabar	Le regard	Inspiré de faits réels

Bizet, Georges	Carmen, Act 1: L'amour est un oiseau rebelle (Habanera)	Bizet: Carmen, Maria Callas, Orchestre de l'Opéra National de Paris
Bocelli, Andrea	Con Te Partiò	Bocelli (Remastered)
Booba	Ma définition	Temps mort
Boulevard des Airs	Bruxelles	Bruxelles
Bowie, David	Life on Mars?	Hunky Dory (2015 Remaster)
Brahms, Johannes	Ein deutsches Requiem (A German Requiem), Op. 45: IV. Wie lieblich sind deine Wohnungen	Brahms: Ein deutsches Requiem, Katherine Fuge, Matthew Brook, The Monteverdi Choir, Orchestre Révolutionnaire et Romantique, John Eliot Gardiner
Brassens, Georges	La non demande en mariage	George Brassens IX (N°11) Supplique pour être enterré à la plage de Sète
BrunuhVille	The Wolf and the Moon	Aurora
Bublé, Michael	That's Life	Call Me Irresponsible
Bush, Kate	Get Out Of My House	The Dreaming
CAN	Vitamin C	Ege Bamyasi (Remastered)
Celldweller	The Lucky One	Wish Upon A Blackstar (Deluxe Edition)
Chao, Manu	Seeds of Freedom	Seeds of Freedom
Chopin, Frédéric	Waltz in C-sharp minor, Op. 64 No. 2	Chopin: Works for Piano, Khatia Buniatishvili
Chopin, Frédéric	Spring Waltz	Spring Waltz, Sung Eun Choi
Christl, Florian	Glücksmoment	Inspiration
Crusher-P	Again	Again
Debussy, Claude	12 Etudes, L.136: 10. Pour les Sonorités opposées	The Genius of Debussy, Jean-Yves Thibaudet
Depeche Mode	World In My Eyes	Violator (Deluxe)
Dub Inc	Tout ce qu'ils veulent	Hors contrôle
Dungen	Peri Banu vid sjön	Häxan
Dvořák, Antonín	Serenade for Strings in E Major, Op. 22, B. 52: II. Tempo di valse	Dvořák: Serenade for Strings, Czech Suite, Prague Chamber Orchestra, Petr Skvor
Dvořák, Antonín	Symphony No.9 In E Minor, Op.95, B.178 - From The New World : 4. Allegro con fuoco	Dvorak: Symphonies Nos.7, Op. 70; No. 8, Op. 88; No. 9 "From The New World" , Op. 95; The Wood Dove, Op. 110 / Smetana: The Moldau, Berliner Philharmoniker, Rafael Kubelik
Dvořák, Antonín	Symphony No.9 In E Minor, Op.95, B.178 - From The New World : 4. Allegro con fuoco	Dvorak: Symphonies Nos.7, Op. 70; No. 8, Op. 88; No. 9 "From The New World" , Op. 95; The Wood Dove, Op. 110 / Smetana: The Moldau, Berliner Philharmoniker, Rafael Kubelik
Dvořák, Antonín	Symphony No.9 In E Minor, Op.95, B.178 - From The New World : 4. Allegro con fuoco	Dvorak: Symphonies Nos.7, Op. 70; No. 8, Op. 88; No. 9 "From The New World" , Op. 95; The Wood Dove, Op. 110 / Smetana: The Moldau, Berliner Philharmoniker, Rafael Kubelik
Editors	All the Kings	In Dream (Deluxe Version)
Einaudi, Ludovico	Experience	Seven Days Walking (Day 6)
Einaudi, Ludovico	Seven Days Walking / Day 6: Ascent	Einaudi: In a time lapse, Federico Mecozi, Redi Hasa
Electric Light Orchestra	Strange Magic	All Over The World: The Very Best Of ELO

