Facing the Sublime: physiological correlates of the relationship between fear and the sublime

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Abstract

The sublime is an enduring concept in Western aesthetic discourse, and is often portrayed such as in Edmund Burke's *A Philosophical Enquiry into the Origin of Our Ideas of the Sublime and Beautiful* of 1759 as a delightful horror, a kind of enjoyment based on negative emotions. In the current paper, the relationship between sublimity and fear was explored using behavioral and physiological measures. In two studies (total N ≈ 120), photographs of nature were selected (Study 1: 192 photographs & Study 2: 72 photographs), rated on sublimity, beauty, fear, happiness, and arousal, before being assessed against facial muscle movement (fEMG) and skin conductance (SCR). In line with philosophical theories, ratings of sublimity showed positive associations with subjective fear ratings in both studies. Looking at facial EMG data (Study 2), sublimity was in fact associated with a decrease of *corrugator supercilli* (frowning) reactions, indicating reduced emotional negativity. Furthermore, sublimity did not change activation levels of the *zygomaticus major* (smiling/positive emotional valence), nor did it influence movements of the *medial frontalis* (inner brow raise/fear). Increased ratings of fear increased *corrugator supercilii* and *medial frontalis* activations, and decreased *zygomaticus major* activation, replicating past findings. SCR activation was not predicted by any variable. The discrepancy between behavioral and physiological results likely result from a combination of false appraisal and distancing mechanisms, and thus encourages the reconsideration of generalizations made over the sublime in its relation to fear.

Keywords: the sublime and beautiful, fEMG, SCR, aesthetic emotions, distancing

Facing the Sublime: physiological correlates of the relationship between fear and the sublime

It would be no grave exaggeration to suggest that the sublime is one of the most persevering ideas borne of Western aesthetic traditions. Ever since its introduction to the intellectual life in 18th century England via the 1743 translation of the Greek text *On the Sublime* (ΠΕΡΙ ΥΨΟΥΣ; *Peri Hypsous*), the sublime became an umbrella term to represent profound experiences linked with fear, shock, and transcendence (Costelloe, 2012). And it is in this broad characterization that contemporary usage of the sublime is made, most relatedly in aesthetic fields such as painting (e.g. Caspar David Friedrich, Mark Rothko, etc.), architecture (e.g. Gothic Cathedrals, Albert Speer, etc.), poetry (e.g. John Milton, William Wordsworth, etc.) and music (e.g. Bruckner, Wagner, Mahler, etc.). That the sublime is a regular subject for exhibitions, such as in the 'On the Sublime' project of the Guggenheim Museum in 2001 or in the 'Art of the Sublime' project of Tate Britain in 2008, adds to the suggestion that the sublime is relevant in the contemporary world.

In the current paper, a prevalent theme in theories of the sublime is explored, namely the relationship of the sublime and fear. Although it was common among philosophers to consider fear as an integral makeup of sublime experiences (e.g. Burke, 1759/2008), recent empirical research portray diverging opinions regarding the involvement of fear in the sublime. While the sublime has on the one hand been assumed as an aesthetic experience of heightened positivity (e.g. Ishizu & Zeki, 2014; Konečni, 2011), some have on the other hand understood the sublime as an experience of fear-driven delight (e.g. Eskine, Kacinik, & Prinz, 2012; Ortlieb, Fischer, & Carbon, 2016). Given the methodological and conceptual issues within these empirical works, it is premature to determine a clear-eyes perspective of the role of fear in the sublime. In light of such context, our work aimed to systematically evaluate the nature of sublimity's relation with fear, by means of combining behavioral and physiological measures.

Fear and the sublime Among aesthetician-philosophers of the 18th century, it was commonplace if not popular to discuss aesthetic experiences through the dichotomy of the sublime and beautiful. This plausible assumption is rooted on the idea that while aesthetic delight can derive from pure pleasure (beauty), it is also possible that one feels great delight in things that are unpleasant (sublimity).

The Irishman Edmund Burke's hugely influential work, *A Philosophical Inquiry into the Origins of our Ideas of the Sublime and Beautiful* made a strong case of this dichotomy, and especially on the importance of the involvement of fear in the sublime, the latter a "sort of delightful horror" (p. 73). Burke explains in his characteristically unsparing tone (Burke, 1759/2008):

> Whatever is fitted in any sort to excite the ideas of pain and danger, that is to say, whatever is in any sort terrible, or is conversant about terrible objects, or operates in a manner analogous to terror, is a source of the sublime. (p. 39)

Throughout much of the text, Burke sees fear as an integral trigger of the sublime, and it is through the startling effects of thing strong negative emotion that the sublime becomes "the strongest emotion which the mind is capable of feeling" (Burke, 1759/2008, p.39).

It must be noted, however, that that fear can coexist with delight can be found beyond philosophical contexts. Synonyms of sublimity that represent an amalgamation of fear, veneration, and delight exist globally. This includes *kua* among the !Kung San people of South-western Africa (Shostak, 1983), *敬畏* in Japan, Korea and China, and *Erhabenheit*, in German speaking countries. As such, the phenomenon of fear being closely associated with sublimity appears hardly a mere relic of 18th century Western thinking.

A psychological perspective of the sublime and its relationship with fear Given the memorable and profound nature of the sublime complemented by its rich historical underpinning, the gaining interest of psychological research on this matter is unsurprising.

However, there have always been diverging viewpoints on whether sublimity is related to fear or not.

In Konečni's (2011) theoretical framework, the sublime (i.e. *sublime-in-context*) represents a profound and universal aesthetic experience of great intensity, and is associated with objects of vast physical dimensions, rarity, beauty, and novelty. While Konečni projects a wide range of psycho-physiological consequence of encountering these sublime objects such as a sense of being moved and thrills/chills, his conjecture construes the sublime as a source of deep positivity and agency of meaning-giving. While fear is mentioned in light of Burke's text, fear is ultimately distanced from a true sublime experience.

Unfortunately, Konečni failed to replicate such conceptualization in his subsequent empirical work (Konečni, Wanic, & Brown, 2007). Neither mood, i.e. happy-sad, nor thrill was associated with the viewing of photographs of sublime objects, e.g. Cheops Pyramid, compared to when viewing non-sublime objects, e.g. The U.N. building & Mona Lisa.

