Cathedrals of sound: Predictors of the sublime and the beautiful in music, images, and music with images

Young-Jin Hur[1, 3], Radvile Medeisyte[2], & I. Chris McManus[1]

Research Department of Clinical, Educational and Health Psychology,

University College London, UK[1]

Division of Psychology and Language Sciences, University College London, UK [2]

Fashion Business Research, London College of Fashion, University of the Arts London, UK [3]

Author Note

Young-Jin Hur, Fashion Business School, London College of Fashion, University of the Arts London, UK & Department of Clinical, Educational and Health Psychology, University College London, UK.

Radvile Medeisyte, Division of Psychology and Language Sciences, University College London, UK

I. Chris McManus, Department of Clinical, Educational and Health Psychology & Research Department for Medical Education (RDME), University College London, UK.

Corresponding Author: Young-Jin Hur, Email: yhur1885@gmail.com. Tel: +44 (0)7715448313.

Abstract

The separate aesthetic responses of sublimity and beauty have been distinguished by philosophers (e.g., Burke, 1759/2008) and explored in recent psychological studies using visual images (e.g., Hur et al., 2022). In these works, sublimity, an experience involving astonishment or grandeur, has been contrasted with beauty's prettiness or cuteness. However, empirical studies of sublimity and beauty in music are rare, as also are aesthetic responses to stimuli of mixed visual and musical components. The present paper examines two questions. Firstly, what are the musical factors that predict sublimity and beauty in musical stimuli? Specifically, what are the contributions of style (Bach vs. Chopin vs. Schoenberg), mode type (major key vs. minor key vs. atonal), and tempo (slow vs. fast)? Secondly, what are the contributions of the visual and musical components in predicting the sublimity and beauty of mixed visual-musical stimuli? For music, mode type was the predominant predictor, with sublimity predicted by the minor key, and beauty by the major key. In the evaluation of mixed visual-musical stimuli, the influence of the sublimity and beauty of the visual component was up to three times as strong as for the musical component. There was also judgment type selectivity; the sublimity levels of visual-musical stimuli were predicted by the sublimity levels of the visual and musical components, but not by the beauty levels of the visual and musical components (and *vice versa*). While sublimity and beauty may be related, the present results demonstrate that sublimity and beauty may also operate on different mechanisms.

Keywords: sublimity, beauty, music, atonality, cross-modality

Introduction

There seems to be no shortage of discussions surrounding the nature and triggers of sublime experiences. While pre-17th century theories of the sublime typically discussed the subject in the realms of rhetoric and poetry, more recent accounts expanded the discussion to include experiences of nature, the arts, music, architecture, and beyond. The variance of accounts across the years notwithstanding, an attempt to extract a generic depiction of a sublime experience (in the philosophical literature) would suggest an aesthetic experience that broadly accompanies, in one way or another, a sense of force, grandeur, and astonishment, sometimes tinged with a sense of confusion, fear, and pain (e.g., Costelloe, 2012; Pelowski et al., 2021). Often, the sublime is seen as a related experience to awe (Clewis, 2021; Keltner & Haidt, 2003; Konečni, 2011)[1] and is set in contrast to the experience of beauty, the latter of which can be viewed as an aesthetic experience based on order and pleasure (e.g., Burke, 1759/2008).[2]

While a complete and unified theory of the sublime seems unlikely (just as no human experience is likely to be exhaustively and entirely accounted for), philosophers such as Edmund Burke, Immanuel Kant, and Archibald Alison, have provided explanations of the physical, physiological, psychological, and associative mechanisms of sublime experiences.[3] Yet, as if to demonstrate how the empirical literature can lag behind the theoretical, much empirical evidence of the sublime so far, at least in experimental psychology, has been concerned with the study of vision or visually oriented stimuli. Past psychological works on the sublime in experimental settings, for

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1 The relationship between sublimity and awe is extensively discussed in Clewis (2021). While the empirical study of awe, primarily via Keltner and Haidt (2003), takes elements from the philosophical traditions of Burke (relatedly, Burke considers "awe" to be a key component of sublimity), much empirical work on awe explores the subject from the direction of social psychology. In Keltner and Haidt (2003), awe is distanced from being an aesthetic experience and is primarily interpreted as a socially functioning, positive emotion. For an exception, see Gordon et al. (2017), who explores awe in the context of negative emotions.

2 See Hur (2020) and Hur et al. (2020; 2022) for more in-depth discussions regarding the relevance and limits of Edmund Burke's assumptions of the sublime, both as sublimity being opposed to beauty and it being essentially fear-based.

3 A recent philosophical work by Sandra Shapshay (2021) may explain some of the important variations that exist between sublime theories. According to Shapshay, sublime experiences can simultaneously be primordial, physiological, and instinctive (the "thin sublime"), and reflective, cognitive, and culturally variant (the "thick sublime"). The "thick sublime" is achieved with the passage of time. An argument can be made that experimental studies as the present work may reflect a study of the "thin sublime" given the general fast-paced nature of experimental trials (although scholars may still debate on what is truly considered a slow- or fast-paced, especially in the context of "thick" and "thin" sublime).

example, have explored factors influencing experiences of sublimity and beauty via the presentation and/or manipulation of visual stimuli (Hur et al., 2018, 2022; Ishizu & Zeki, 2014).

However, aesthetic experiences involve modalities beyond vision (Gerdes et al., 2014; Marin, 2015), and the addressing of how non-visual modalities interact with visual aspects in sublime experiences has rarely been explored. In this context, the present paper explores two questions via an experimental setting. On the one hand, what predicts the sublimity and beauty of musical stimuli when presented alone? Music is one of the most common art forms in everyday life (e.g., Rentfrow & Gosling, 2003), and is associated with strong emotional, aesthetic responses (e.g., Harrison & Loui, 2014; Hunter et al., 2008, 2010; Salimpoor et al., 2011). On the other hand, how do musical sublimity and beauty coexist with the sublimity and beauty of visual images in influencing aesthetic experiences of mixed visual-musical stimuli? The relative contributions of images and music may help explore the intricacies of sublimity and beauty as a holistic, multi-sensory experience, and may have important implications for media that combines music and images, for instance, in film, video games, etc.

It is worth noting that the title of the paper uses the phrase, "Cathedrals of Sound", which in many ways summarises the potential mixed-modality of music and images, with its implication that music might itself evoke a sense of visual (architectural) grandeur, while music might in turn sound different within particular visual spaces, both being topics which deserve exploration within aesthetics[4].

A Musical Sublime: Mode, Tempo as Predictors of the Sublime

Musicologists have commonly ascribed sublimity and beauty in terms of musical descriptions. Sublime music, for instance, has been associated with "intensifying dissonance" (Wurth, 2009) and "truly horrible harmony" (Morrow, 1990), which evoke impressions of obscurity, complexity, incomprehensibility (Korstvedt, 2000; Wurth, 2009), and music that is "not always correct" (Johnson,

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[4] The phrase "Cathedrals of Sound" is a metaphoric epithet, whose the first usage (in English) of which we are aware is that of Reed (1919), but is now often used to describe the majestic sublimity of the symphonies of Anton Bruckner (1824-1896). The phrase is a metaphorical example of the music-vision association of sublimity, which is explored in the present work in an albeit simplified experimental setting.

1986), i.e., an experience of ambiguity. Emotionally, sublime music is "not lovely", "terrible", and "deep [in] melancholy" (Johnson, 1986), or may portray a form of mixed delight such as "pleasing melancholy" (Johnson, 1986) and "sweet dread" (Allanbrook, 2010). Sublimity in music also may be driven by tempo-related aspects, represented by music that is "rapid" with "quick transitions" (Johnson, 1986), which evoke a sense of "shock and awe" (Allanbrook, 2010). Conversely, it has also been argued that slow tempi, e.g., "where notes are long" (Johnson, 1986) or "slow movement" (Allanbrook, 2010), can give rise to musical sublimity. The latter view likely derives from the assumption that slow notes give impressions of largeness. Vastness, indeed, has been argued to be an important predictor of the sublime (Burke, 1759/2008; Hur et al., 2022).

In contrast to the tumultuous nature of sublime music, beautiful music flows without discords, leaving impressions of "sweetness and elegance" (Johnson, 1986) and "tenderness" (Morrow, 1990). Grace, agreeableness, and delicacy are among the various words that describe such music (Scott, 2003). Assuming beauty to be an opposing force to the sublime as philosophers such as Burke (1759/2008) would argue, there are reasons to consider musical "pastoralism" as a related notion to beautiful music. Musicologists have described Haydn's late two oratorios to be a musical dialogue between the contrasting voices of the sublime and the pastoral; the description of the musical pastoral, evoking "an easeful way of life and a tranquil state of mind" (Groves, 2013, p. 480), recollects Burke's description of the beautiful (see also Webster [2005]).

In the field of music psychology, several musical cues have been associated with certain emotional (e.g., happiness/sadness) and cognitive (e.g., ambiguity) outcomes, many of which – based on the musicological description above – can be associated with experiences of the sublime and the beautiful. Studies have considered the roles of mode (major vs. minor keys) and tempo (slow vs. fast) on judgments of emotional valence. While major key and fast tempo have been associated with happiness, minor key and slow tempo have been linked with sadness (Cohen, 1991; Gerardi & Gerken, 1995; Hevner, 1935, 1937; Horn & Costa-Giomi, 2011; Isbilen & Krumhansl, 2016; Poon & Schutz, 2015). On the other hand, musical stimuli with mixed emotional cues, e.g., a major key with a slow tempo or a minor key with a fast tempo, have been argued to result in ambiguity caused by the

trigger of both pleasant and unpleasant emotions (Hunter et al., 2008, 2010). Of the two cues, tempo may play a larger role than mode, as has been demonstrated using both complex (Hevner, 1937) and controlled (Gagnon & Peretz, 2003) melody stimuli.

