Exp Brain Res (2015) 233:3271–3281
DOI 10.1007/s00221-015-4395-5

RESEARCH ARTICLE

Subliminal presentation of emotionally negative vs positive primes increases the perceived beauty of target stimuli

Vanessa Era[1,2] · **Matteo Candidi**[1,2] · **Salvatore Maria Aglioti**[1,2]

Received: 7 March 2015 / Accepted: 22 July 2015 / Published online: 4 August 2015
© Springer-Verlag Berlin Heidelberg 2015

Abstract Emotions have a profound influence on aesthetic experiences. Studies using affective priming procedures demonstrate, for example, that inducing a conscious negative emotional state biases the perception of abstract stimuli towards the sublime (Eskine et al. Emotion 12:1071–1074, 2012. doi:10.1037/a0027200). Moreover, subliminal happy facial expressions have a positive impact on the aesthetic evaluation of abstract art (Flexas et al. PLoS ONE 8:e80154, 2013). Little is known about how emotion influences aesthetic perception of non-abstract, representational stimuli, especially those that are particularly relevant for social behaviour, like human bodies. Here, we explore whether the subliminal presentation of emotionally charged visual primes modulates the explicit subjective aesthetic judgment of body images. Using a forward/backward masking procedure, we presented subliminally positive and negative, arousal-matched, emotional or neutral primes and measured their effect on the explicit evaluation of perceived beauty (high vs low) and emotion (positive vs negative) evoked by abstract and body images. We found that negative primes increased subjective aesthetic evaluations of target bodies or abstract images in comparison with positive primes. No influence of primes on the emotional dimension of the targets was found, thus ruling out an unspecific arousal effect and strengthening the link between emotional valence and aesthetic appreciation. More specifically, that subliminal negative primes increase beauty ratings compared to subliminal positive primes indicates a clear link between negative emotions and positive aesthetic evaluations and vice versa, suggesting a possible link between negative emotion and the experience of sublime in art. The study expands previous research by showing the effect of subliminal negative emotions on the subjective aesthetic evaluation not only of abstract but also of body images.

Keywords Aesthetics · Body perception · Affective misattribution · Emotions

«Les plus désespérés sont les chants les plus beaux» Alfred de Musset (Allégorie du Pélican)
«The most desperate melodies are the most beautiful ones»

Introduction

The importance of the aesthetic experience for human beings becomes evident when thinking about the sense of pleasure that individuals feel towards what they find "beautiful". However, we may not only like beautiful images or melodies but also terrible and desperate ones. This apparent contradiction is a core aspect of what is referred to in the philosophical and experimental tradition as the difference between what we find beautiful and what we experience as sublime (Burke 1757; Ishizu and Zeki 2014). Philosophical

Electronic supplementary material The online version of this article (doi:10.1007/s00221-015-4395-5) contains supplementary material, which is available to authorized users.

Vanessa Era and Matteo Candidi are shared first author.

✉ Vanessa Era
vanessa.era@uniroma1.it

✉ Matteo Candidi
matteo.candidi@uniroma1.it

[1] Department of Psychology, "Sapienza" University of Rome, Rome, Italy

[2] IRCCS, Fondazione Santa Lucia, Rome, Italy

approaches to aesthetics have long disputed on the contribution of sensory, rational and emotional components to aesthetic experiences (Kant 1790/1987; Hume 1757; Baumgarten 1783). The concept of the sublime, where a terrible image turns out to be beautiful in the light of some active engagement of the perceiver (Burke 1757), captures the difficulty in establishing clear distinctions, or the interaction, between perceptual, cognitive and emotional reactions to a stimulus. Authors from philosophy of aesthetics have traditionally proposed (Burke 1757; Kant 1790/1986; Schopenhauer 1844) that beauty and sublime are different notions as they entertain a different relation with sensory processing and imagination (with beauty pertaining more to the sensory features of a stimulus and the sublime more to active processes implemented by an individual) as well as with emotions. For example according to Burke "While beauty came to be associated with feelings of pleasure, reward, and satisfaction, the sublime was associated with awe, fear and terror" because "whatever therefore is terrible, with regard to sight, is sublime too" (Burke 1757, 2: II). But, significantly, these feelings were read into scenes from a safe distance. The sublime was associated, above all, with the obscure and the uncertain, with "some sort of approach toward infinity" (Burke 1757, 2: IV). (Ishizu and Zeki 2014). Similarly, in more recent years, with the use of imaging methods it has been suggested that although beauty and the sublime might be correlated at an explicit level (Ishizu and Zeki 2014), the experience of the beauty and that of the sublime seem to partially dissociate in terms of their neural correlates (Ishizu and Zeki 2011, 2014).