Keltner and Haidt (2003), too, discuss Burke's theory of the sublime in light of their own notion of awe – although the writers never mention the term sublime, their source of theorization, by discussing Burke's text, is clearly a matter of the sublime. The authors construe the aesthetic emotions of the sublime as variants of social emotions. For example, the sense of reverence evoked by grand nature, is argued to be rooted from the everyday experience of reverence toward awe-inducing personalities. Crucially, Keltner and Haidt, much like Konečni, ultimately reject the idea that fear is central to sublime experiences.

Supporting the theoretical assumptions set by Konečni, Kelter, and Haidt is the empirical work of Ishizu and Zeki (2014). When subjects were asked to rate a wide range of National Geographics photographs on sublimity (not at all sublime – very sublime), beauty (ugly –beautiful), pleasure (fearful –pleasant), and scale (small –grand), sublimity correlated strongly with beauty and scale, but weakly, albeit statistically significantly, to pleasure.

Importantly, when fMRI activity was analyzed in light of sublimity ratings, judgements of sublimity were associated with the activation of the posterior hippocampus, an area associated with variants of positive emotions, such as romance (Zeki & Romaya, 2010). However, sublimity ratings did not have any noticeable effect on areas of the brain often related to immediate threat and fear, such as the amygdala and the insula (Mattavelli, et al., 2013). Areas that are often associated with negative emotionality such as perceived pain, such as the anterior cingulate/medial prefrontal cortex (Etkin, Egner, & Kalisch, 2011), were de-activated with increased sublimity ratings.

At the other end of the spectrum are works that imply fear's importance in sublime experiences. It was in Eskine and colleague's (2012) paper where the priming of fear, not arousal or happiness induced heightened sublimity ratings of abstract artworks, suggesting that fear and sublimity may share a common mechanism. A similar claim can be made of the work by Ortlieb and colleagues (2016), who demonstrated that threat and liking can have strong positive associations despite that being modulated by individual differences. These findings link well with the *Distancing-Embracing model*, which argues that unpleasantness is essential to strong aesthetic experiences (Menninghaus, Wagner, Hanich, Wassilliwizky, Jacobsen, & Koelsch, 2017). Certainly, such viewpoint gives a nod to Bullough's classic essay on *psychical distance*, where Bullough develops a similar logic of thought (Bullough, 1912).

Some recent works have also pointed out that sublimity can exist in both fearful and non-fearful forms. Referring to Burke's conceptualization of the sublime, Piff and colleagues (2015; Study 4) reported that 3-mins video clips of threat-based/nature and positive/non-nature had similar ratings of sublimity despite being rated differently in terms of fear. This was replicated in a work by Gordon and colleagues using 2-minutes video clips (2016; Study 5).

Limitations of past research Despite the increasing number of research, a dispersion of conclusions allows little space for concrete insight in deciphering the relationship between sublimity and fear. The discrepancy can be addressed to a number of methodological issues. While most empirical works derive statistical generalization based on human responses to certain stimuli, the choice and content of stimuli, especially in terms of which stimulus represents the sublime and which not, still remains in the domain of the researchers' own subjective choice (e.g. Konečni, Wanic, & Brown, 2007; Gordon et al., 2016). Given that the sublime still remains in psychology an umbrella terminology to denotes a general state of mixed or exalted emotions (Hur & McManus, 2017), a researcher's own idea of what a sublime item might be could considerably differ from those of another.

Also problematic are conclusions sought over a single stimulus per conditions (e.g. Eskine et al., 2012; Gordon et al., 2016); simulations studies have demonstrated small number of items to compromise statistical power (Judd, Westfall, & Kenny, 2016; Westfall, Kenny, & Judd, 2014). In the lack of stimuli that represent the sublime or a specific dimension of it, generalizations based on the subject's response to those items generates difficulties.

Current research In addressing the relationship between sublimity and fear, we set out to conduct two sets of systematic studies that were theoretically informed and based on mixed methodologies. In Study 1, participants were asked to bring in a set of photographs of their own choices, before an independent group of participants rated all those photographs in their felt degrees of emotions including sublimity and fear. In line with Burke's characterization of the sublime, all photographs were limited to objects in nature.

Using a large subset of these rated images, Study 2 involved the use of physiological measures, namely, facial electromyography (fEMG) and skin conductance response (SCR), to further assess the emotional states people experience during experiences of sublimity and

fear. Both fEMG and SCR have been previously used to uncover emotional processes underlying aesthetic experiences (Gerger, Leder, & Kremer, 2014; Gerger, Leder, Tinio, & Schacht, 2011; Gerger, Pelowski, & Leder, 2017; Gordon et al., 2016). Furthermore, both measures are associated with the experience of fear or fear-related states such as arousal (Bradley, Codispoti, Cuthbert, & Lang, 2001; Cacioppo, Petty, Losch, & Kim, 1986; Dimberg, 1986; Ekman & Friesen, 1975; Ekman, Friesen, & Ancoli, 1980; Lang, Greenwald, Bradley, & Hamm, 1993; Moody, McIntosh, Mann, & Weisser, 2007; Scherer & Ellgring, 2007). In particular, Gordon and colleagues (2016) had reported skin conductance to not be associated with sublimity. By adopting such multi-leveled measurements based on a wide range of participant-generated stimuli, we aimed to present a relationship between sublimity and fear that is generalizable over a wide range of stimuli and measures.

Study 1

According to several aesthetic theories, scenes of nature that evoke fear can be important emotional components of sublime experiences (e.g. Burke, 1759/2008). Thus, Study 1 served the purpose to generating a pool of nature-based photographs that could relate to the emotional nature of the sublime, all the while controlling for potential researcher-based bias in stimuli selection. One cohort of subjects (Cohort A) were first asked to bring in a number of photographs of their own choice that suit a certain set of criteria. Afterward, a separate group of subjects (Cohort B) rated these photographs in a lab setting.

Methods

Participants For Cohort A, subjects from London, UK (17 participants, 9 female, mean age = 24.65 years, sd = 3.83) and Vienna, Austria (17 participants, 10 female, mean age = 25.76 years, sd = 5.89) were recruited in return for being entered into a raffle to win an amazon voucher worth 10 GBP. For Cohort B, two groups of participants, one from London,

UK (21 participants, 20 female, mean age = 20.67, sd = 2.78) and one from Vienna, Austria (21 participants, 16 female, mean age = 20.67, sd = 2.01) were recruited in return for course credit.