Ambiguity may also be achieved with atonal music, a style of music that lacks a tonic reference point, i.e., lack of a key, and, indeed, many listeners often feel challenged when listening to atonal music (Mencke et al., 2019, 2022). Underscoring the complex emotions of atonal music, compared to traditional tonal music people exhibit difficulties in cognitively processing atonal music as with recall tasks (Vuvan et al., 2014). Atonal music's ambiguity (i.e., low key clarity & low predictability; Mencke et al., 2019, 2022), may be related to accounts for why atonal and heavily dissonant styles of music have often been used to represent unpleasantness (e.g., Blood et al., 1999) and "unpleasant and reportedly "fearsome" emotions" (Flores-Gutiérrez et al., 2007). Some studies, though, such as by Gagnon and Peretz (2003), have utilized atonality to represent emotional neutrality (see also Daynes [2010]). [5]

There are reasons to believe that musical cues, such as tempo and mode, may have specific links with the sublime and the beautiful. The sublime has been argued to represent an aesthetic delight associated with difficulty, ambiguity, and fear, whereas the beautiful has been argued to be associated with pleasure and harmony (Burke, 1759/2009). It may thus be that musical cues eliciting unpleasantness, mixed emotions, or ambiguity – in accordance to past studies, triggered via minor key, atonality, or mixed emotional cues – may be associated with sublimity (although perhaps not exclusively to sublimity; see Vuoskoski & Eerola [2017] for the experience of pleasurable sadness via mixed musical cues), whereas cues soliciting unmixed pleasure – via major key or non-mixed emotional cues – may be associated with beauty.

Cross-modality: Visual vs. Auditory Information

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[5] The authors justify this decision by citing the relative rarity of atonality in "widespread music" as opposed to major and minor modes. This decision is empirically verified by the authors.

Most real-world aesthetic activities involve the simultaneous processing of multiple sensory modalities. Studies, for example, have documented that visual information can assist the comprehension of lyrics in music, and can enhance auditory pitch perception (Jesse & Massaro, 2010; Platz & Kopiez, 2012; Thompson et al., 2010). Likewise, background music can alter the emotional interpretation, comprehension, and recall of film scenes depending on the emotional fit between the scene and music (Bolivar et al., 1995), and it can also increase experienced emotional intensities of facial (Logeswaran & Bhattacharya, 2009) and pictorial (Baumgartner et al., 2006) stimuli. The general message is that the connection between certain auditory and visual sources of information can be used to the advantage of overall aesthetic experiences. All this seems to happen without the need for conscious control or explicit task-orientated strategies from the experiencer's perspective (Spence & Deroy, 2013).

Despite a growing body of research on cross-modal interactions between auditory and visual stimuli over a wide range of methodologies and stimuli types (Fekete et al., 2023; Frame et al., 2023; Gerdes et al., 2014; Marin, 2015), the literature is still somewhat sparse regarding the relative aesthetic contributions of each modality in an overall cross-modal experience. The present study therefore also asks whether there is a systematic way in which modalities combine to result in an overall experience of the sublime and the beautiful.

Specifically, the present research asks questions regarding the relative contributions of auditory and visual components on the experience of multi-modal stimuli. Previous works have shown that participants can extract affective information from both video and audio when they are simultaneously presented (DePaulo et al., 1978). However, much aesthetics research on the relative contributions of modalities in multi-modal stimuli comes from music psychology that uses kinetic cues; for example, although people perceive and experience happiness in happy music regardless of the emotional body language of a performer, for sad music, the visual body language takes priority in determining the overall emotion (Krahé et al., 2015). In a similar study yet in more controlled settings, Vuoskoski and colleagues (2014; 2016) have observed that overall felt and perceived emotions are affected by what is both auditorily and visually suggested, although for perceived

emotions the effect size of visual cues was larger than that for musical cues. These studies suggested that in a multi-modal stimulus, the visual component may take priority despite the contributions of all modalities. Note that a recent work by Frame et al., (2023) explored the predictors of pleasure in visual-musical stimuli (consisting of paintings and music [jazz and classical]). The authors reported that ratings of images or music in bimodal stimuli were unbiased by the simultaneously present, other modality, and that the holistic pleasure derived from bimodal stimuli can be described by calculating the mean pleasure levels of individually rated painting and music stimuli.

Importantly, no past works to our knowledge seem to have systematically explored the contributions of cross-modal effects on the specific and separate experiences of both sublimity and beauty. Of relevance, Gordon et al. (2017) used video stimuli that incorporate both music and moving images (Studies 3 and 5) to induce experiences of awe. While the authors did not systematically explore whether certain musical characteristics induced awe more than did others, and how music interacted with visual stimuli in predicting responses of awe (nor was beauty separately measured), the authors did demonstrate that states of awe can be induced via multi-modal stimuli.

Current Work

The first aim of the present study was to extend the assessment of sublimity and beauty beyond vision, which was considered in earlier studies (e.g., Hur et al., 2022), and obtain comparable outcomes for musical stimuli. These analyses asked if specific musical features, such as mode, tempo, and style, relate to evaluations of sublimity and beauty for music presented alone. As discussed above, it was predicted that musical features that elicit unpleasantness, mixed emotions, or ambiguity (e.g., minor key, atonality, and mixed emotional cues) may be associated with sublimity experiences and that musical features that elicits unmixed pleasantness (e.g., major key) may be associated with beauty experiences. The second aim was to explore mechanisms of cross-modality, where the relative roles of visual and auditory information on overall sublimity and beauty experiences from mixed visual-musical stimuli are investigated. While it was expected that the visual component might play a larger role than the musical component (in line with Vuoskoski et al., 2014), the overall research aim was exploratory given the presence of mixed evidence from the past.

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Methods

Participants

39 participants (35 female, M_{age} = 18.95, SD_{age} = 1.26) from University College London were recruited in return for course credit. In terms of ethnic backgrounds, 15 participants identified themselves as being "Asian or Asian British: Chinese", 11 as being "White: Other", six as being "Asian or Asian British: Other", three as being "White: English/Welsh/Scottish/Northern Irish/British", one as being "Asian or Asian British: Indian", one as being "Mixed: White and Asian", one as being "Mixed: White and Black Caribbean", and one as being "Mixed: Other." The study received ethical approval and all participants provided written consent prior to the start of the study.

Stimuli

Visual Stimuli. 36 photographs were selected from a pool of previously-rated photographs from the three studies by Hur et al. (2022). The source of the images was wide. Some images were from the IAPS database (Lang et al., 1997), while others were selected by researchers and participants.[6] To ensure that the images were adequately spread across sublimity and beauty ratings and thereby avoid biased stimulus sampling, and to increase the generalizability of findings, the *Aesthetic Hexagon* was adopted (see Hur et al. [2022] for a detailed depiction and justification of the *Aesthetic Hexagon*). The *Aesthetic Hexagon* represents a six-way categorization of stimuli within a sublimity-beauty rating space and can be used as a heuristic device for stimulus selection.

Specifically, it represents (based on empirical data) images that evoke in viewers both low levels of sublimity and beauty ("Boring/Disgusting"; e.g., an unkept kitchen, an empty jail cell, etc.), both high levels of sublimity and beauty ("Marvellous/Astonishing"; e.g., a starry night sky, a mountain under a bright sky, etc.), high levels of sublimity but moderate levels of beauty ("Powerful/Imposing"; e.g., an erupting volcano, a roaring bear, etc.), moderate levels of sublimity but low levels of beauty ("Dreadful/Fearful"; a car falling from a cliff, fighting animals, etc.), high

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[6] The images were selected beyond the IAPS to diversity the range of stimuli. In doing so, it was hoped that the stimulus set would represent a wide range of the sublimity-beauty experience. Please refer to Hur et al. (2022) for further details.

levels of beauty but moderate levels of sublimity ("Peaceful/Elegant"; e.g., a snowy road, a meadow, etc.), and moderate levels of beauty but low levels of sublimity ("Tender/Adorable"; e.g., a smiling girl, a cat, etc.). Please note that the naming of the hexagon is based on a previous word association task, which is explained in further detail in Hur et al. (2022).

In the present work, six items were selected for each of the six corners of the *Aesthetic Hexagon* (depictions of some stimuli used in the present study are provided in the brackets above). The final set of images, all selected from aggregated ratings from the entire stimulus set in Hur et al. (2022), had a moderately but not significantly correlated sublimity and beauty pre-rating profile, r (36) = 0.28, p = .456.

Musical Stimuli. 36 excerpts of musical pieces lasting six seconds were selected, divided equally in numbers into three categories of style/composer, namely Baroque/Bach, Romantic/Chopin, and Modernist/Schoenberg. Following previous work that has used J. S. Bach's *Well Tempered Clavier* (henceforth WTC) to study the roles of tempo and mode on musical emotions (Cohen, 1991; Horn & Costa-Giomi, 2011; Isbilen & Krumhansl, 2016; Poon & Schutz, 2015), the present work also used the WTC.

To generalize the roles of musical cues across different styles, two further sets of musical works were considered. The first was Frédéric Chopin's *Preludes*, a 19th-century Romantic work inspired by the WTC and, like its predecessor, a study of the 24 keys. Poon and Schutz (2015) have previously explored musical emotions using both Bach's WTC and Chopin's *Preludes*. The last category of musical stimuli derived from post-1908 piano works by Arnold Schoenberg to represent the style of atonality, or music without a tonal center. One composer representing each stylistic period was a way to keep the levels of artistic variability relatively consistent, with all three composers being largely similar in conceived musicological and artistic significance.

There are advantages to using solo piano music excerpts for experimental studies. The use of such stimuli means that contingent musical factors, such as song text (e.g., vocal music) or the number and timbre of instruments (as in symphonic music) are controlled. Furthermore, given the use

of existing compositions, relationships between controlled musical structures and psychological outcomes can be established without overtly sacrificing aesthetic integrity.