Evanescence	My Immortal	Fallen
Explosions In The Sky	Your Hand in Mine	The Earth Is Not a Cold Dead Place
Fingers Mitchell Cullen	Freedom Rides	Ocean Blue
Florence + The Machine	Cosmic Love	Lungs (Deluxe Version)
François, Claude	Comme d'habitude	Hommages
Gabriel, Peter	Don't Give Up - Live	Secret World Live
Gainsbourg, Serge	La chanson de Prévert	L'étonnant Serge Gainsbourg (N°3)
Gibbons, Beth	Mysteries	Out Of Season, Rustin Man
Glass, Philip	Metamorphosis 1	Glass Piano, Bruce Brubaker
Glass, Philip	The Hours	The Hours (Music from the Motion Picture Soundtrack), Nick Ingman
Grieg, Edvard	Peer Gynt, Op. 23: IV. In the Hall of the Mountain King	Fright Night: Music That Goes Bump in the Night, Andrew Davis, Philharmonia Orchestra
Groove Armada	Hands of Time	Lovebox
Hallyday, Johnny	L'envie	Gang
Indochine	Dunkerque	Paradize
Infected Mushroom	Heavyweight	Vicious Delicious
Janáček, Leoš	Glagolitic Mass: Introduction	Life with Czech Music - Janáček, Martinů, Czech Philharmonic, Sir Charles Mackerras
Justice	Pleasure	Woman
Kahan, Noah	False Confidence	Busyhead
Kalkbrenner, Paul	Sky and Sand	Berlin Calling (The Soundtrack by Paul Kalkbrenner), Fritz Kalkbrenner
Labrinth	Still Don't Know My Name	Euphoria (Original Score from the HBO Series)
Larsson, Zara	Uncover	Uncover
Lateef, Yusef	Love Theme From Spartacus	Eastern Sounds
Lemay, Lynda	De tes rêves a mes rêves - Remastered	Best of
Les Cowboys Fringants	Plus rien	La grand-messe
Les Wiggles	Petit bonhomme	Tant pis! Tant mieux!
Lester Bowie's Brass Fantasy	Blueberry Hill	Avant Pop
Mahler, Gustav	Symphony No. 5 in C-Sharp Minor: IV. Adagietto. Sehr langsam	Mahler: Symphony No. 5, Daniel Barenboim, Chicago Symphony Orchestra
Mansell, Clint	Summer Overture	Requiem for a Dream / OST, Kronos Quartet
Marais, Marin	Sonnerie de Ste. Geneviève du Mont-de-Paris (Marin Marais)	Tous les matins du monde (Bande originale du film), Rolf Lislevand, Jordi Savall, Fabio Biondi, Pierre Hantaï
Metallica	Welcome Home (Sanitarium)	Master Of Puppets (Remastered)
Moroccan Spirit	Music For 1001 Nights	Moroccan Spirit
Mozart, Wolfgang Amadeus	Piano Concerto No. 20 in D Minor, K. 466: II. Romance	Mozart: Symphony No. 39, K. 543, Piano Concerto No. 20, K. 466 & Divertimento No. 15, K. 287, Clara Haskil, Philharmonia Orchestra, Herbert von Karajan

Mozart, Wolfgang Amadeus	Requiem, K. 626: Lacrimosa	Mozart: Requiem Realisations, Michael Finnissy, Academy of Ancient Music, Choir of King's College, Stephen Cleobury
Mozart, Wolfgang Amadeus	Requiem, K. 626: Lacrimosa	Mozart: Requiem Realisations, Michael Finnissy, Academy of Ancient Music, Choir of King's College, Stephen Cleobury
N U I T	Hold Your Horses	Looking for Gold
Opeth	Ghost of Perdition	Ghost Reveries
Petit Biscuit	Beam	Presence
Piazzolla, Astor	Adios Nonino	El Tango, Astor Piazzolla
Pink Floyd	Atom Heart Mother Suite	Atom Heart Mother (2011 Remastered Version)
Pink Floyd	Comfortably Numb	The Wall (Remastered)
Powell, John	Once There Were Dragons	How To Train Your Dragon: The Hidden World (Original Motion Picture Soundtrack)
Powell, John	Test Drive - From How To Train Your Dragon Music From The Motion Picture	How To Train Your Dragon: The Hidden World (Original Motion Picture Soundtrack)
Pretto, Eddy de	Mamere	Cure
Punch	Done For Me	Hotel del Luna (Original Television Soundtrack) Pt.12
Queen	You Take My Breath Away	A Day At The Races (Deluxe Edition 2011 Remaster)
Rachmaninoff, Sergei	Piano Concerto No. 2 in C Minor, Op. 18: 2. Adagio sostenuto	Rachmaninov: Piano Concerto No.2, Valentina Lisitsa, London Symphony Orchestra, Michael Francis
Rachmaninoff, Sergei	Symphonic Dances, Op. 45: I. Non allegro	Rachmaninoff: Symphonic Dances, Op.45; Intermezzo "Aleko"; Vocalise, Op.34, Berliner Philharmoniker, Lorin Maazel
Radiohead	No Surprises	OK Computer
Radiohead	Paranoid Android	OK Computer
Ravel, Maurice	Boléro	Ravel: Bolero / Daphnis Et Chloë, London Symphony Orchestra
Ravel, Maurice	Piano Concerto in G Major, M. 83: II. Adagio assai	Ravel: Piano Concertos; Valses nobles et sentimentales, Krystian Zimerman, The Cleveland Orchestra, Pierre Boulez
Reich, Steve	Different Trains: America, Before the War	Different Trains / Electric Counterpoint, Kronos Quartet
Röyksopp	Monument	Do It Again
Saez	Germaine	Germaine, Jojo, Mandela (Extraits de l'album "Le Manifeste 2016 2019 Ni dieu ni maître")
Saint-Saëns, Camille	Symphonie No. 3 Op.78 avec orgue en ut mineur : Finale	Saint-Saëns : Symphonies Nos 2 & 3 "Organ" (Apex), Georges Prêtre, Françoise Garcin
Satie, Erik	Gnossienne: No. 1	Satie: Avant-dernières pensées (Bonus Track Version), Alexandre Tharaud
Schubert, Franz	String Quintet in C Major, D. 956: II. Adagio	Schubert: String Quintet In C Major D.956, Op. 163, Mstislav Rostropovich, Emerson String Quartet