Materials and procedure Participants of Cohort A were asked to bring in photographs of nature, six of which the subjects believed elicited fear and another six, happiness. We restricted stimulus selection to fearful and happy photographs, as we wanted to create a set of images that ranged in its degree of fearful. The sublime or beautiful were not mentioned at any point in this task, given the concern that participants' suspicion of the purpose of the task may influence their image selection.

Of those six images within each emotional category, half of them were asked to be close angle shots and the other half, wide angle shots; this was done in order to diversity content. All photographs had to be without traces of humans or human-associated artifacts (e.g. cars, houses, etc.), be chosen without collaboration with others, and be at least 800 × 600 pixels in size. To maximize the diversity of content, the instructions regarding the emotional associations were kept vague and general. When the images were selected, they were sent in to the researchers via email.

Based on the compiled 192 images, a separate group of participants (Cohort B) rated the pool of images for their felt degree of sublimity, beauty, fear, happiness, arousal, and dominance.

Each session took place at a standard experimental cubicle at the University of Vienna and University College London, and was run via E-prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). In both locations the image sizes were kept constant, and all images did not exceed the size of 2160 × 1080 pixels. The images were shown on 19 inch monitors. Rating measures were acquired via a cursor on the screen (controlled by a mouse), and participants rated each target photograph for its degree of the aforementioned six categories

of judgements. Subjects were provided with a set of standard definitions of the six judgements (see Appendix A of the Supplemental Material for further details).

The ratings were paired together into three sets of in an *evaluative space grid* (Larsen, Norris, McGraw, Hawkley, & Cacioppo, 2009). Two scales of rating were simultaneously represented on a single response grid, with one scale located on the x-axis and the other category located on the y-axis. Each axis of the grid was based on a 5-point rating scale, and was anchored with 'low' and 'high' at the edge of each scale. Previous research by Larsen and colleagues (2009) demonstrated that this method is suitable not only in measuring mixed emotion, but also in achieving efficiency, as compared to the use of two separate unipolar scales. Sublimity (on x-axes)-beauty (on y-axis) dimension was always rated first, followed by fear (x-axes)-happiness (y-axes), and arousal (x-axes)-dominance (y-axes) ratings. As was done in the original work by Larsen and colleagues (2009), we ensured participants understood the workings of the response grid. The order of the last two grids were counterbalanced across participants. The presentation order of the 192 images were randomized for each participant. The study was run in English in London, and German in Vienna.

Results

The photographs brought in from the participants in Cohort A were filtered for overlapping content and stylistic appropriateness, resulting in a set of 192 images (i.e. 79 fearful & 113 happy; 87 close up & 105 wide shot). Subjects from Cohort B rated those images in the aforementioned emotional dimensions. Presented below are analyses of the rating data.

Rating analyses The raw responses from both the London and Vienna groups were averaged by stimulus. Correlation analyses between the ratings of the two cohorts over stimulus revealed overall good levels of consistency ($ps < .001$): beauty ($r = .74$), sublimity (r

= .76), fear (r = .84), happiness (r = .79), arousal (r = .46), and dominance (r = -.22). The dominance scale was excluded from further analyses given the negative correlation between the two cohorts. The ratings of the two cohorts were averaged together per image.

Furthermore, the relationship between emotional category allocated for the self-brought image (Cohort A) and the newly rated levels of fear and happiness (Cohort B) were analyzed. A 2-sample t-test assuming unequal variance revealed that images brought in as fearful (M = 2.91) were rated as more fearful as compared to pre-selected happy images (M = 1.48, $t(109.13) = 16.34$, $p < .001$, $d = 2.51$). Likewise, images brought in as happy (M = 3.47) were rated as more happy as compared to images pre-selected as fearful (M = 2.28, $t(141.01) = 13.71$, $p <. 001$, $d = 2.07$).

Sublimity ratings were correlated with all of the other scales over the 192 images (see Table 1a). Results revealed sublimity to be significantly correlated with beauty (r = .36, $p <$ .001), fear (r = .38, $p < .001$) and arousal (r = .70, $p < .001$). However, sublimity was not significantly correlated with happiness (r = .02, *ns*). The unique emotional associations of sublime feelings independent of beauty was further calculated, via partial correlations. After controlling for beauty, sublimity was correlated negatively with happiness ($r(69) = -.68$, $p <$ .001), and positively with fear ($r(69) = .78$, $p < .001$) and arousal ($r(69) = .70$, $p < .001$). When beauty was correlated with these variables after controlling for sublimity, beauty correlated positively with happiness ($r(69) = .94$, $p < .001$), and negatively with fear ($r(69) =$ -.84, $p < .001$) and arousal ($r(69) = -.17$, $p < .05$).

Stimulus selection for Study 2 A subset of images from Study 1 were selected to be used in Study 2, where the images were associated with fEMG and SCR activations. Using the obtained average ratings of Study 1, the stimuli were categorized into four groups consisting of high and low levels of sublimity and fear, namely ‘high sublimity & high fear’ (HSHF), ‘high sublimity & low fear’ (HSLF), ‘low sublimity & high fear’ (LSHF), and ‘low

sublimity & high fear' (LSLF). This was achieved using a median split of each scale. From the median split, 18 images were selected, and we ensured there was a diverse spread of image content throughout the four rough categories (Table 2). Note that the categories were assumed as proxies of stimuli inducing high vs. low levels of sublimity and fear, not as fixed variables (see analysis of Study 2).

Study 2

In Study 1 the relationship between sublimity and five other aesthetic-related scales were explored. Items considered high in sublime were also seen as high in beauty, fear, and arousal. Happiness, on the other hand, was not associated with sublimity. These results indeed confirm philosophical outlooks that associate sublimity with fear, such as presented by Edmund Burke (1759/2008).

How do these correlations between ratings translate into corresponding physiological responses? In Study 2, two physiological measures that are commonly associated with a wide range of emotional experiences, namely facial electromyography (fEMG) and skin conductance response (SCR) were included in addition to rating procedures.

Methods

Participants Forty-one participants (mean age = 21.54, sd = 3.29; 7 male, 34 females) were recruited through the University of Vienna online participant recruit system, and were compensated for course credit. Before the start of the experimental session, participants signed a consent form through which they were informed that the study would involve filming as well as physiological measures of certain areas of the face.