For the music of the Bach/Baroque and Chopin/Romantic categories, the music was divided in equal numbers by mode type (i.e., major vs. minor keys) and tempo (i.e., slow vs. fast). Since the atonal music of Schoenberg cannot be divided into major or minor keys, half of the Schoenberg/Atonal stimuli were slow, the other half fast. The categorization of musical stimuli is presented in Table 1. A description of stimuli and details regarding the categorization of musical stimuli (e.g., the determination of tempo via the measure of attack rate) can be found in the *Supplemental Material*. The excerpts were adjusted for loudness by equating the maximum amplitude across stimuli. Each excerpt faded in across the first second and faded out across the last second.[7]

Table 1. Number of musical stimuli by category.

		Baroque/ Bach	Romantic/Chopin	Atonal/Schoenberg
Major	Fast	$n = 4$	$n = 4$	
	Slow	$n = 4$	$n = 4$	
Minor	Fast	$n = 4$	$n = 4$	
	Slow	$n = 4$	$n = 4$	
Atonal/Schoenberg	Fast			$n = 6$
	Slow			$n = 6$

Design and General Procedure

The study took place in a completely darkened room. Visual and auditory stimuli were presented by software on a laptop computer, using MATLAB 2016b (MathWorks, Inc., Natick, MA, USA). Visual images were presented onto a white wall of the room using a 200W Epson EBX03 projector. Music was presented pair of LTC Multicav 3-way stand speakers located diagonally left and right from the viewer so as to not obstruct the view of the projected images.

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[7] Fading was inserted to avoid any surprises to the participants (for some musical pieces began rather abruptly). In effect, participants had full exposure to each musical stimulus for four seconds. While four seconds may not sound long enough, Frame et al. (2023), using a similar design as the present study, were able to successfully extract aesthetic judgment effects using two and five seconds of musical stimuli exposure.

The experiment had three blocks: firstly, an image-only block (Block 1), a music-only block (Block 2), and an image-with-music block (Block 3). For Block 1, participants were presented with 18 out of the pool of 36 images. The images were quasi-randomly selected, such that 3 images were randomly selected for each of the six *Aesthetic Hexagon* categories per participant. For Block 2, all 36 excerpts of music were presented. Lastly, for Block 3, all 36 images (including all images from Block 1) were entirely randomly paired with a music excerpt (all from Block 2) per participant. For all blocks, the trial presentation order was entirely randomized per participant. Participants could take breaks between the three blocks. The design is depicted in Figure 1.

All images in Blocks 1 and 3 were in landscape format, of size 150cm × 200cm at a distance of 390cm, and hence visual angles of 21.77˚ × 38.70˚. For Block 2, a grey rectangle of the same size as the images in Blocks 1 and 3 was presented on the wall.

For each trial, a fixation point lasting 0.5 seconds preceded the six-second[8] lasting stimulus presentation. A self-paced response screen followed for participants to give sublimity-beauty ratings for the stimulus they had just seen or heard. Once ratings were given, participants could proceed to the next trial by clicking the mouse.

Ratings used the *Evaluative Space Grid* (Larsen et al., 2009), which was used in previous studies on sublimity and beauty (Hur et al., 2018, 2022). Two perpendicular Likert-like scales of sublimity (x-axis; from "low sublimity" to "high sublimity") and beauty (y-axis; from "low beauty" to "high beauty") formed the grid. By clicking anywhere within the grid, sublimity and beauty ratings were simultaneously given.

As in Hur et al. (2018) and Hur et al. (2022), participants received standardized characterizations of sublimity and beauty, which represent the feeling for each experience upon perceiving a certain object (see *Supplemental Material*). This enhanced construct validity, given that the researchers had a more precise idea of what was measured through the ratings. Conversely,

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[8] The exposure length was set to be six seconds to be consistent with Hur et al. (2022), from which the images and general study design were derived.

without the characterizations, it may very well be the case that some participants rate sublimity as a

form of beauty (or *vice versa*), while others may have entirely different ideas of sublimity and beauty

(from the theoretical literature on which the study is based). A brief training block consisting of rating

three practice images preceding Block 1. A single session took around 45 minutes per participant.
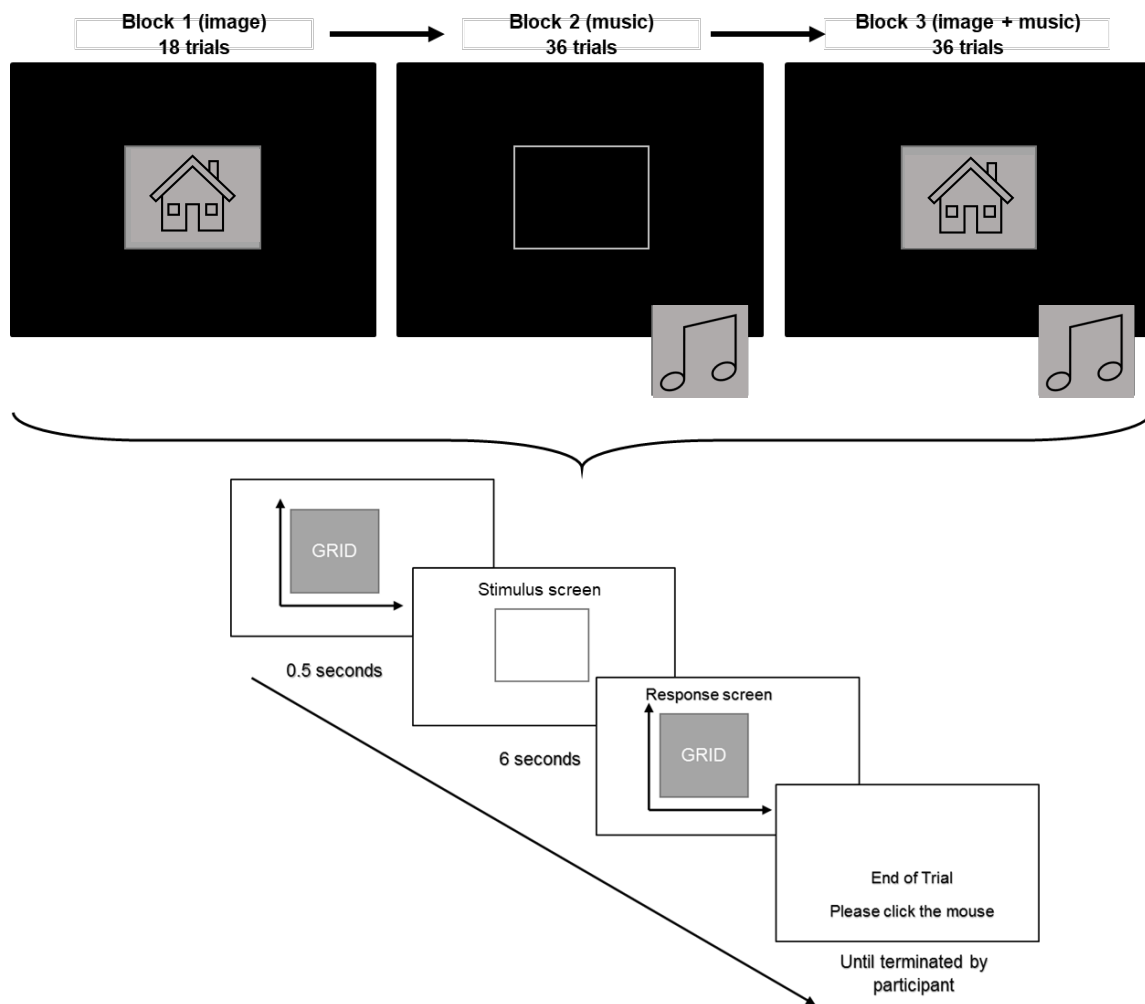

Figure 1. Study design.

Note. The figures represent the three experimental blocks in chronological order. The figures below

represent each trial (common to all experimental blocks), in chronological order. The icons are

generated by Microsoft Corporation (2024).

Analytic Approach

Statistical analyses were based on *R* version 3.4.1 (R Development Core Team, 2008). Unless mentioned otherwise, inferential statistics were based on linear mixed models. As linear mixed models simultaneously accounts by-item and by-participant variations, linear mixed models are useful when drawing generalizable fixed effects from a sample of complex stimuli (Judd et al., 2017; Westfall et al., 2014). Models to predict fixed effects were constructed in similar ways to those used in previous work in empirical aesthetics (Brieber et al., 2014; Hur et al., 2018, 2022; Vartanian et al., 2017).

The analyses were done using the lmer() function of the *lme4* package (Bates et al., 2015; Judd et al., 2017). *p*-values, via 95% confidence intervals, were obtained using the *lmerTest* package (Kuznetsova et al., 2017). Estimations on t-tests were based on the Satterthwaite approximation for degrees of freedom, and ANOVAs were based on Type II sums of squares.

<div align="center">

Results

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Descriptive Statistics

Basic descriptive statistics for the judgments of sublimity and beauty are provided in Table 2. The grid allowed scores in the range of 0 (low) to 1 (high). Means were approximately at the center of the range (0.5), and SDs averaged at about 0.29. Figure 2 shows that judgments are spread out across the entire range of possible responses, and broadly can be described as rectangular with small additional peaks at around .17 and .82. The modes within each marginal distribution are at .18 and .83 for ratings of beauty, and .16 and .81 for sublimity.

Table 2. Mean and Standard Deviation (SD) of judgments of sublimity and beauty.