Scott, Naomi	Speechless (Full)	Aladdin (Original Motion Picture Soundtrack)
Sham, Yoyo	Light poursuiveur	電視劇《夏至未至》原聲帶
Shostakovich, Dmitri	Symphony No. 8 in C Minor, Op. 65: 1. Adagio - Live	Shostakovich: Symphony No.8, Chicago Symphony Orchestra, Sir Georg Solti
Sibelius, Jean	Violin Concerto, Op. 47: III. Allegro, ma non tanto	Violon X, Sergey Khachatryan, Multi-interprètes
Simone, Nina	Strange Fruit	Pastel Blues
Stevens, Sufjan	Futile Devices (Doveman Remix)	Call Me By Your Name (Original Motion Picture Soundtrack)
Strauss, Johann	La Marche de Radetzky	J. Strauss: La Marche de Radetzky, Willi Boskovsky, Wiener Johann Strauss Orchester
Strauss, Johann	La Marche de Radetzky	J. Strauss: La Marche de Radetzky, Willi Boskovsky, Wiener Johann Strauss Orchester
Tchaikovsky, Pyotr Ilyich	Swan Lake, Op. 20, Act 2: No. 10, Scene. Moderato	Tchaikovsky: Swan Lake, André Previn, London Symphony Orchestra
The Art Of Noise	Moments In Love	(Who's Afraid Of) The Art Of Noise? [Remastered]
The Cinematic Orchestra	Arrival of the Birds	The Crimson Wing: Mystery Of The Flamingos, London Metropolitan Orchestra
The Killers	Be Still	Battle Born
The Verve	Bitter Sweet Symphony	Urban Hymns (Remastered 2016)
The Verve	Bitter Sweet Symphony	Urban Hymns (Remastered 2016)
The xx	Intro	xx
Thirty Seconds To Mars	This Is War	This Is War
Tiersen, Yann	Comptine d'un autre été, l'après-midi	Le fabuleux destin d'Amélie Poulain (Bande originale de film)
Villa-Lobos, Heitor	Bachianas brasileiras No. 5, W. 389: 1. Aria (Cantilena)	Melancolía - Spanish Arias and Songs, Patricia Petibon, Orquesta Nacional De España
Violet, Tessa	Interlude III	Bad Ideas
Vivaldi, Antonio	The Four Seasons, Violin Concerto in G Minor, Op. 8 No. 2, RV 315 Summer : III. Presto	Vivaldi: The Four Seasons, Nigel Kennedy, English Chamber Orchestra
Wagner, Richard	Lohengrin: Prelude	Wagner, R.: Orchestral Highlights From Operas, Slovak Philharmonic, Michael Halasz
Zimmer, Hans	Cornfield Chase	Interstellar (Original Motion Picture Soundtrack) [Expanded Edition]
落日飛車 Sunset Rollercoaster	My Jinji	Jinji Kikko

Table 2: The Beautiful 1 Collection (63 tracks)