Materials and procedure Each session took place at a standard experimental cubicle at the University of Vienna, and was run via E-prime 2.0 software (Psychology Software Tools, Pittsburgh, PA). For the presentation of images, participants sat 1 m away from an LCD monitor (Nec MultiSyncLCD 3090 WQXi, 33'', 2400 × 1200 pixels).

For the fEMG measurement, participants were prepared following the guidelines suggested by Fridlund and Cacioppo (1986). First, participants were asked to clean their faces with water. Then, areas of the participants' faces corresponding to the emotions of our theoretical interests were cleansed (by the researchers) using alcohol patches. Specifically, we were interested in activations at the *corrugator supercilii* (frowning), *zygomaticus major* (smiling), and *medial frontalis* (inner brow raise) regions, representing negative valence, positive valence, and fear respectively (Cacioppo, Petty, Losch, & Kim, 1986; Ekman & Friesen, 1975; Ekman, Friesen, & Ancoli, 1980; Lang, Greenwald, Bradley, & Hamm, 1993; Moody, McIntosh, Mann, & Weisser, 2007; Scherer & Ellgring, 2007). We then applied abrasive paste (Nu Prep, Weaver, USA) in order to decrease impedances below 10 kΩ. For each region, a pair of electrodes (Ag/AgCl of 4 mm diameters) filled with electrolyte (Signa Gel, USA) were attached. An electrode on the right mastoid was attached as a ground.

For the SCR measurement, we attached a pair of electrolyte (Grass Skin Conductance Paste, USA) applied electrodes onto the middle phalanx of the ring and middle fingers of the left hand of each participant. Past studies have demonstrated heightened SCR responses to be related to arousal (Bradley et al., 2001; Dimberg, 1986; Lang et al., 1993). Given that fear is highly arousing (e.g. Scherer, 2005), and given philosophical projections of sublime being highly arousing and fearful (e.g. Burke, 1759/2008), we thought SCR activity could be correlated to sublime experiences. Before attaching the electrodes participants were asked to rinse their hands with water (no soap used). Both fEMG and SCR electrodes were connected to an amplifier (TMS International Portilab 20 channel, www.tmsi.com, Netherlands), and were sampled at 2048 Hz.

The rating procedure adopted that of Study 1. Each trial started with a fixation cross for 2 seconds. Participants were instructed to attend the fixation cross once it appeared on the screen. Then a stimulus followed for six seconds after which participants rated the stimulus

for their degree of elicited emotions. For the ratings the stimulus was reduced in size and presented on the left half of the screen whereas the scales appeared on the right half. After participants rated each stimulus on 5 × 5 grids, first on the dimension of beauty and sublime and on the dimensions of fear and happiness. Arousal was rated on a unipolar five point scale (1 low, 5 high). Dominance was dropped, given the high inter-individual heterogeneity in the ratings in Study 1. An inter-stimulus interval of six seconds followed the last rating.

The selected 72 images from Study 1 were presented in random order to each participant. After the rating task, the researchers removed the apparatuses used for physiological measures. All subjects were debriefed. A session took around 75 minutes to complete. All written information presented to the subjects were in German. All sessions was filmed via a Logitech HD c130 webcam.

fEMG analysis Following van Boxtel (2001), EMG data was put through a 20 Hz high pass filter to reduce noise resulting from blink and slow drifts. A 500 Hz low pass and 50Hz notch filters were additionally implemented, the latter which had the purpose to reduce powerline artifacts. Afterward, the data was rectified and smoothed with a 125ms moving average filter. A baseline correction was executed, by subtracting the average activation of 1000 ms before stimulus presentation from activations occurring during the 6000ms stimulus presentation (e.g. Gerger & Leder, 2015; Gerger et al., 2014). Each trial was inspected for movement artifacts (e.g. chewing, not looking at the screen, etc.) by reviewing the video and physiological data side by side (Gerger et al., 2014). Trials with artifacts were excluded.

SCR analysis SCR data were downsampled to 32Hz, and submitted to a Butterworth low pass filter (1Hz, 4^{th} order), before being subjected to the Continuous Decomposition Analysis (CDA) via LedaLab Toolbox (Benedek & Kaernbach, 2010). This procedure allows for a continuous measurement of independent tonic and event-related phasic activities, optimized for individuals' unique sudomoto-response characteristics.

Results

Behavioral results- comparisons of ratings with Study 1 To examine if the ratings of Study 2 are consistent to those of Study 1, the five behavioral ratings of Study 2 were averaged over the 72 images, before the same was done over the same 72 images from the Study 1 data. When the mean ratings scores were correlated between the two studies over each scale, there were high correlations in all five rating scales. This implies that the images were rated consistently in both studies, i.e. sublimity ($r(72) = .92$, $p < .001$), beauty ($r(72) = .91$, $p < .001$), happiness ($r(72) = .93$, $p < .001$), fear ($r(72) = .96$, $p < .001$), and arousal ($r(72) = .86$, $p < .001$).

Also consistent with the outcomes of Study 1, ratings of sublimity were positively correlated with ratings of beauty ($r(72) = .31$, $p < .01$), fear ($r(72) = .51$, $p < .001$), and arousal ($r(72) = .70$, $p < .001$) and not significantly correlated with happiness ($r(72) = .04$, *ns*; the full correlation is available in Table 1b). To see if these correlations statistically differed to those obtained in Study 1, the five coefficients were compared to those of Study 1, based on Fisher's Z-transformation. Further supporting the notion that the ratings over the 72 images are consistent in both studies, the correlations between sublimity and the other variables did not reveal significant differences between the two studies (beauty, $Z = 0.40$, *ns*; fear, $Z = 1.16$, *ns*; happiness, $Z = 0.14$, *ns*; arousal, $Z = 0.00$, *ns*).

Last but not least, to determine the unique emotional correlates of sublime feelings independent of beauty, sublimity was correlated with the emotional variables after controlling for beauty, via partial correlation. It was revealed that sublimity was correlated negatively with happiness ($r(69) = -.60$, $p < .001$), and positively with fear ($r(69) = .83$, $p < .001$) and arousal ($r(69) = .77$, $p < .001$). When beauty was correlated with these variables after controlling for sublimity, beauty correlated positively with happiness ($r(69) = .94$, $p < .001$),

and negatively with fear ($r(69) = -.86$, $p < .001$) and arousal ($r(69) = -.35$, $p < .01$). These partial correlations replicate those of Study 1.