	Sublimity rating			Beauty rating		
	Mean	SD	N	Mean	SD	N
All judgements	.49	.30	3510	.52	.29	3510

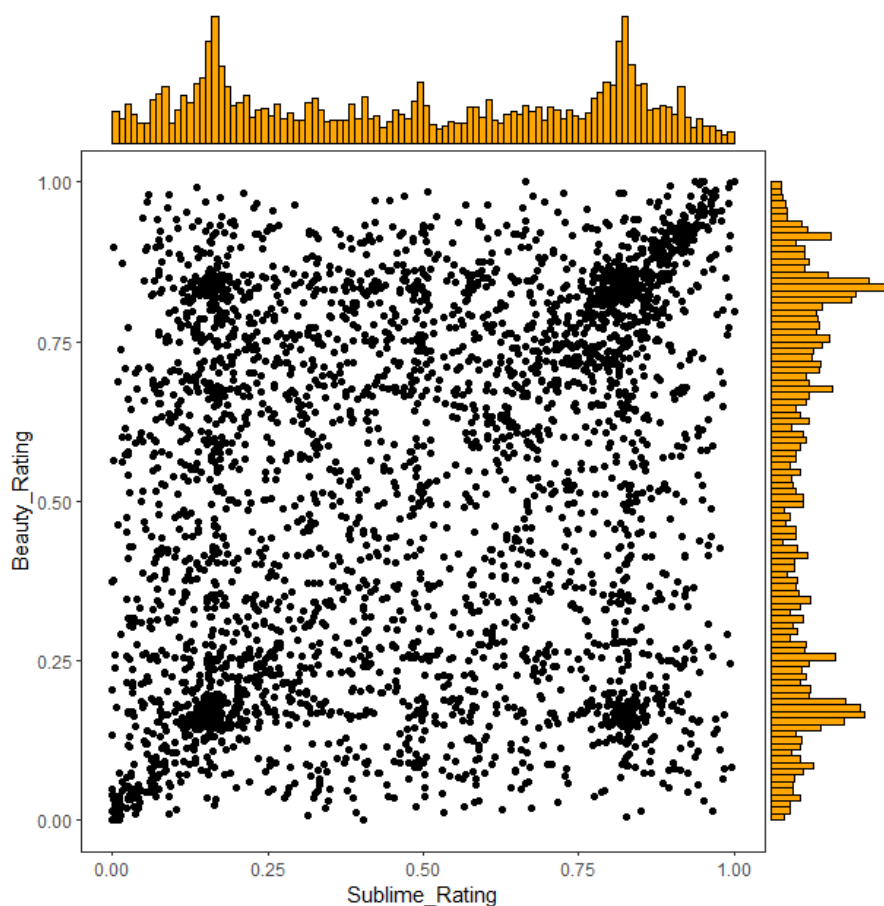|						
Block 1 (Image only)	.50	.32	702	.51	.32	702
Block 2 (Music only)	.44	.27	1404	.54	.27	1404
Block 3 (Image with Music)	.52	.30	1404	.51	.29	1404

Figure 2. Scattergram of Ratings of beauty (vertical) and sublimity (horizontal), with marginal distributions shown in color (all blocks combined).

Block 1 Analysis: Manipulation Checks for Image Ratings

To assess the reliability of each of the sublimity and beauty measures, ratings from Block 1 were averaged by items, then correlated with the items' averaged previous ratings from Hur et al. (2022). The sublimity ratings were reliable across studies, $r = .89$, $p < .001$, as were the beauty ratings, $r = .96$, $p < .001$. Likewise, there were high consistencies for the degree to which an image was rated as both sublime and beautiful (calculated by adding sublimity and beauty ratings), $r = .95$, $p < .001$, and

the degree to which an image was rated as being more sublime and beautiful (calculated by subtracting beauty ratings from sublimity ratings), $r = .90$, $p < .001$.[9]

For each individual participant, the correlation of sublimity and beauty ratings was calculated, with a mean correlation across participants of .35.[10] Figure 3 reflects the general replication of the data from Hur et al. (2022), and the *Aesthetic Hexagon* is clearly visible.
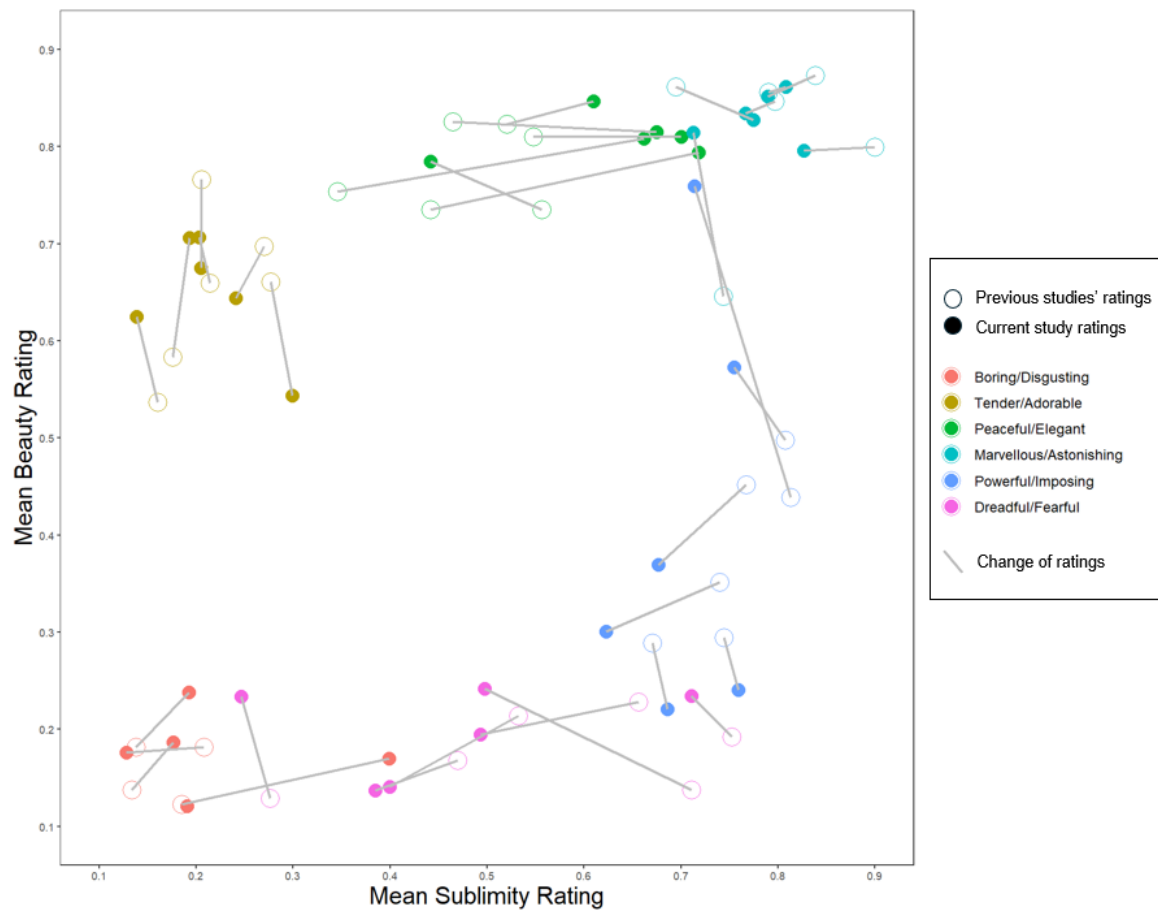

Figure 3. Between-study consistency for image ratings.

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[9] It should be noted that the two generated measures were largely independent, $r = -.19$, $p = .278$.
[10] This coefficient is comparable to previous sublimity-beauty correlations reported by Hur et al. (2020: rs = .36 & .31; 2022: .32).

Note. Open circles represent averaged pre-ratings from aggregated ratings from the three studies in Hur et al., (2022). Filled circles represent averaged ratings from the current study, with the grey lines demonstrating how much the rating for each image changed from the previous ratings. The images are categorized into the six *Aesthetic Hexagon* categories.

Block 2 Analysis: Mode type, Tempo, and Style/Composer, and the Musical Sublime

Block 2 consisted of trials with music stimuli only. Figure 4 shows a plot of the mean sublimity and beauty ratings for each of the 36 music excerpts. The three composers, Bach, Chopin, and Schoenberg are shown in red, green, and blue, with the labels indicating the excerpt number, whether it is in a major or minor key, and its tempo. Several features are apparent, in particular the variability in the rating of the excerpts. The Schoenberg excerpts are noticeable for being in the lower left quadrant, which corresponds to the elicitations of low beauty and low sublimity. Bach and Chopin are more variable, and while most have high beauty ratings, there is much more variability in experienced sublimity.[11]

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[11] An interesting comparison is between Chopin #31, the slow Prelude in A minor, the only excerpt in the lower right quadrant, with high sublimity and low beauty ratings. Interestingly a YouTube video describes this piece as "Chopin's darkest work" https://www.youtube.com/watch?v=T_2FM2qGZZY). In contrast, a fast Chopin prelude in B major by Chopin, excerpt # 29, in the furthermost top left corner with high beauty and low sublimity is described as "absolutely beautiful … one of the sweetest short pieces." (https://www.youtube.com/watch?v=O486LUQMtsw). Finally, a fast Chopin prelude in E flat major, excerpt # 30, is high in the top right quadrant, and a YouTube excerpt says, "Quelle beauté ! … La pièce en est sublime" [What beauty, the piece is sublime] (https://www.youtube.com/watch?v=O486LUQMtsw). These three examples, therefore, give some face validity to the map of Figure 4.
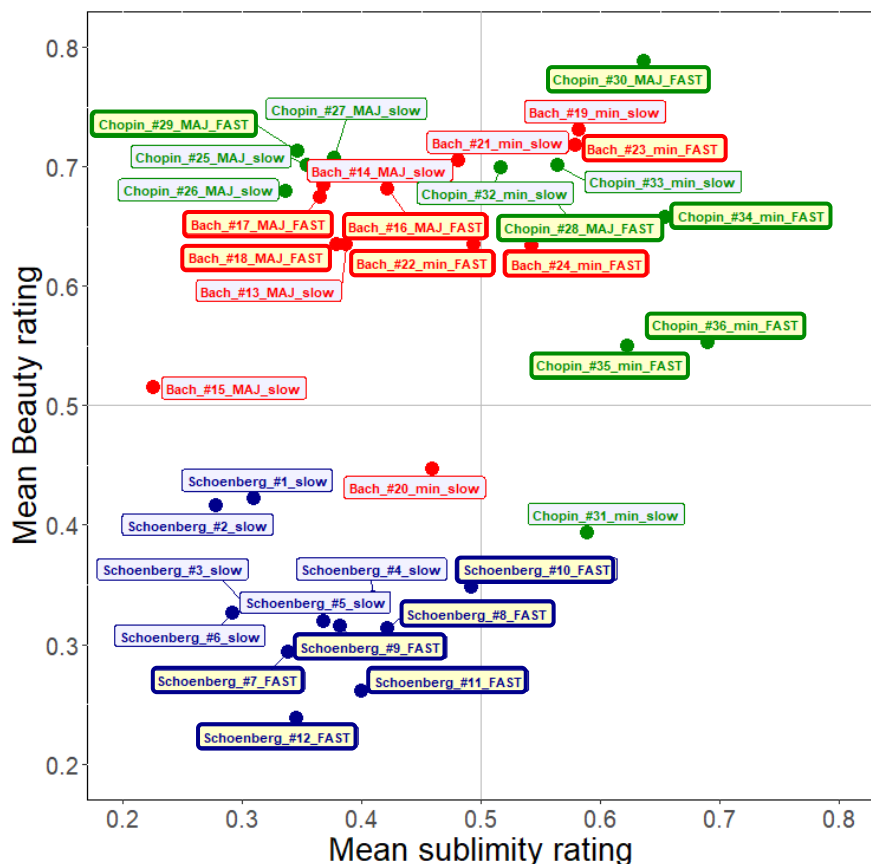
Figure 4. This visualization shows the mean sublimity and beauty ratings of each of the 36 music excerpts, red indicating Bach, green Chopin, and blue Schoenberg. Labels give the excerpt number in the *Supplemental Material*, whether the excerpt is in a major (MAJ) or minor (min) key (for Bach and Chopin only), and whether the excerpt is at a slow or a fast tempo (this is also indicated by the shading and outline of the labels).