artist	name	album
alt-J	Taro	An Awesome Wave
Asaduryan, Suren	Bir Ömür Sadece - Benim Yolum	Bir Ömür Sadece
Bach, Johann Sebastian	Goldberg Variations, BWV 988: Aria	Bach: The Goldberg Variations, BWV 988 (1981 Gould Remaster), Glenn Gould
Bach, Johann Sebastian	Goldberg Variations, BWV 988: Aria	Bach: The Goldberg Variations, BWV 988 (1981 Gould Remaster), Glenn Gould
Bach, Johann Sebastian	Cello Suite No. 1 in G Major, BWV 1007: I. Prélude	Bach: Cello Suites Nos. 1, 5 & 6, Yo-Yo Ma
Bill Evans Trio	My Foolish Heart	Waltz For Debby (Original Jazz Classics Remaster 2010)
Brahms, Johannes	Schicksalslied, Op. 54	Brahms: Symphony No.3; Tragic Overture; Song of Destiny, Ernst Senff Chor, Berliner Philharmoniker, Claudio Abbado
Bush, Kate	Snowflake	50 Words for Snow
Chopin, Frédéric	Ballade No. 1 in G Minor, Op. 23	Chopin: Ballades; Barcarolle; Fantaisie, Krystian Zimerman
Corpo-Mente	Dorma	Corpo-Mente
Daft Punk	Veridis Quo	Discovery
De Roubaix, François	Générique - From "Chapi Chapo"	Chapi Chapo (Télévision)
Delerm, Vincent	Vie varda	Panorama
Delibes, Léo	The Flower Duet (From "Lakmé")	Serenade, Katherine Jenkins, Kiri Te Kanawa, Philharmonia Orchestra, Anthony Inglis
Do Zua, Filho	Ditado	Tudo ou Nada, Carla Prata
Dream Theater	Scene Eight: The Spirit Carries On	Metropolis, Pt. 2: Scenes from a Memory
Eno, Brian	An Ending (Ascent)	Apollo
Fauré, Gabriel	Pavane, Op. 50	Fauré: Requiem, Op. 48 / Pavane, Op. 50
Fauré, Gabriel	Masques et bergamasques Suite, Op. 112: IV. Pastorale	FAURE: Orchestral Music, RTE Sinfonietta, John Georgiadis
Grieg, Edvard	Peer Gynt, Op. 23: IV. In the Hall of the Mountain King	Fright Night: Music That Goes Bump in the Night, Andrew Davis, The Philadelphia Orchestra, The Cleveland Orchestra
Hahn, Reynaldo	À Chloris	La Belle Époque: The Songs of Reynaldo Hahn, Susan Graham
Handel, Georg Friedrich	Sarabande (From "Barry Lyndon")	100 Greatest Classical Pieces, The City of Prague Philharmonic Orchestra, Paul Bateman
Haydn, Joseph	Die Schöpfung Hob. XXI:2 - Dritter Teil: 32. Duett: Holde Gattin, dir zur Seite - Der tauende Morgen	Haydn: Die Schöpfung (The Creation), Edith Mathis, Dietrich Fischer-Dieskau, Academy of St. Martin in the Fields, Sir Neville Marriner
Hurt, Mississippi John	I'm Satisfied	Complete Studio Recordings
Jane's Addiction	Summertime Rolls	Nothing's Shocking

Jarrett, Keith	Köln, January 24, 1975, Pt. I - Live	The Köln Concert
Jarrett, Keith	Köln, January 24, 1975, Pt. I - Live	The Köln Concert
Jarrett, Keith	Köln, January 24, 1975, Pt. I - Live	The Köln Concert
Kamakawiwo'ole, Israel	Somewhere Over The Rainbow_What A Wonderful World	Facing Future
Knopfler, Mark	Going Home: Theme Of The Local Hero	Music From Local Hero
Lenorman, Gérard	L'enfant des cathédrales	Les Jours Heureux: Tribute to Gérard Lenorman
Liszt, Franz	Années de pèlerinage III, S. 163: No. 4, Les jeux d'eau à la Villa d'Este	Les impressionnistes et la musique, Walter Gieseking, George Cziffra
Madonna	Frozen	Ray of Light
Massenet, Jules	Thaïs: Méditation (Arr. R. Nichols for Violin and Piano)	Massenet: Thaïs: Méditation (Arr. R. Nichols for Violin and Piano), Christian Li, Timothy Young
Metallica	One	...And Justice For All
Miguel, Amanda	Calla, El Silencio Es Sagrado	El Pecado (Reedición)
Mozart, Wolfgang Amadeus	Clarinet Concerto in A Major, K. 622: II. Adagio	Mozart: Clarinet Concerto/Debussy: Première Rhapsodie/Takemitsu: Fantasma/Cantos, Sabine Meyer, Berliner Philharmoniker, Claudio Abbado
Mozart, Wolfgang Amadeus	Piano Concerto No. 21 in C Major, K. 467 "Elvira Madigan": II. Andante	Mozart: Piano Concertos, Vol. 6, Howard Shelley, London Mozart Players
Mozart, Wolfgang Amadeus	Symphony No. 40 in G Minor, K. 550: I. Molto allegro	Mozart: Symphonies Nos.40 & 41, London Symphony Orchestra, Claudio Abbado
Opeth	Allting tar slut	In Cauda Venenum (Swedish Version)
Oscar Peterson Trio	Hymn To Freedom	Night Train (Expanded Edition)
Pink Floyd	The Great Gig In The Sky	The Dark Side Of The Moon (2011 Remastered Version)
Queen	Love Of My Life - Remastered 2011	A Night At The Opera (Deluxe Edition 2011 Remaster)
Ravel, Maurice	Pavane pour une infante défunte, M. 19	Ravel: Daphnis et Chloé Suite No. 2, Rapsodie espagnole, Pavane pour une infante défunte, Alborada del gracioso & Boléro, Chicago Symphony Orchestra, Daniel Barenboim
Ravel, Maurice	Boléro	Ravel: Bolero / Daphnis Et Chloë, London Symphony Orchestra
Satie, Erik	Première Gymnopédie	Satie: Avant-dernières pensées (Bonus Track Version), Alexandre Tharaud
Schubert, Franz	Moment musical No. 3, D. 780	Schubert: Moment musical No. 3, Aurélien Pontier
Schumann, Robert	Piano Concerto in A Minor, Op. 54: I. Allegro affettuoso	Schumann / Grieg: Piano Concertos, Krystian Zimerman, Berliner Philharmoniker, Herbert von Karajan
Segundo, Compay	Chan chan	Antologia