Physiological data results

Data preparation In the analysis of the physiological data, the dichotomized categorization (low vs. high) of aggregated data was not retained, as it overlooks the continuous nature of sublimity/fear ratings and the subtleties of individual differences. The latter point is crucial in highlighting the fact that the data is in fact nested, e.g. ratings are nested within participants.

To address this issue, a series of linear mixed-effects models (also hiearchical models) were developed, via the *lmer*() function within the *lme4* package (version 1.1-15; Bates, Mächler, Bolker, & Walker, 2017) in R (version 3.4.1, R Core Team, 2017). By adopting this methodology, both items and subjects were considered as random effects within a single model. Specifically, the analyses were subjected to random slope models, such that the models accounted for variations that occur between subjects and items for each independent variable, i.e. fear and sublimity ratings (Judd, Westfall, & Kenny, 2016). Four models were run in total, in predicting the three facial muscles and SCR (see Appendix B of the Supplemental Material for further details).

Significance levels were obtained using the *lmerTest* package (version 2.0-36; Kuznetsova, Brockhoff, & Christensen, 2017), and *p*-values were estimated based on *t*-tests using the Satterwaite approximation for denominator degrees of freedom. Effect sizes in the form of *r* were computed using the Scatterwaite-adjusted degrees of freedom and *t* values from the lmer() output, using equations suggested by Rosnow & Rosenthal (2003). The significance of random effects were estimated by comparing a full model to a model without components of random slopes and intercepts of both sublimity and fear ratings per

item/subject. Statistics were calculated with 95% confidence intervals. Averaged activations over 6 seconds post stimulus exposure were taken as dependent measures.

Corrugator supercilii For the *corrugator supercilii* (frowning), the analysis revealed significant fixed effects of ratings of fear, β = .37, *SE* = .13, $p < .01$, $r = .51$, and sublimity, β = -.27, *SE* = .10, $p < .01$, $r = .43$. Thus increased levels of fear predicted frowning. At the same time higher sublimity coincided with reduced levels of corrugator activation. There was no significant interaction between sublimity and fear in predicting frowning, β = -.07, *SE* = .08, *ns*, $r = .18$. Tables 3 presents the summary statistics for all models, including those of the *corrugator supercilii* (see Appendix B of the Supplemental Material for further details).

Zygomaticus major Activations of the *zygomaticus major* (smiling) was predicted negatively by fear ratings, β = -.14, *SE* = .05, $p = .01$, $r = .31$, such that higher levels of fear were a precursor to decreased smiling. Both ratings of sublimity, β = .02, *SE* = .04, *ns*, $r = .05$, and the interaction between sublimity and fear, β = .05, *SE* = .05, *ns*, $r = .16$, did not predict activation changes of this muscle.

Medial frontalis For the *medial frontalis* (inner brow raise), there was a significant effect of fear, β = .06, *SE* = .03, $p < .05$, $r = .38$. That is, an increasing level of fear led to an increased medialis frontalis activation. No effects were found for sublimity, β = -.01, *SE* = .03, *ns*, $r = .12$, nor an interaction between sublimity and fear, β = .004, *SE* = .02, *ns*, $r = .14$.

SCR One subjects was further excluded due to electrode attachment issues. As a result, data from 39 participants were analyzed. In predicting the average phasic driver within response window (Benedek & Kaernbach 2010), no main effects were present for fear, β = .78, *SE* = 1.62, *ns*, $r = .07$, and sublimity, β = 2.08, *SE* = 2.46, *ns*, $r = .14$. Equally, no interaction between fear and sublimity was detected, β = -1.89, *SE* = 1.31, *ns*, $r = .19$.

Discussion

Since the translation of *Peri Hypsous* in 1743, philosophical discussions have often moulded the sublime as a kind of delight borne out of shock and terror, a view epitomized in Burke's *A Philosophical Enquiry* (1759/2008). Nevertheless, psychological explorations into the sublime have often remained generic, with various methodological issues (e.g. ill-characterization of sublime stimulus; Hur & McManus, 2017). In two studies, we set out to explore the relationship between sublimity and fear, using both behavioral and physiological measures and a wide range of participant-generated stimuli.

Behavioral data concerning the sublime and fear

Given the historical association between fear and sublimity (e.g. Burke, 1759/2008), we believed the positive correlation between sublimity and fear a real possibility. Such prediction was indeed verified via our positive correlation between ratings of sublimity and fear in both studies, replicating empirical works that presented sublimity as an experience based on fear (e.g. Ortlieb et al., 2016). Thus objects that are often sublime are also likely to be fearful, confirming Burke's view that the source of the sublime is "whatever is fitted in any sort to excite the ideas of pain and danger…or operates in a manner analogous to terror" (p. 39).

Still, the positive link between experiences of sublimity and fear contradict many theories in the field of empirical aesthetics, as sublimity is often seen as emotionally positive, rather than fear-related (e.g. Keltner & Haidt, 2003). A common explanation is that despite the connotation of fear in the history of sublime theories, the actual experience of sublimity, as a peak aesthetic experience, is predominantly joyful. A direct comparison is possible with the empirical work of Ishizu and Zeki (2014), who reported that sublimity was positively and negatively associated with pleasure and fear respectively in photograph rating behavior. Certainly, there are important aspects that our work shares with those of Ishizu & Zeki

(2014), such as the rating of multiple photographs; most empirical works in the field rely on single stimuli (e.g. Gordon et al., 2016), and this can compromise statistical power (e.g. Judd et al., 2016). Yet a head-to-head methodological comparison between the two works reveal a crucial difference. Where the earlier work measured fear as being opposite to pleasure (i.e. happiness) via a semantic differential, we allowed participants to rate fear and happiness as independent scales. For our work, participants were hence able to also rate stimuli as either being both high in fear and happiness or both low in those emotions. In such methodological adjustment, we were able to acknowledge the possibility of mixed emotions in aesthetic experiences (e.g. Menninghaus et al., 2017), and thereby measure assess emotional subtleties in understanding the sublime.

In closer inspection of the raw data, our rating data revealed a non-straightforward relationship between sublimity, fear, and happiness. Since sublimity correlated positively with fear but not with happiness, it was verified that fear and happiness are indeed not opposites. The results further indicated that although sublime feelings are likely to be fear-inducing, there can be sublime feelings that are either happy or non-happy.