Statistical analyses showed that, across participants, sublimity and beauty had a mean correlation of r = .31. When the effect on ratings of style/composer (i.e., Baroque/ Bach vs. Romantic/Chopin vs. Modernist/Schoenberg) was analyzed using linear mixed models, style/composer made a difference for both sublimity, $F(2, 39.42) = 3.18$, $p = .053$, and beauty, $F(2, 39.85) = 39.36$, $p < .001$. *Post hoc* comparisons revealed no differences between Baroque/Bach and Romantic/Chopin for either sublimity, $t(33.36) = 1.81$, $p = .079$, or beauty, $t(32.93) = 0.09$, $p = .926$. Therefore, the distinction

between Baroque/Bach and Romantic/Chopin was disregarded throughout the remainder of the analyses.

Two linear mixed models showed that mode type (i.e., major vs. minor vs. atonal), tempo (i.e., slow vs. fast), and their interaction predicted sublimity in one model and beauty in the other model. Importantly, given the generally positive correlation between sublimity and beauty, when predicting sublimity or beauty, the other dependent measure was inserted as a covariate in each model. Full descriptive and inferential statistics are provided in Table 3 and Table 4, with visualization provided in Figure 3.

When sublimity was predicted by mode type, tempo, and their interaction, there was a main effect of mode type, $F(2, 51.06) = 17.02$, $p < .001$. *Post hoc* comparisons revealed that music excerpts in the minor key elicited higher sublimity than those in the major key, $t(48.55) = 4.91$, $p < .001$, and those in the atonal style, $t(47.75) = 4.82$, $p < .001$. Major key excerpts and atonal style excerpts did not differ in elicited sublimity, $t(59.82) = 0.27$, $p = .792$. There was also a main effect of tempo, $F(1, 56.61) = 5.21$, $p = .026$, with fast music eliciting more sublimity than slow music. The interaction between mode type and tempo did not reach significance, $F(2, 30.09) = 0.25$, $p = .780$.

A similar set of analyses was run predicting elicited beauty. Only the main effect of mode type was significant, $F(2, 45.60) = 44.70$, $p < .001$. *Post hoc* comparisons revealed that excerpts in the major key were more beautiful than those in the minor key, $t(41.51) = 2.02$, $p = .050$, whereas excerpts in the minor key were more beautiful than those in the atonal style, $t(48.29) = 7.18$, $p < .001$. Excerpts of the major key were experienced as more beautiful than those in the atonal style, $t(47.48) = 9.11$, $p < .001$. No significance was reached for the main effect of tempo, $F(1, 45.67) = 0.15$, $p = .700$, nor for the interaction between mode type and tempo, $F(2, 34.92) = 1.25$, $p = .299$.

Table 3. Mode type and tempo effects, descriptive statistics table.

		Sublimity rating	Beauty rating
Atonal	Fast	0.40 (*SD* = 0.27)	0.30 (*SD* = 0.20)
	Slow	0.33 (*SD* = 0.26)	0.36 (*SD* = 0.24)
Major	Fast	0.45 (*SD* = 0.28)	0.70 (*SD* = 0.18)
	Slow	0.34 (*SD* = 0.24)	0.65 (*SD* = 0.21)
Minor	Fast	0.59 (*SD* = 0.23)	0.62 (*SD* = 0.23)
	Slow	0.53 (*SD* = 0.28)	0.61 (*SD* = 0.24)

Note. Descriptive statistics represent raw mean values.

Table 4. Mode type and tempo effects, inferential statistics table.

	Predicting sublimity			Predicting beauty		
	df	*F*	*p*	*df*	*F*	*p*
Mode Type	2, 51.06	17.02	**< .001**	2, 45.60	44.70	**< .001**
Tempo	1, 56.61	5.20	**.026**	1, 45.67	0.15	.700
Mode Type × Tempo	2, 30.09	0.25	.780	2, 34.92	1.25	.299
(Covariate)	1, 1340.49	16.91	**< .001**	1, 1236.07	19.79	**< .001**

Note. Bold shows inferential statistics that are significant at $p < .05$.

The results demonstrate that musical components selectively affect experiences of sublimity and beauty. The extent to which mode type and tempo differentially affected sublimity and beauty was assessed in a linear mixed model, with sublimity and beauty being entered as predicting variables, i.e., judgment type, in addition to mode type and tempo. Any interaction between judgment type and the two main manipulations (i.e., mode type & tempo) would indicate that sublimity and beauty ratings differed in these manipulations. The full model outcome is presented in Table 5.

Table 5. Mode type, tempo, and judgment type effects, inferential statistics table.

	df	F	p
Mode Type (M.T.)	2, 50.54	38.49	**< .001**
Tempo	1, 54.96	2.33	.133
Judgment Type	1, 56.32	16.99	**< .001**
M.T. × Tempo	2, 30.01	1.14	.332
M.T. × Judgement Type	2, 30.01	33.12	**< .001**
Tempo × Judgement Type	1, 30.01	6.87	**.014**
M.T. × Tempo × Judgement Type	2, 30.01	0.58	.563

Note. Bold shows inferential statistics that are significant at $p < .05$.

The model output demonstrated significant interactions between mode type and judgment type, $F(2, 30.01) = 33.12$, $p < .001$. Pairwise comparisons revealed that although sublimity and beauty are similarly elicited for the minor key, $t(50.20) = 1.63$, $p = .109$, and the atonal style, $t(50.20) = 1.05$, $p = .300$, there was more elicited beauty than sublimity in the major key, $t(50.20) = 8.38$, $p < .001$. The model further produced a tempo and judgment type interaction, $F(1, 30.01) = 6.87$, $p = .014$. While slow music was linked with elicited beauty more than sublimity, $t(55.22) = 4.88$, $p < .001$, fast music was not distinguishable between the two judgment types, $t(55.22) = 1.96$, $p = .055$. Thus, it was mainly the major key and slow tempo that differentiated the elicitations of sublimity from beauty.

Block 3 Analysis: The Relative Importance of Music and Images on Aesthetic Evaluations of their Combined Presentations

The average sublimity-beauty correlation across participants was $r = .25$. To separate the influences of the image and the music when both image and music are simultaneously presented, sublimity and beauty ratings from each of Blocks 1 and 2 (i.e., for the images and the music respectively) were entered as the four predicting variables in predicting the sublimity and beauty ratings in Block 3.[12] As

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[12] This was possible because the same images and music appeared again in Block 3. Each participant's unique ratings in Blocks 1 and 2 were used to explain their unique responses in Block 3. However, because only half of the images from Block 1 reappeared in Block 3 per participant, the linear mixed models analysis only made use of half of the data in Block 3. To avoid the incurrence of data loss, an alternative analysis was run in parallel, where all image and music stimuli were averaged by stimuli across participants, and those averaged ratings predicted individually unique Block 3 data. While this alternative aggregation-based method made use of the entire responses from Block 3, the method does not respect the unique ratings given per participant in the

before, the other rating variable was used as a covariate (e.g., beauty rating was used as a covariate when predicting sublimity rating), to account for the sublimity-beauty correlation.[13] It is important to note that the standard deviations of the sublimity (0.30) and beauty (0.29) ratings are very similar, which means that the differences in the beta coefficients reported in the next paragraph are not due to differences in the range of the measures.

For Block 3 stimuli, an increase in sublimity ratings of visual-musical stimuli was positively predicted by ratings of sublimity ratings in images, $\beta = 0.41$, $t\,(45.03) = 8.35$, $p < .001$, and in music, $\beta = 0.17$, $t\,(59.33) = 4.81$, $p < .001$, but was negatively predicted by ratings of beauty in images, $\beta = -0.10$, $F(1, 135.77) = 4.31$, $p = .039$.[14] The beauty ratings of music did not influence the sublimity ratings of trials in Block 3, $\beta = 0.05$, $t\,(51.07) = 1.35$, $p = .184$. Comparing the separate beta coefficients of the effects of image and music on visual-musical stimuli, the sublimity of the image had more than twice the effect (i.e., $0.41/0.17 = 2.41$) as the sublimity of the music excerpt. The difference between the two beta coefficients was statistically significant, $Z = 3.97$, $p < .001$, using the equation of Clogg, Petkova, and Haritou (1995).[15] It should be noted that comparing two fitted models of having 1) only image ratings and 2) both image and music ratings as predictors, the inclusion of the music components significantly improved the model fit, $\chi^2\,(2) = 29.83$, $p < .001$.