Shore, Howard	May It Be	The Lord of the Rings: The Fellowship of the Ring (Original Motion Picture Soundtrack)
Shostakovich, Dmitri	Jazz Suite No. 2: VI. Waltz 2	Shostakovich: Jazz Suites Nos. 1 - 2 / The Bolt / Tahiti Trot, Russian State Symphony Orchestra
Skyline, Florida	Home - Resonance - Florida Skyline Remix	Utopian
Stirling, Lindsey	Elements	Lindsey Stirling
Suave, Feng	Honey, There's No Time	Feng Suave
The Beatles	I Will - Remastered 2009	The Beatles (Remastered)
The Black Keys	Everlasting Light	Brothers (Deluxe Remastered Anniversary Edition)
Tiersen, Yann	Comptine d'un autre été, l'après-midi	Le fabuleux destin d'Amélie Poulain (Bande originale de film)
Vangelis	Conquest of Paradise	1492: Conquest of Paradise
Vivaldi, Antonio	The Four Seasons, Violin Concerto in G Minor, Op. 8 No. 2, RV 315 "Summer": III. Presto	Vivaldi: The Four Seasons, Nigel Kennedy, English Chamber Orchestra
Vivaldi, Antonio	The Four Seasons, Violin Concerto in G Minor, Op. 8 No. 2, RV 315 "Summer": III. Presto	Vivaldi: The Four Seasons, Nigel Kennedy, English Chamber Orchestra
Wonder, Stevie	For Once In My Life	For Once In My Life
Xiangting, Li	Meihua San Nong - Trois variations sur la fleur de prunus	Chine, L'art Du Qin (The Art of the Qin)

Appendix II: Differences in Corpus 1 and Corpus 2

Dynamics:

		Sublime1/Beautiful1		Sublime2/Beautiful2	
	Features	p-value	Test	p-value	Test
Spotify	Energy	0.060	Mann-Whitney	0.301	Mann-Whitney
Spotify	Loudness	0.041	Mann-Whitney	0.225	Mann-Whitney
MIRtoolbox	RMS	0.107	Mann-Whitney	0.328	Mann-Whitney
MIRtoolbox	Lowenergy	0.177	Student	0.363	Student

Rhythm:

		Sublime1/Beautiful1		Sublime2/Beautiful2	
	Features	p-value	Test	p-value	Test
MIRtoolbox	Pulseclarity_Log	0.718	Student	0.114	Student
MIRtoolbox	Eventdensity	0.152	Mann-Whitney	0.420	Mann-Whitney
Spotify	Time Signature	0.213	χ^2	0.465	χ^2
Spotify	BPM	0.416	Welch	0.038	Mann-Whitney
MIRtoolbox	Tempo (outliers)	0.192	Student	0.465	Student
MIRtoolbox	Tempo	0.267	Mann-Whitney	0.459	Mann-Whitney
Spotify	Danceability	0.818	Student	0.993	Student

Timbre:

		Sublime1/Beautiful1		Sublime2/Beautiful2	
	Features	p-value	Test	p-value	Test
Spotify API	Instrumentalness	0.118	Mann-Whitney	0.039	Mann-Whitney
Spotify API	Acousticness	0.002	Mann-Whitney	0.017	Mann-Whitney
MIRtoolbox	Brightness	0.006	Mann-Whitney	0.006	Mann-Whitney
MIRtoolbox	Spectralcentroid	0.011	Student	0.016	Student
MIRtoolbox	Roughness	0.070	Mann-Whitney	0.085	Mann-Whitney
MIRtoolbox	Zero-crossing	0.018	Student	0.011	Student
MIRtoolbox	Irregularity	0.017	Student	0.004	Mann-Whitney

Tonality:

		Sublime1/Beautiful1		Sublime2/Beautiful2	
	Features	p-value	Test	p-value	Test
MIRtoolbox	Inharmonicity	0.757	Student	0.204	Mann-Whitney
Spotify API	Key	0.587	χ^2	0.399	χ^2
MIRtoolbox	Key	0.240	Student	0.878	Student
Spotify API	Mode	0.015	χ^2	0.002	χ^2
MIRtoolbox	Mode	0.805	Mann-Whitney	0.690	Mann-Whitney

Appendix III: Detailed comparison of Corpus 1 and Corpus 2

Dynamics

	loudness		energy	
	beautiful_1	sublime_1	beautiful_1	sublime_1
Valid	63	128	63	128
Missing	0	0	0	0
Median	-16.201	-14.928	0.195	0.294
Mean	-17.502	-15.070	0.277	0.357
Std. Deviation	7.638	7.292	0.230	0.272
Skewness	-0.356	-0.488	0.603	0.544
Std. Error of Skewness	0.302	0.214	0.302	0.214
Kurtosis	-0.790	-0.406	-1.056	-0.951
Std. Error of Kurtosis	0.595	0.425	0.595	0.425
Shapiro-Wilk	0.963	0.953	0.885	0.918
P-value of Shapiro-Wilk	0.054	< .001	< .001	< .001
Minimum	-35.422	-36.252	0.005	0.001
Maximum	-5.550	-3.690	0.746	0.946

	loudness		energy	
	beautiful_2	sublime_2	beautiful_2	sublime_2
Valid	63	128	63	128
Median	-16.201	-14.293	0.195	0.318
Mean	-16.750	-15.261	0.318	0.364
Std. Deviation	7.968	7.821	0.279	0.288
Skewness	-0.270	-0.629	0.735	0.528
Std. Error of Skewness	0.302	0.214	0.302	0.214
Kurtosis	-0.753	-0.158	-0.805	-0.971
Std. Error of Kurtosis	0.595	0.425	0.595	0.425
Shapiro-Wilk	0.961	0.947	0.876	0.915
P-value of Shapiro-Wilk	0.043	< .001	< .001	< .001
Minimum	-35.750	-36.857	0.004	0.002
Maximum	-4.671	-3.001	0.948	0.976

	RMS_Mean		Lowenergy_Mean	
	beautiful_1	sublime_1	beautiful_1	sublime_1
Valid	63	128	63	128
Missing	0	0	0	0
Median	0.074	0.091	0.565	0.557
Mean	0.089	0.109	0.565	0.555
Std. Deviation	0.063	0.075	0.046	0.050
Skewness	1.021	0.678	-0.384	-0.140
Std. Error of Skewness	0.302	0.214	0.302	0.214
Kurtosis	0.422	-0.614	0.173	-0.348
Std. Error of Kurtosis	0.595	0.425	0.595	0.425
Shapiro-Wilk	0.904	0.914	0.983	0.991
P-value of Shapiro-Wilk	< .001	< .001	0.557	0.627
Minimum	0.012	0.013	0.430	0.418
Maximum	0.263	0.310	0.670	0.670

	RMS_Mean		Lowenergy_Mean	
	beautiful_2	sublime_2	beautiful_2	sublime_2
Valid	65	128	65	128
Missing	0	0	0	0
Median	0.075	0.090	0.546	0.561
Mean	0.099	0.112	0.552	0.559
Std. Deviation	0.071	0.080	0.046	0.050
Skewness	0.901	0.853	0.510	-0.093
Std. Error of Skewness	0.297	0.214	0.297	0.214
Kurtosis	-0.306	0.031	-0.199	-4.518×10 ⁻⁴
Std. Error of Kurtosis	0.586	0.425	0.586	0.425
Shapiro-Wilk	0.887	0.913	0.964	0.990
P-value of Shapiro-Wilk	< .001	< .001	0.055	0.475
Minimum	0.012	0.009	0.474	0.440
Maximum	0.266	0.386	0.670	0.710

Rhythm

	tempo		time_signature	
	beautiful_1	sublime_1	beautiful_1	sublime_1
Valid	63	128	63	128
Missing	0	0	0	0
Median	107.847	112.300	4.000	4.000
Mean	110.642	112.768	3.746	3.695
Std. Deviation	25.425	32.103	0.439	0.779
Skewness	0.739	0.101	-1.158	-2.449
Std. Error of Skewness	0.302	0.214	0.302	0.214
Kurtosis	0.498	0.583	-0.681	7.414
Std. Error of Kurtosis	0.595	0.425	0.595	0.425
Shapiro-Wilk	0.961	0.981	0.542	0.589
P-value of Shapiro-Wilk	0.043	0.071	< .001	< .001
Minimum	65.079	0.000	3.000	0.000
Maximum	184.595	209.648	4.000	5.000