These findings point to the philosophical viewpoint that sublimity represents an aesthetic experience based on fear, as opposed to the pleasure-based beauty. Confirming such viewpoint, sublimity and beauty showed very different emotional profiles. Although sublimity and beauty showed a moderate degree of correlations in both studies, sets of partial correlations revealed that when beauty was controlled for, sublimity was linked with high levels of fear and arousal, and low levels of happiness. Beauty, on the other hand, was uniquely (i.e. after controlling for sublimity) linked with high levels of happiness, and low levels of fear and arousal. Even when raw correlations were observed, sublimity and beauty did not share any emotional characteristics. Such differing emotions of sublimity and beauty

reflect the various sublimity-beauty contrasts if not dichotomies that Burke and other notable aestheticians often utilized.

In further support of the contrast between sublimity and beauty, in both our current work and in a series of pilot works unrelated to the current work, we have consistently found stimuli distinctly evoking sublimity but not beauty (e.g. volcanoes) and vice versa (e.g. flowers). Thus despite both theoretical and empirical works in psychology arguing for the inherent link between sublimity and beauty (e.g. Ishizu & Zeki, 2014; Konečni, 2011), our results demonstrate a much more subtle and complex side to the experience of the sublime in relation to beauty. At least, it appears sublimity and beauty differ considerably in terms of their association with fear.

Sublimity's positive association with arousal is in line with Burke's notion of the sublime being an experience of heightened tension, or "the strongest emotion the mind is capable of feeling" (p. 39). Given sublimity's correlation with the fear – an emotion of high arousal (e.g. Scherer, 2005) – the positive correlation found between ratings of sublimity and arousal was not surprising. On the contrary, this does not align well with previous empirical evidence. Of these are Eskine et al. (2012), who implied that induced fear (a 17-second video clip), but not arousal (jumping jacks), triggered feelings of sublimity of an artwork. The outcomes further defy the findings of Konečni et al. (2007), who failed to verify the induction of reported thrills – a proxy for arousal – based on exposure to sublime photographs. Considering the disagreements, it is plausible that the current study have major methodological strengths compared to these former works. While the former works drew conclusions based on 2 to 4 researcher-selected stimuli, the outcomes from the current work were based on a large number of participant-generated stimuli (192 images in Study 1 & 72 images in Study 2). Furthermore, given that the same patterns of results were replicated in

both of our studies, one can assume that the positive correlation between ratings of sublimity and arousal provide useful insight into the literature.

Physiological activations predicted by perceptions of sublimity and fear

An important aspect of the current work was to measure physiological reactions from photographs that evoke feelings of sublimity and fear. Given that fEMG and SCR are often used to measure subtle emotional experiences including positive/negative emotional valence and arousal (e.g. Cacioppo et al., 1986), we were particularly interested in how these physiological activations would reflect ratings of emotions toward photographs. Fascinatingly, Burke (1759/2008) makes specific predictions concerning facial expressions related to experiences of the sublime, when he observes that anyone undergoing a sublime experience has "his eye-brows are violently contracted, his forehead is wrinkled…" (p. 129). Here, Burke had thought that whatever is sublime is also associated with fear and pain, and he thus argued that bodily responses to fear must also be present in responses to sublimity.

To start with, that photographs rated as fear inducing were associated with positive activations at the *corrugator supercilli* (frowning) and *medial frontalis* (inner brow raise), and with negative activations at the *zygomaticus major* (smiling), sits well with the empirical literature (e.g. Scherer & Ellgring, 2007) as well as with Burke's prediction. It was expected that a similar form of fEMG activation pattern would exist for sublime photos, given sublimity's positive association with fear. Yet sublimity was not associated with any physiological responses associated with fear and negative emotionality. On the contrary, photographs rated as sublime were associated with a decreased activation at the *corrugator supercilli* (frowning).

There are two ways to interpret the link between sublimity and the deactivation of the *corrugator supercilli* (frowning). Deactivations of the *corrugator supercilli* have on the one

hand been associated with the experience of positive valence compared to emotional baseline (e.g. Bradley et al., 2001), indicating that sublime experiences indicate positive affect. Such characterization of sublimity has its proponents (e.g. Keltner & Haidt, 2003), although report of physiological response to sublimity have been rare. This view, however may ultimately fall short, since sublime photographs in our work failed to activate an area of the face most distinctly related to positive valence, namely the *zygomaticus major* (smiling; e.g. Scherer & Ellgring, 2007). The generalization of the sublime as a positive experience *per se* thus meets reservations.

The other interpretation of the deactivation of the *corrugator supercilli*, on the other hand, is that the sublime represents an experience marked by a decrease of negative emotionality. This interpretation is satisfying for a number of reasons. Theoretically, the ultimate aesthetic value underlying sublimity has often been seen as a derivative of a relief from negativity. When Burke discussed the unique qualities of sublime encounters, he assumed a distinction between pleasure and delight, the sources of beauty and sublimity respectively. In doing this, he characterized delight as "the sensation which accompanies the removal of pain or danger" (p. 36). Kant's notion of the *dynamically sublime* (1790/1951), too, outlines how the mind is elevated by reducing the threatening aspects of sublime sources, and idea that forms for the core of what Keltner and Haidt's (2003) would call *accommodation*. These views are in line with the fMRI study of Ishizu and Zeki (2014), who reported the deactivation of brain regions related to negative emotionality upon the perception of sublime photographs. In this light, feelings of the sublime is a negative delight shaped by the elimination of negative emotionality.

Note, however, that the decrease of negativity is limited to the deactivation at the *corrugator supercilli*, as a similar effect was not found at the *frontalis medialis* (inner brow raise), the latter which has been linked with experiences of fear (e.g. Scherer & Ellgring,

2007). One possibility of this result is that the deactivation of negative emotionality through sublimity is confined to the decreased experience of general negative emotions instead of fear specifically. In support of this notion, Ishizu and Zeki (2014) also failed to find deactivations of brain areas known to linked specifically with fear, such as the amygdala (Mattavelli, et al., 2013). It is also possible that because the *frontalis medialis* area has been associated with other experiences such as novelty (e.g. Scherer & Ellgring, 2007), which in itself is valence-free, the outcome of decreased negative emotionality through exposure to sublimity may has been relatively downplayed. Based on the evidence we have so far, it is difficult to determine which of these two options was at play, however.