Based on a similar procedure, beauty in Block 3 was predicted by beauty ratings both in visual images, $\beta = 0.59$, $t\,(43.53) = 13.89$, $p < .001$, and in music, $\beta = 0.21$, $t\,(46.45) = 5.49$, $p < .001$. Beauty in Block 3 was not influenced by sublimity ratings of images, $\beta = 0.02$, $t\,(53.01) = 0.64$, $p = .524$, or of music, $\beta = 0.01$, $t\,(450.43) = 0.08$, $p = .939$. The beauty of a visual-musical stimulus was therefore determined by the beauty of both the image and the music, but with the beauty of the image almost three times (i.e., $0.59/0.20 = 2.95$) as influential as the beauty of the music excerpt. The

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predicting variables. Because the initial analytical approach still generalizes over all 36 images and 36 music excerpts across all participants, the initial method is reported. Importantly, all statistical significance from this initial method was replicated in the alternative method.

[13] As a reviewer noted, the Block 3 analysis used the same dataset twice (i.e., data from Blocks 1 and 2 were used for predicting Block 3's sublimity and beauty ratings). If the Block 3 analysis accounts for family-wise error via Bonferroni correction, only p values equal to or below .025 can be considered statistically significant.

[14] See footnote above on Bonferroni correction.

[15] $Z = \dfrac{\beta_1 - \beta_2}{\sqrt{(SE\beta_1)^2 + (SE\beta_2)^2}}$

difference between the two beta coefficients was significant, $Z = 6.96$, $p < .001$. It should be noted that comparing two fitted models of having 1) only image ratings and 2) both image and music ratings as predictors, the inclusion of the music components significantly improved the model fit, $\chi^2 (2) = 31.02$, $p < .001$. A full table of inferential statistics is provided in Table 6. Figure 5 presents a summary of the findings.

Table 6. Sublimity and beauty ratings effects, inferential statistics table.

	Predicting Sublimity				Predicting Beauty			
	β	*df*	*t*	*p*	β	*df*	*t*	*p*
Sublimity-I	0.41	45.03	8.35	**< .001**	0.02	53.01	0.64	.524
Beauty-I	-0.10	134.08	2.08	.039	0.59	43.53	13.89	**< .001**
Sublimity-M	0.17	59.33	4.81	**< .001**	0.00	450.43	0.08	.939
Beauty-M	0.05	51.07	1.35	.184	0.20	46.45	5.49	**< .001**
(Covariate)	0.22	629.40	4.65	**< .001**	0.13	650.68	4.95	**< .001**

Note. "-I" refers to the image-only block (Block 1). "-M" refers to the music-only block (Block 2). Bold shows inferential statistics that are significant at $p < .025$ (please refer to the footnote above on Bonferroni correction).
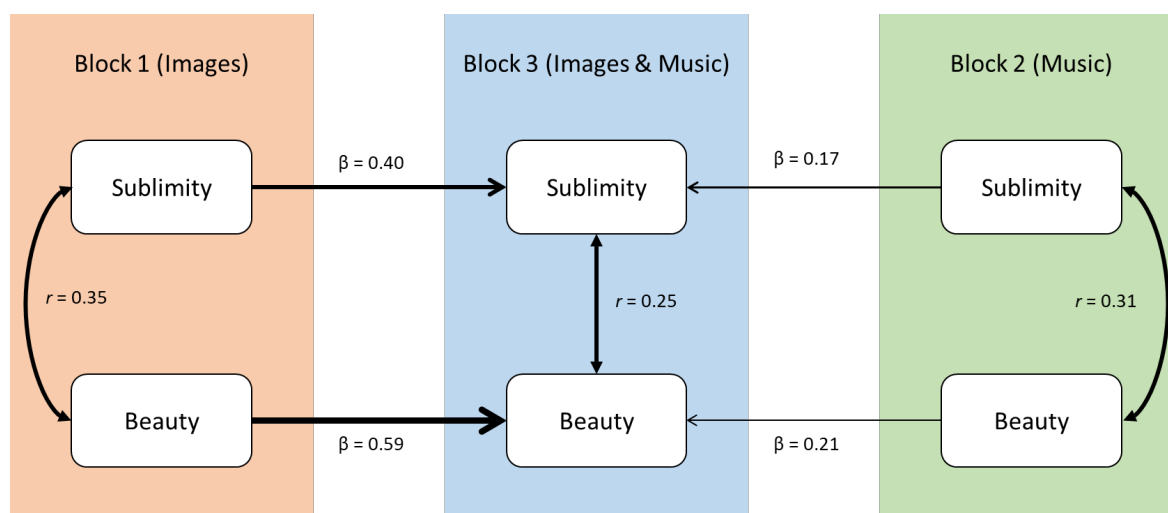

Figure 5. Summary of findings. For linear mixed models analysis (unidirectional arrows; thickness approximately corresponds to the size of the effect), standardized beta coefficients are presented. Correlation coefficients (bidirectional arrows) are averaged correlations across participants. Only

significant effects at $p < .025$ are visualized (please refer to the footnote above on Bonferroni correction).

Discussion

The present study explored two novel areas of sublimity research. On the one hand, the study explored the triggers of sublimity and beauty in music. The study demonstrated that music excerpts with music in minor keys were particularly rated as eliciting sublimity, whereas music in major keys was rated as eliciting beauty. Unlike the situation predicted in the introduction of this paper, mixed musical cues (e.g., fast tempo in a minor key; slow tempo in a major key) and atonality were not associated with a musical stimulus being rated as eliciting sublimity. One can surmise that while mixed emotions and ambiguity may be important components of sublime experiences (e.g., Johnson, 1986), they do not guarantee a sublime experience *per se* in the context of music. It is possible that while the mixed emotion of fear and positivity is typical of descriptions of sublime experiences, fear was not elicited in the piano music pieces used in the study. More will be discussed below regarding factors that affect sublimity and beauty in music.

The present study also explored sublimity and beauty in a cross-modal setting, exploring the visual and musical factors that contribute to aesthetic experiences in multi-modal stimuli. The general finding was that while the experienced sublimity and beauty of images and music (rated separately in Blocks 1 and 2) contributed to the overall experienced sublimity and beauty of the multi-modal stimuli (Block 3), the influence of the image was significantly larger than the influence of the music. The present work also reports a selectivity effect: the sublimity of a multi-modal stimulus was predicted by the sublimity ratings of its two components but not the beauty ratings of its components. Conversely, the beauty of a multi-modal stimulus was predicted by the beauty of its two components but not the sublimity of its components.

These findings are in line with Vuoskoski et al. (2014), who reported the superiority of the visual components over the musical in the rating of perceived expressivity in multi-modal stimuli. However, the findings stand in contrast with the recent work by Frame et al. (2023), who reported

equal contributions from images and music in a similar study setting, but using measurements of experienced pleasure. Given that the three studies (including the present study) used differing stimuli and designs, future works may wish to capitalize on these varying conclusions. However, where the past works did not explore the measure of sublimity and beauty, the present work explored how two comparable and related aesthetic experiences can operate on separate mechanisms and how their effects take hold in the context of multiple modalities.

Predictors of Sublimity and Beauty in Music

In the present work, the major key as a musical feature was an important predictor of musical beauty, while the minor key was important for evoking musical sublimity. Tempo affected sublimity marginally with faster music evoking more sublimity, but tempo effects were absent in the experience of beauty. Given that the major key is often linked with positive emotions and the minor key with negative emotions (e.g., Hevner, 1937), these results fit the frameworks of philosophical notions of sublime experiences entailing elements of negative emotionality. Beauty, on the other hand, as seen as an elicitor of "mere positive pleasure" by Burke, was predicted by the major key.

If sublimity is also a delight with negative emotionality (mixed emotionality) or is something that is difficult to grasp (ambiguity), as is commonly argued by musicologists and philosophers (e.g., Johnson, 1986), does the present data support the view that sublimity is experienced in the context of mixed emotions or ambiguity? The results from the present work do not provide a clear picture. According to Hunter and colleagues (2008), mixed emotions are evoked by mixed musical cues, e.g., minor key (sadness) with a fast tempo (happiness), or major key (happiness) with a slow tempo (sadness). In the present work, while sublimity was most evoked in music in a minor key and in a fast tempo, sublimity was least evoked in music in a major key and in a slow tempo (see Figure 4; see *Supplemental Material* for an alternative visualization) – both scenarios would constitute as music of mixed emotions in accordance with Hunter et al. (2008). Furthermore, where Hunter and colleagues (2008) reported slow music to generally evoke more mixed emotions than fast music, one of the main effects from the present data was that fast tempo evoked more sublimity than slow tempo. In other words, the present results do not provide a clear picture with regard to the link between sublimity and

mixed emotions (as conceptualized by Hunter et al. [2008]) in musical contexts. If anything, the results demonstrate that the literature on mixed emotions in music, which observed the predictors of mixed emotions of sadness and happiness, may be limited in its transferability to the context of mixed emotions in sublimity (often conceptualized as a mixed emotion of fear and positivity).

Ambiguity is another experience said to be characteristic of sublime experiences (although not verifiable using the present methods, one may perhaps stretch the argument to say that music with mixed emotions may provide a sense of [emotional] ambiguity). In this context, the present study identified a decisively ambiguous musical stimulus in atonal music. Atonal music is known to exhibit lower levels of key and pulse clarity than tonal music, and, therefore, presents ambiguity to its listeners (Mencke et al., 2019, 2022). In the present work, atonal music, regardless of tempo, elicited the least amount of sublimity, together with works in the major key. Overall, the evidence points to the direction that there is insufficient proof to interpret sublimity as elicited by mixed emotions or ambiguity.