	tempo		time_signature	
	beautiful_2	sublime_2	beautiful_2	sublime_2
Valid	63	128	63	128
Missing	0	0	0	0
Median	99.839	111.067	4.000	4.000
Mean	102.594	112.572	3.762	3.703
Std. Deviation	27.233	31.607	0.560	0.787
Skewness	0.661	0.550	-2.305	-2.173
Std. Error of Skewness	0.302	0.214	0.302	0.214
Kurtosis	0.110	-0.340	8.624	5.393
Std. Error of Kurtosis	0.595	0.425	0.595	0.425
Shapiro-Wilk	0.960	0.959	0.572	0.600
P-value of Shapiro-Wilk	0.039	< .001	< .001	< .001
Minimum	59.602	63.074	1.000	1.000
Maximum	176.597	209.648	5.000	5.000

	Eventdensity_Mean		Pulseclarity_Mean		Tempo_Mean	
	beautiful_1	sublime_1	beautiful_1	sublime_1	beautiful_1	sublime_1
Valid	63	128	63	128	63	128
Missing	0	0	0	0	0	0
Median	1.107	1.441	0.174	0.163	121.743	123.026
Mean	1.266	1.553	0.206	0.219	121.972	124.049
Std. Deviation	0.798	1.096	0.180	0.178	13.179	12.966
Skewness	0.502	0.554	2.344	1.521	1.257	1.128
Std. Error of Skewness	0.302	0.214	0.302	0.214	0.302	0.214
Kurtosis	-0.640	-0.453	6.545	2.322	4.872	2.470
Std. Error of Kurtosis	0.595	0.425	0.595	0.425	0.595	0.425
Shapiro-Wilk	0.942	0.941	0.752	0.846	0.916	0.918
P-value of Shapiro-Wilk	0.005	< .001	< .001	< .001	< .001	< .001
Minimum	0.148	0.036	0.036	0.021	89.414	97.745
Maximum	3.183	4.370	0.957	0.853	178.342	166.407

	Eventdensity_Mean		Pulseclarity_Mean		Tempo_Mean	
	beautiful_2	sublime_2	beautiful_2	sublime_2	beautiful_2	sublime_2
Valid	65	128	65	128	65	128
Missing	0	0	0	0	0	0
Median	1.233	1.395	0.123	0.166	121.158	123.265
Mean	1.367	1.535	0.184	0.219	122.895	124.293
Std. Deviation	0.915	1.088	0.176	0.186	11.941	12.997
Skewness	0.685	0.854	2.539	1.690	1.303	1.057
Std. Error of Skewness	0.297	0.214	0.297	0.214	0.297	0.214
Kurtosis	0.002	0.431	7.803	2.716	4.204	1.903
Std. Error of Kurtosis	0.586	0.425	0.586	0.425	0.586	0.425
Shapiro-Wilk	0.948	0.934	0.731	0.815	0.900	0.928
P-value of Shapiro-Wilk	0.008	< .001	< .001	< .001	< .001	< .001
Minimum	0.118	0.047	0.019	0.033	92.542	97.972
Maximum	4.004	5.205	0.957	0.853	170.380	166.407

Timbre

	Irregularity_Mean		Zero-Crossing Rate_Mean		Roughness_Mean	
	beautiful_1	sublime_1	beautiful_1	sublime_1	beautiful_1	sublime_1
Valid	63	128	63	128	63	128
Missing	0	0	0	0	0	0
Median	0.574	0.528	709.728	901.509	243.356	319.979
Mean	0.568	0.527	815.363	938.911	379.499	657.781
Std. Deviation	0.107	0.114	310.744	349.623	451.118	824.545
Skewness	0.428	-0.049	1.162	0.673	1.779	1.890
Std. Error of Skewness	0.302	0.214	0.302	0.214	0.302	0.214
Kurtosis	0.205	0.177	1.365	0.223	2.518	3.517
Std. Error of Kurtosis	0.595	0.425	0.595	0.425	0.595	0.425
Shapiro-Wilk	0.976	0.995	0.906	0.961	0.758	0.755
P-value of Shapiro-Wilk	0.253	0.956	< .001	< .001	< .001	< .001
Minimum	0.327	0.219	298.863	392.583	4.294	7.430
Maximum	0.829	0.874	1766.102	1999.152	1934.366	3796.772