Discussing the discrepancy between behavioral and physiological data

The discrepancy between the rating and fEMG data paint a complex picture of the sublime. Although our rating data support the philosophical notion that sublimity represents a fear-related aesthetic experience, there has been no fEMG evidence indicating that sublimity actually evokes fear and negative emotionality.

Yet closer inspection of the data reveals that the discrepancy between rating and physiological data is pronounced in other ways too. One such area is the difference in effect size between the two types of measures. In Study 2, the magnitude of correlation coefficient between fear and happiness ratings, $r = .72$, significantly differs to the effect size r of the relationship between fear rating and *zygomaticus major* (smiling; positive valence), $r = .31$ ($Z = 0.14$, $p = .01$). A similar observation can be made regarding the arousal data. Where both sublimity and fear ratings correlated positively with arousal, report of sublimity and fear both failed to be significantly associated with SCR activation, despite SCR's close association with arousal (e.g. Bradley et al., 2001).

One can construe the general reduction of effect size in physiological data compared to rating data as a consequence stemming from limitations and of rating as a method of capturing truly felt emotions and of the stimuli pool. Although some stimuli were rated relatively highly in evoking specific emotions compared to others, the actual emotional impact of those stimuli, represented through physiological activations, may not have been sufficiently strong. This may have been caused by the use of a distant 2D screen, where the sense of presence coming from the nature-related photographs may have been compromised. Furthermore, despite our efforts to create ecologically valid stimuli, the selected items may have inherently been short of emotional impact as desired. In turn, sublimity's link with physiological indicators of emotional negativity, fear, and arousal, though weakly present, may have been annulled.

Still, sublimity's lack of association with fear-related physiological responses is not an issue of effect size, as physiological activations linked to sublimity go in opposite directions to those of fear (this pattern of outcome is maintained even when sublimity is used as a sole predictor of the physiological reactions). How can something be seen as fearful, even though it fails to trigger physiological responses of fear? There are two conceptual ways to think about the paradox, although neither is entirely satisfactory in its own right.

The first option is "false appraisal". Ontologically, it is probable that physiological reactions precede explicit appraisals such as ratings (Palmer, Schloss, & Sammartino, 2013). A likely scenario, thus, is that although an individual felt something positive toward a sublime photograph, the intensity and perhaps novelty of the experience would have rendered the individual to falsely interpret the texture of experience as fear. Given Study 2's design where participants viewed each stimulus for 6 seconds – during which physiological responses were measured – before they appraised the stimulus, this interpretation seems chronologically fitting too.

However, the "false appraisal" view is limited by the crucial fact that the claim cannot be empirically demonstrated. In our work, all generalizations of physiological measures per item were made on the bases of ratings per item. This means that from an analytical perspective, it is impossible to derive any generalization of how physiological activations cause rating behavior. Ideally, we would have used a set of stimuli with them guaranteeing elicitations of specific emotions at early stages of perception, and analyzed how those stimuli would have caused alterations of specific aesthetic and emotional ratings later. Unfortunately, this was not within the scope of the current work.

The other interpretational possibility, then, is "distancing." Bullough (1912), in his notion of *psychical distance*, explains that the existential safety upon viewing a displeasing object is possible as soon as the viewer allows the object of aesthetic contemplation, or "to stand outside the context of [the viewer's] personal needs and end – in short, by looking at [the object] 'objectively'" (p. 89). Taking this logic to our scenario, although subjects acknowledged the threat and excitement associated with a sublime stimulus (e.g. erupting volcano), the subject also knew that he/she is located in a safe context of an experimental laboratory. If stimuli evoking danger are in no reach of actual harm, this may in turn reduce the amount of actually felt threat (deactivation of *corrugator supercilli*).

The advantage of this theory is its large following that continues to this day (e.g. Menninghaus et al., 2017; Pelowski et al., 2017), and the fact that the idea commonly underlies general theories of how unpleasant things can be enjoyed (e.g. Bullough, 1912). Yet two crucial problems emerge. On the one hand, the logic of the argument would suggest that anything unpleasant presented in psychological experiments should be translated into an aesthetic, somewhat pleasing (we can be assured those who regularly watch horror films, which are content-wise inherently shocking if not displeasing, would do so in exchange for some kind of delight), or less displeasing phenomenon. Clearly, this outcome does not

account for our results regarding the link between fear ratings and their positive correlations with fear-related physiological measures, nor does it support the consistent reports from lab studies that found a link between displeasing objects and increase of *corrugator supercilli* activations, for instance. On the other hand, even if it were true that participants distanced themselves from fear upon viewing a photograph considered sublime, why would they return to reporting fear afterward? Here, we seem to revert to the "false appraisal" hypothesis.

In sum, both "false appraisal" and "distancing", while they give important insights into the dissociation between rating and physiological responses, fall short in giving satisfactory conclusions. Recent psychological models of aesthetic processing, too, are insufficient in providing acute explanations, since most models assume congruence between physiological, emotional, and evaluative outcomes, at least within short timeframes of stimulus processing (e.g. Menninghaus et al., 2017; Pelowski et al., 2017). What is certain is that the aesthetic emotion of our enquiry, namely sublimity, despite its link with fear, acts differently to fear in terms of bodily reactions. Evidently, such view of the sublime would fit into Scherer's (2005) distinction between *utilitarian* and *aesthetic* emotions, the latter which is "not shaped by the appraisal of the work's ability to satisfy my bodily needs, further my current goals or plans, or correspond to my social values… [but instead] by the appreciation of the intrinsic qualities of the beauty of nature, or the qualities of a work of art or an artistic performance." (p. 706). Reactions of pure fear, which immediately activate physiological responses linked with fear, in contrast, would fit the mold of *utilitarian* emotions, which are linked with adaptive functions such as fight/flight tendencies and motivational enhancements.

One can assume that the reported fear associated with sublimity, if it can be called fear that is, is likely an aesthetic fear. In fact, despite Burke's (1759/2008) militant observation of fear-riddled sublimity, he, too, conceded of the possibility of the unique qualities of fear in sublimity, as he argued that the elements of threat and pain in sublimity

must be experienced “at certain distances, and with certain modifications” (p. 40). That certain modification, we tentatively suggest, roots from what is likely a mix of “false appraisal” and “distancing.”