Future works may look further into the aesthetics of atonal music. In the present work, atonal music largely represented music of both low sublimity and low beauty. It may be the case that the presence of tonal music surrounding the atonal stimuli may have relatively overpowered (since all musical excerpts were presented together within experimental blocks) the more subtle aesthetic appeal of atonal music. Still, the fact that atonal music remains part of the core classical repertoire and teaching syllabus implies that the emotional and aesthetic merits of atonal music are not negligible. Importantly, the aesthetics of atonal music may be moderated by individual factors such as musical experience, music ability, music education, and/or music expertise. Familiarity with the musical stimuli may especially be important to consider. In particular, the musical stimuli (and the various aesthetic concepts used in the present work), were developed in the context of Western cultures. While the present study had participants from a wide range of ethnic backgrounds (as outlined in the Methods section) and the analytical method (i.e., linear mixed models) accounted for by-participant variations in deriving its fixed effects, the study's generalizability may still largely be limited to the context of Western culture or the expectations of Western culture (it should also be noted that the

majority of the participants were female and resided in London, UK). Future works may, therefore, run a more controlled study on some of these factors to better estimate the limits of the present findings' generalizations.

Limitations

Some technical aspects of the study do warrant consideration. While the present work had the experimental blocks fixed ordered in the sequence of image-only (Block 1), music-only (Block 2), and image and music (Block 3), there is the possibility that this may have created an unwanted order effect (e.g., participants could have been fatigued by the time they reached Block 3). The ordering of the image-only and music-only blocks could have been counterbalanced or these blocks could have come after the multimodal experimental block, both of which were done in Frame et al. (2023). At the same time, perhaps it is a matter of priority; the present work fixed the experimental blocks in this way to ensure continuation from previous studies (e.g., Hur et al., 2022), which used the same visual stimuli. In other words, at least for the first experimental block, the experimental conditions of the previous studies were intentionally maintained to ensure a comparison of the present work's outputs to those of the past. Indeed, the manipulation checks in the Results section demonstrated that the present work's results are consistent with previous findings, which ultimately enhances the continuity and validity of the present findings. Nevertheless, future works should explore the potential order effect. Indeed, there may be an argument for stimulus type (music, image, or mixed) being completely randomized in terms of presentation order in future studies.

The present work, like many other studies in empirical aesthetics, only explored linear relationships in predicting certain outcome variables (e.g., sublimity and beauty). There is much to be said for exploring non-linearities and interactions in more detail in future studies. While the paper considers the general rating tendencies of the sublime and the beautiful, little is known, however, of the underlying experiences beneath what people call sublime experiences. Previous works, for example, explored the various semantic associations of sublime experiences; sublimity was triggered by various sources (even though the experience of the sublime itself didn't vary much across people; Pelowski et al., 2021). This is especially crucial in cross-modal settings, as there is little guarantee

that the sublimity evoked by an image would correspond to precisely the same quality of sublimity raised by a music piece. While the present work tried to mitigate much of this concern by unifying the rating method across all experimental blocks and by providing participants with standardized characterizations of sublimity and beauty, there are still questions as to whether the sublime experience of seeing an erupting volcano can said to trigger the same type of sublime experience of listening to a lugubrious Chopin piece (relatedly, while the study assumed atonal music to represent the emotional/cognitive experience of ambiguity, the study did not directly measure ambiguity to verify this assumption; note that ambiguity could also arise from tonal music [e.g., with a high-level chromaticism or with clashing keys]).

Furthermore, the provision of standardized characterizations of sublimity and beauty can rightfully be argued to potentially lead to circular reasoning or associative effects. It could also be argued that the provided characterizations of sublimity and beauty, largely founded on historical texts, may no longer resonate with the modern population. However, as was discussed before (the Methods section) and elsewhere (e.g., Hur et al., 2022), it was considered crucial – especially in a work that doesn't aim to directly explore the semantics of sublimity and beauty – to set up a theory-informed set of measures in which the researchers would at least know exactly what was being measured, rather than assume. This way, the present results may also be directly comparable to studies of similar designs.[16] It may be of interest for future works to explore whether the present results may be replicated in the context where characteristics of the main measured variables (e.g., sublimity and beauty) are not provided or are provided in an altered version.

Similarly, further research may explore the nature of sublimity and beauty in relation to general preference and contextual effects. Atonal music is a special case here. While atonal music has been rated relatively low in both sublimity and beauty, atonal works are, as mentioned earlier, often

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[16] The potential danger of associative (or priming) effects in the stimulus rating tasks may, fortunately, be exaggerated since participants were given characteristics of an experience rather than those of a specific stimulus. It should also be mentioned that using this method of providing characterizations of sublimity and beauty to participants, the sublimity and beauty ratings in images were fairly consistent across different raters (Hur et al., 2022) and within raters (Hur, 2020). At the minimum, the providing of characterizations enable a reliable measure of sublimity and beauty.

programmed and attended to in concert halls and opera houses. Crucially, atonal music has become successful in cinema, where it provides the soundtracks for many films, particularly in genres such as horror, or for evoking fear. Future works may explore how (e.g., as background music) and where (e.g., cinema) the use of atonal music may feel generally appreciated. Finally, research in aesthetics has, mostly for practical reasons, concentrated on visual images, with a rather smaller literature on auditory objects, but there is little work outside of those fields, into other sensory modalities or other cross-model fields, involving touch, kinesthesis, and so on, of which a laboratory study on the aesthetics of autonomous interactive forms provides an unusual and carefully carried out exemplar (Soranzo et al, 2018). Further research could consider aesthetic processes outside its traditional areas and consider the sublime and beautiful in everyday aesthetics such as fashion and clothing (Hur et al., 2023), and how cross-modality operates in those areas (e.g., catwalks, which, like theater more generally, have a multimodality that Wagner would have seen as *Gesamtkunstwerk*).

Conclusion

Although sublimity and beauty have a long history, relatively little empirical research has looked at the sublime and beautiful in modalities other than vision. The present study considered sublimity and beauty in the contexts of music, specifically exploring the musical features that may trigger sublimity and beauty in music and exploring the impact of music on the aesthetic judgment of multi-modal stimuli., In effect, the study demonstrates the inter-relations between the stimulus modalities and raises many further questions pertinent to a range of art forms, particularly cinema and theater.

References

Allanbrook, W. J. (2010). Is the sublime a musical topos?. *Eighteenth-Century Music*, *7*(2), 263-279.

Baumgartner, T., Lutz, K., Schmidt, C. F., & Jäncke, L. (2006). The emotional power of music: how music enhances the feeling of affective pictures. *Brain Research*, *1075*(1), 151-164.

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). *lme4: Linear mixed-effects models using Eigen and S4* [Computer software]. Retrieved fromhttp://CRAN.R-project.org/packagelme4

Blood, A. J., Zatorre, R. J., Bermudez, P., and Evans, A. C. (1999). Emotional responses to pleasant and unpleasant music correlate with activity in paralimbic brain regions. *Nat. Neurosci.*, 2, 382–387.

Bolivar, V. J., Cohen, A. J., & Fentress, J. C. (1994). Semantic and formal congruency in music and motion pictures: Effects on the interpretation of visual action. *Psychomusicology: A Journal of Research in Music Cognition*, *13*(1-2), 2 –59.

Brieber, D., Nadal, M., Leder, H., & Rosenberg, R. (2014). Art in time and space: Context modulates the relation between art experience and viewing time. *PloS one*, *9*(6), e99019.

Brielmann, A. A., & Pelli, D. G. (2017). Beauty requires thought. *Current Biology*, *27*(10), 1506-1513.

Burke, E. (2008). *A philosophical inquiry into the origins of our ideas of the sublime and beautiful*. Oxon, UK: Routledge Classics. (Original work published 1759).

Clewis, R. R. (2021). Why the sublime is aesthetic awe. *The Journal of Aesthetics and Art Criticism*, *79*(3), 301-314.

Clogg, C. C., Petkova, E., & Haritou, A. (1995). Statistical methods for comparing regression coefficients between models. *American Journal of Sociology*, *100*(5), 1261-1293.

Cohen, A. J. (1991). Tonality and perception: Musical scales primed by excerpts from The Well-Tempered Clavier of JS Bach. *Psychological Research*, *53*(4), 305-314.

Costelloe, T. M. (Ed.). (2012). *The sublime: From antiquity to the present*. Cambridge University Press.Dalla Bella, S., Peretz, I., Rousseau, L., & Gosselin, N. (2001). A developmental study of the affective value of tempo and mode in music. *Cognition*, *80*(3), 1-10.

Daynes, H. (2011). Listeners' perceptual and emotional responses to tonal and atonal music. *Psychology of Music*, *39*(4), 468-502.

DePaulo, B. M., Rosenthal, R., Eisenstat, R. A., Rogers, P. L., & Finkelstein, S. (1978). Decoding discrepant nonverbal cues. *Journal of Personality and Social Psychology*, *36*(3), 313–323.

Fekete, A., Specker, E., Mikuni, J., Trupp, M. D., & Leder, H. (2023). When the painting meets its musical inspiration: The impact of multimodal art experience on aesthetic enjoyment and

subjective well-being in the museum. *Psychology of Aesthetics, Creativity, and the*

Arts. Advance online publication. https://doi.org/10.1037/aca0000641

Flores-Gutiérrez, E. O., Díaz, J. L., Barrios, F. A., Favila-Humara, R., Guevara, M. Á., del Río-

Portilla, Y., et al. (2007). Metabolic and electric brain patterns during pleasant and unpleasant

emotions induced by music masterpieces. *Int. J. Psychophysiol.*, *65*, 69–84

Frame, J., Gugliano, M., Bai, E., Brielmann, A., & Belfi, A. M. (2023). Your ears don't change what

your eyes like: People can independently report the pleasure of music and images. *Journal of*

Experimental Psychology: Human Perception and Performance, 49(6), 774–785.

Gagnon, L., & Peretz, I. (2003). Mode and tempo relative contributions to "happy-sad" judgements in

equitone melodies. *Cognition & Emotion*, *17*(1), 25-40.