	Brightness_Mean		Spectral Centroid_Mean		Inharmonicity_Mean	
	beautiful_1	sublime_1	beautiful_1	sublime_1	beautiful_1	sublime_1
Valid	63	128	63	128	63	128
Missing	0	0	0	0	0	0
Median	0.268	0.330	1555.753	1879.680	0.376	0.388
Mean	0.274	0.328	1734.161	1984.329	0.376	0.378
Std. Deviation	0.129	0.125	689.574	688.948	0.058	0.055
Skewness	0.415	-0.119	1.123	0.482	0.071	-0.465
Std. Error of Skewness	0.302	0.214	0.302	0.214	0.302	0.214
Kurtosis	-0.466	-0.402	1.175	-0.254	1.683	0.608
Std. Error of Kurtosis	0.595	0.425	0.595	0.425	0.595	0.425
Shapiro-Wilk	0.966	0.986	0.913	0.971	0.964	0.970
P-value of Shapiro-Wilk	0.079	0.195	< .001	0.007	0.066	0.006
Minimum	0.067	0.062	802.213	868.769	0.208	0.229
Maximum	0.628	0.604	4000.605	3964.172	0.542	0.540

	Irregularity_Mean		Zero-Crossing Rate_Mean		Roughness_Mean	
	beautiful_2	sublime_2	beautiful_2	sublime_2	beautiful_2	sublime_2
Valid	65	128	65	128	65	128
Missing	0	0	0	0	0	0
Median	0.584	0.525	710.126	887.103	151.141	285.730
Mean	0.582	0.531	808.939	949.749	445.892	684.374
Std. Deviation	0.127	0.118	311.802	364.944	559.672	882.248
Skewness	-0.229	-0.405	1.162	0.671	1.758	1.981
Std. Error of Skewness	0.297	0.214	0.297	0.214	0.297	0.214
Kurtosis	1.921	1.505	1.534	0.242	2.668	3.939
Std. Error of Kurtosis	0.586	0.425	0.586	0.425	0.586	0.425
Shapiro-Wilk	0.968	0.972	0.909	0.964	0.753	0.740
P-value of Shapiro-Wilk	0.091	0.009	< .001	0.002	< .001	< .001
Minimum	0.175	0.147	338.473	288.127	3.430	4.326
Maximum	0.953	0.933	1935.339	2021.578	2417.482	4435.940

	Brightness_Mean		Spectralcentroid_Mean		Inharmonicity_Mean	
	beautiful_2	sublime_2	beautiful_2	sublime_2	beautiful_2	sublime_2
Valid	65	128	65	128	65	128
Missing	0	0	0	0	0	0
Median	0.236	0.327	1511.043	1879.680	0.365	0.378
Mean	0.270	0.327	1719.007	1993.546	0.367	0.375
Std. Deviation	0.131	0.134	702.538	775.137	0.066	0.056
Skewness	0.423	-0.113	0.798	0.589	-0.386	-0.880
Std. Error of Skewness	0.297	0.214	0.297	0.214	0.297	0.214
Kurtosis	-0.712	-0.485	-0.124	0.112	1.308	1.686
Std. Error of Kurtosis	0.586	0.425	0.586	0.425	0.586	0.425
Shapiro-Wilk	0.957	0.984	0.926	0.966	0.970	0.956
P-value of Shapiro-Wilk	0.024	0.131	< .001	0.002	0.114	< .001
Minimum	0.050	0.042	711.427	775.488	0.159	0.159
Maximum	0.599	0.607	3756.104	4472.991	0.530	0.511

Tonality

	Mode_Mean		Key_Mean	
	beautiful_1	sublime_1	beautiful_1	sublime_1
Valid	63	128	63	128
Missing	0	0	0	0
Median	-0.021	-0.019	6.405	6.574
Mean	-0.018	-0.019	6.438	6.539
Std. Deviation	0.019	0.022	0.538	0.629
Skewness	1.071	-0.644	0.258	-0.092
Std. Error of Skewness	0.302	0.214	0.302	0.214
Kurtosis	2.820	1.756	0.145	0.115
Std. Error of Kurtosis	0.595	0.425	0.595	0.425
Shapiro-Wilk	0.935	0.969	0.989	0.995
P-value of Shapiro-Wilk	0.002	0.005	0.825	0.932
Minimum	-0.055	-0.102	5.321	4.717
Maximum	0.054	0.037	7.912	8.254

	Mode_Mean		Key_Mean	
	beautiful_2	sublime_2	beautiful_2	sublime_2
Valid	65	128	65	128
Missing	0	0	0	0
Median	-0.019	-0.021	6.391	6.611
Mean	-0.020	-0.021	6.400	6.523
Std. Deviation	0.017	0.022	0.595	0.646
Skewness	0.448	-0.392	-0.003	-0.369
Std. Error of Skewness	0.297	0.214	0.297	0.214
Kurtosis	0.898	2.080	-0.238	0.252
Std. Error of Kurtosis	0.586	0.425	0.586	0.425
Shapiro-Wilk	0.972	0.970	0.985	0.986
P-value of Shapiro-Wilk	0.147	0.006	0.628	0.236
Minimum	-0.053	-0.113	5.068	4.462
Maximum	0.036	0.037	8.012	8.012