Ultimately, we do not believe researchers were incorrect in their view of sublimity being emotionally positive, because that view would reflect our physiological data. Yet the picture of sublimity as a fear-driven aesthetic occasion, as was argued by the likes of Burke (1759/2008) is also no pure fantasy, given our rating data. At this point, we wonder if the emotional taxonomy of the sublime may depend on how and where one assesses the sublime as an experience. Should one concentrate on the purely verbal and evaluative elements of sublimity, it would not be surprising that one finds a positive association between sublimity and fear. Conversely, considering the visceral experiences of sublime encounters would encourage taking an alternative stance against this controversial claim.

Limitations and future directions

The findings offer new insight into the relationship between sublimity and fear. Nevertheless, the sublime remains a complex phenomenon (Hur & McManus, 2017), and warrants methodological expansion in future studies. Firstly, while we have detected discrepancies between what people verbally report and what people actually experience the latter represented through the fEMG data, we only measured three areas of the face. However, in reality aesthetic emotions are likely accommodated by a network of physiological and bodily reactions, some of them possibly more sensitive to the sublime than the areas presently measured. Recent studies, for example, by Suckfüll (2010), used a wide range of bodily and facial reactions – such as observing reactions in according to the Facial Action Coding System (Ekman, Friesen, & Hager, 2002) – to understand emotional processing of aesthetic stimuli. For a fuller understanding of the sublime and its emotional implications, a wider range of measurements, especially on how the sublime develops across

different areas of the body will provide useful insights. Secondly, while the stimuli used in the current work concerned nature, this was in large due to keeping with theories from notable texts of philosophy. Philosophers in the past often used nature in their descriptions of the sublime and beautiful (e.g. Burke, 1759/2008). However, as various sources show, the sublime can also be found in other forms, such as in architecture, human face perception, landscape design, music and painting (Monk, 1960), and even in mass media. As put by Palmer and colleagues (2013), "virtually everyone has some aesthetic response to virtually everything they see" (p.80). Future works on the sublime should thus attempt to address how the sublime can play a role in the everyday, and strive to find commonalities of the sublime among various media.

Conclusion

In philosophy, the sublime is often portrayed as being closely linked with the experience of fear. In the current work, the relationship between sublimity and fear was explored based on a number of behavioral and physiological measures. Although sublimity was highly correlated with fear in terms of behavioral evaluations, sublimity was not linked with the activation of measures related to fear. Furthermore, sublimity appeared to attenuate general negative emotional experiences. A couple of potential mechanisms can be identified, namely false appraisal and distancing, although both accounts fall short in ways of their own. As such, the relationship between sublimity and fearful is more complicated than not.

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Table 1a

Zero-order correlation matrix among rating variables of Study 1 (N=192 images)

	Beauty	Sublimity	Fear	Happiness	Arousal
Beauty (M=3.52, SD=.75)					
Sublimity (M=2.91, SD=.72)	.36***				
Fear (M=2.07, SD=.89)	-.59***	.38***			
Happiness (M=2.98, SD=.81)	.88***	.02	-.83***		
Arousal (M=2.86, SD=.45)	.14	.70***	.58***	-.11	

Note. * p <.05, ** p <.01, *** p <.001.

Table 1b

Zero-order correlation matrix among rating variables of Study 2 (N=72 images)

	Beauty	Sublimity	Fear	Happiness	Arousal
Beauty (M=3.22, SD=.85)					
Sublimity (M=2.99, SD=.95)	.31**				
Fear (M=2.07, SD=1.00)	-.53***	.51***			
Happiness (M=2.72, SD=.92)	.91***	.04	-.72***		
Arousal (M=2.97, SD=.71)	-.10	.70***	.77***	-.22	

Note. * p <.05, ** p <.01, *** p <.001.

Table 2

Example image content of image selection for Study 2

Category	Sublimity rating	Fear rating	Example content
HSHF	M=3.71, SD=.23	M=3.14, SD=.63	Cliff, volcano, lightning, storm, bear, shark, sea, clouds, forest fire, craggy mountain, etc.
HSLF	M=3.51, SD=.31	M=1.48, SD=.18	Night sky, sun, beach, lake, landscape, bright forest, etc.
LSHF	M=2.38, SD=.35	M=2.84, SD=.55	Spider, snake, fighting animals, animal carcass, cave, dark forest, etc.
LSLF	M=1.93, SD=.26	M=1.15, SD=.09	Fruit, small animal (rabbit, dog, kitten, monkey, bird, etc.), flower, butterfly, etc.

Table 3a

Summary statistics for all models

	*Corrugator supercilii****†††						*Zygomaticus major****†					
	df	*t*	β	SE	*r*	*p*	*df*	*t*	β	SE	*r*	*p*
Intercept	51.99	.07	-.008	.12	.01	.95	55.45	3.20	.34	.10	.39	<.001
Fear	24.13	2.90	.37	.13	.51	.01	62.86	2.58	-.14	.05	.31	.01
Sublimity	35.98	2.86	-.27	.10	.43	.01	140.96	.53	.02	.04	.05	.26
Fear × Sublimity	23.06	.88	-.07	.08	.18	.39	49.19	1.13	.05	.05	.16	.60

Note. Degrees of freedom (df) use Scatterwaite approximations. ***Random slopes and intercepts per subject do not add to the model at $p < .001$. ††† Random slopes and intercepts per item do not add to the model at $p < .001$. † Random slopes and intercepts per item do not add to the model at $p < .05$.

Table 3b

Summary statistics for all models (continued)

	*Medial frontalis****†††						*SCR*					
	df	*t*	β	SE	*r*	*p*	*df*	*t*	β	SE	*r*	*p*
Intercept	41.14	.93	-.03	.03	.14	.36	39.60	2.88	-7.60	2.63	.42	.01
Fear	30.82	2.29	.06	.03	.38	.03	41.41	.48	.78	1.62	.07	.63
Sublimity	28.17	.64	-.01	.03	.12	.64	34.96	.85	2.08	2.46	.14	.40

Fear × Sublimity	32.23	.82	.004	.02	.14	.82	56.78	1.44	-1.89	1.31	.19	.15

Note. Degrees of freedom (df) use Scatterwaite approximations. ***Random slopes and intercepts per subject do not add to the model at $p < .001$. ††† Random slopes and intercepts per item do not add to the model at $p < .001$. † Random slopes and intercepts per item do not add to the model at $p < .05$.