Gerardi, G. M., & Gerken, L. (1995). The development of affective responses to modality and

melodic contour. *Music Perception: An Interdisciplinary Journal*, *12*(3), 279-290.

Gerdes, A., Wieser, M. J., & Alpers, G. W. (2014). Emotional pictures and sounds: a review of

multimodal interactions of emotion cues in multiple domains. *Frontiers in Psychology*, *5*,

1351.

Gordon, A. M., Stellar, J. E., Anderson, C. L., McNeil, G. D., Loew, D., & Keltner, D. (2017). The

dark side of the sublime: Distinguishing a threat-based variant of awe. *Journal of Personality*

and Social Psychology, 113(2), 310–328.

Groves, S. (2013). The Picturesque Oratorio: Haydn's Art in Nature's Clothing. *Music and*

Letters, *93*(4), 479-512.

Harrison, L., & Loui, P. (2014). Thrills, chills, frissons, and skin orgasms: toward an integrative

model of transcendent psychophysiological experiences in music. *Frontiers in Psychology*, *5*,

790.

Hevner, K. (1935). The affective character of the major and minor modes in music. *American Journal*

of Psychology, *47*, 103–118

Hevner, K. (1937). The affective value of pitch and tempo in music. *The American Journal of*

Psychology, *49*(4), 621-630.

Horn, K. & Costa-Giomi, E. (2011). Fast/major and slow/minor pairings in J.S.Bach's Well Tempered Clavier Books 1 and 2. *Empirical Musicology Review, 6*, 155–163.

Hunter, P. G., Schellenberg, E. G., & Schimmack, U. (2008). Mixed affective responses to music with conflicting cues. *Cognition & Emotion*, *22*(2), 327-352.

Hunter, P. G., Schellenberg, E. G., & Schimmack, U. (2010). Feelings and perceptions of happiness and sadness induced by music: Similarities, differences, and mixed emotions. *Psychology of Aesthetics, Creativity, and the Arts*, *4*(1), 47–56.

Hur, Y.-J. (2020). *An empirical aesthetics of the sublime and beautiful* [Doctoral thesis, University College London]. https://discovery.ucl.ac.uk/id/eprint/10091352/18/Hur_10091352_thesis_redacted.pdf

Hur, Y. J., Etcoff, N. L., & Silva, E. S. (2023). Can fashion aesthetics be studied empirically? The preference structure of everyday clothing choices. *Empirical Studies of the Arts*, *41*(2), 525-545.

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.* Advance online publication. https://doi.org/10.1037/aca0000480

Hur, Y. J., & McManus, I. C. (2017). Representing the sublime in the VIMAP and empirical aesthetics: Reviving Edmund Burke's A Philosophical Enquiry into the Origins of Our Ideas of the Sublime and Beautiful: Comment on" Move me, astonish me... delight my eyes and brain: The Vienna Integrated Model of top-down and bottom-up processes in Art Perception (VIMAP) and corresponding affective, evaluative, and neurophysiological correlates" by Matthew Pelowski et al. *Physics of Life Reviews*, *21*, 135-137.

Isbilen, E. S., & Krumhansl, C. L. (2016). The color of music: Emotion-mediated associations to Bach's Well-tempered Clavier. *Psychomusicology: Music, Mind, and Brain*, *26*(2), 149–161.

Ishizu, T., & Zeki, S. (2014). A neurobiological enquiry into the origins of our experience of the sublime and beautiful. *Frontiers in Human Neuroscience*, *8*, 891.

Jesse, A., & Massaro, D. W. (2010). The temporal distribution of information in audiovisual spoken-word identification. *Attention, Perception, & Psychophysics*, *72*(1), 209-225.

Johnson, C. L. (1986). " Giant HANDEL" and the Musical Sublime. *Eighteenth-Century Studies*, *19*(4), 515-533.

Judd, C. M., Westfall, J., & Kenny, D. A. (2017). Experiments with more than one random factor: Designs, analytic models, and statistical power. *Annual Review of Psychology*, *68*, 601-625.

Kant, I. (1986). *Critique of judgment* (W. S. Pluhar Trans.). Indianapolis, IN: Hackett Publishing. (Original work published 1790).

Keltner, D., & Haidt, J. (2003). Approaching awe, a moral, spiritual, and aesthetic emotion. *Cognition and Emotion*, *17*, 297–314.

Konečni, V. J. (2011). Aesthetic trinity theory and the sublime. *Philosophy Today*, *55*(1), 64-73.

Korstvedt, B. M. (2000). *Bruckner: Symphony no. 8*. Cambridge University Press.

Krahé, C., Hahn, U., & Whitney, K. (2015). Is seeing (musical) believing? The eye versus the ear in emotional responses to music. *Psychology of Music*, *43*(1), 140-148.

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest package: tests in linear mixed effects models. *Journal of Statistical Software*, *82*(13), 1548–7660.

Larsen, J. T., Norris, C. J., McGraw, A. P., Hawkley, L. C., & Cacioppo, J. T. (2009). The evaluative space grid: A single-item measure of positivity and negativity. *Cognition & Emotion*, *23*(3), 453-480.

Lee, I. E., Latchoumane, C. F. V., & Jeong, J. (2017). Arousal rules: An empirical investigation into the aesthetic experience of cross-modal perception with emotional visual music. *Frontiers in Psychology*, *8*, 440.

Logeswaran, N., & Bhattacharya, J. (2009). Crossmodal transfer of emotion by music. *Neuroscience Letters*, *455*(2), 129-133.

Marin, M. M. (2015). Crossing boundaries: toward a general model of neuroaesthetics. *Frontiers in Human Neuroscience*, *9*, 443.

Mencke, I., Omigie, D., Wald-Fuhrmann, M., & Brattico, E. (2018). Atonal Music: Can uncertainty lead to pleasure?. *Frontiers in Neuroscience*, *12*, 979.

Mencke, I., Omigie, D., Quiroga-Martinez, D. R., & Brattico, E. (2022). Atonal music as a model for investigating exploratory behavior. *Frontiers in Neuroscience*, *16*, 793163.

Microsoft Corporation. (2024). Microsoft Word. Retrieved from https://office.microsoft.com/word.

Morrow, M. S. (1990). Of Unity and Passion: The Aesthetics of Concert Criticism in Early Nineteenth-Century Vienna. *Nineteenth-Century Music*, 193-206.

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, 15*(2), 216–240.

Platz, F., & Kopiez, R. (2012). When the eye listens: A meta-analysis of how audio-visual presentation enhances the appreciation of music performance. *Music Perception: An Interdisciplinary Journal*, *30*(1), 71-83.

Plomp, R., & Levelt, W. J. M. (1965). Tonal consonance and critical bandwidth. *The Journal of the Acoustical Society of America*, *38*(4), 548-560.

Poon, M., & Schutz, M. (2015). Cueing musical emotions: An empirical analysis of 24-piece sets by Bach and Chopin documents parallels with emotional speech. *Frontiers in Psychology*, *6*, 1419.

Reed, F. L. (1919). Militarism and the music of the future. *Texas Review*, *4*(2), 146-156.

Rentfrow, P. J., & Gosling, S. D. (2003). The do re mi's of everyday life: the structure and personality correlates of music preferences. *Journal of Personality and Social Psychology*, *84*(6), 1236–1256.

Salimpoor, V. N., Benovoy, M., Larcher, K., Dagher, A., & Zatorre, R. J. (2011). Anatomically distinct dopamine release during anticipation and experience of peak emotion to music. *Nature Neuroscience*, *14*(2), 257–262.

Scott, D. B. (2003). *From the erotic to the demonic: On critical musicology*. Oxford University Press.

Shapshay, S. (2021). A two-tiered theory of the sublime. *The British Journal of Aesthetics*, *61*(2), 123-143.

Soranzo, A., Petrelli, D., Ciolfi, L., & Reidy, J. (2018). On the perceptual aesthetics of interactive objects. *Quarterly Journal of Experimental Psychology*, *71*(12), 2586-2602.

Spence, C., & Deroy, O. (2013). How automatic are crossmodal correspondences?. *Consciousness and Cognition*, *22*(1), 245-260.

Thompson, W. F., Russo, F. A., & Livingstone, S. R. (2010). Facial expressions of singers influence perceived pitch relations. *Psychonomic Bulletin & Review*, *17*(3), 317-322.

Vartanian, O., Navarrete, G., Chatterjee, A., Fich, L. B., Leder, H., Modroño, C., ... & Nadal, M. (2019). Preference for curvilinear contour in interior architectural spaces: Evidence from experts and nonexperts. *Psychology of Aesthetics, Creativity, and the Arts*, *13*(1), 110–116.

Vuoskoski, J. K., & Eerola, T. (2017). The pleasure evoked by sad music is mediated by feelings of being moved. *Frontiers in Psychology*, *8*, 245046.

Vuoskoski, J. K., Thompson, M. R., Clarke, E. F., & Spence, C. (2014). Crossmodal interactions in the perception of expressivity in musical performance. *Attention, Perception, & Psychophysics*, *76*(2), 591-604.

Vuoskoski, J. K., Thompson, M. R., Spence, C., & Clarke, E. F. (2016). Interaction of sight and sound in the perception and experience of musical performance. *Music Perception: An Interdisciplinary Journal*, *33*(4), 457-471.

Vuvan, D. T., Podolak, O. M., & Schmuckler, M. A. (2014). Memory for musical tones: The impact of tonality and the creation of false memories. *Frontiers in Psychology*, *5*, 582.

Webster, J. (2005). The sublime and the pastoral in The Creation and The Seasons In C. Clark (Ed.), *The Cambridge companion to Haydn* (pp. 150–163). Cambridge University Press.

Westfall, J., Kenny, D. A., & Judd, C. M. (2014). Statistical power and optimal design in experiments in which samples of participants respond to samples of stimuli. *Journal of Experimental Psychology: General, 143,* 2020–2045.

Wurth, K. B. (2009). *Musically sublime: Indeterminacy, infinity, irresolvability*. Fordham University

Press.