It has already been suggested (Ishizu and Zeki 2014) that "*compelling the differences between the two experiences [i.e. beauty and sublime] may be at the extremes, there remain many experiences, of which the Pietà of Michelangelo at St Peter's Basilica is a supreme example, which are easy to characterize as both beautiful and sublime*".

Crucially indeed, although it is recognized that the field of neuroaesthetics needs to better describe the subjective and psychological terms of aesthetic appreciation and preference (Palmer et al. 2013; Chatterjee 2012; Aglioti et al. 2012), modern neuroscientific approaches have shown that the pleasure experienced by people looking at beautiful objects automatically taps into their emotion and reward neural circuitry (Lacey et al. 2011; Kuhn and Gallinat 2012) as reflected in changes in the activity of orbitofrontal and medial-frontal cortex, the ventral striatum, the anterior cingulate and the insula (Vartanian and Goel 2004; Jacobsen et al. 2005; Jacobs et al. 2012; Di Dio et al. 2007). The crucial role of these regions during the aesthetic experience supports the idea that the aesthetic judgment is influenced both by the emotional content of the object of appreciation and by the emotional state of the subject who is appreciating it.

Before reaching the higher-order regions where an evaluative reaction to perceived stimuli is coded, images are processed along the visual systems in parallel and hierarchical ways where their content triggers specific transformations that lead to their final evaluation. Importantly, such evaluations also depend on whether people perceive stimuli in an everyday context or with the specific aim to judge their aesthetics (Cupchik et al. 2009). As regards to the content of visual artworks, several studies highlighted a general tendency to prefer representative images such as landscapes and portraits over abstract images (Hekkert and van Wieringen 1996; Furnham and Walker 2001; Nadal et al. 2010; Pihko et al. 2011) and that this tendency is also modulated by dispositional traits and induced motivational states (Chirumbolo et al. 2014). Relevant to this advantage of representational images over abstract ones is that the visual system seems to maintain a regional selectivity dedicated to specific stimuli such as objects (lateral occipital complex, LOC; Malach et al. 1995), landscapes (parahippocampal place area, PPA; Epstein and Kanwisher 1998), faces (fusiform face area, FFA; Kanwisher et al. 1997) and bodies (extrastriate body area, EBA; Downing et al. 2001).

The activation of brain areas involved in the visual perception of a specific stimulus' content might have a preliminary role in influencing its aesthetic appreciation (Calvo-Merino et al. 2010). Among all possible stimuli, body images activate a dedicated sequence of regions of the occipito-temporal cortex (review Peelen and Downing 2005; Urgesi et al. 2004, 2006; Pitcher et al. 2009), which possibly reflect our familiarity with this type of visual stimulus as well as its importance in guiding our social behaviour and interactions. For these very same reasons, it is no surprise that artists have dealt with body image representation for centuries and across all cultures, being the body a major source of inspiration and also a fundamental object of aesthetic appreciation. Crucially, the occipito-temporal system dedicated to body images processing is connected to fronto-parietal regions that are involved in the transformation of visual information concerning body actions in their motor counterpart. Knowledge on the anatomical and functional relationship between the visual system and the motor system offers an important key to understand the mechanisms by which visual perception might be transformed into aesthetic perception of bodies and bodily stimuli (Chatterjee and Vartanian 2014 for a review). Based on the observation that dynamic stimuli elicit higher ratings of aesthetic appreciation (Cazzato et al. 2012; Calvo-Merino et al. 2008; Cross and Ticini 2012), it has been proposed that static stimuli with a high dynamic content might induce the simulation of a movement in the observer (Urgesi et al. 2006; Di Dio and Gallese 2009) and that this simulation plays a key role in enhancing the aesthetic evaluation of a work of art (not necessarily a body) through a mechanism of personal

involvement in the work itself (embodied Aesthetics theory, Freedberg and Gallese 2007; Umiltà et al. 2012; Massaro et al. 2012; Leder et al. 2012). This possibility is supported by neuroimaging studies showing the activation of different parietal foci when participants are engaged in the aesthetic appreciation of stimuli rated as beautiful versus ugly (Cela-Conde et al. 2009) and of ill-defined forms compared to well-defined forms (Cupchik et al. 2009).

Concerning the impact of perceived emotions on aesthetic experience, recent studies extended the notion of affective misattribution, i.e. when the affective reaction to a stimulus is projected over another one (Murphy and Zajonc 1993; Klauer and Musch 2003), to the case of abstract visual art appreciation (Eskine et al. 2012). Importantly, affective misattribution effects on abstract visual art were obtained also for emotional stimuli not perceived consciously (Flexas et al. 2013). Affective misattribution studies showed that the affective qualities implicitly triggered by a stimulus influence the subsequent pleasantness evaluation of ambiguous stimuli (e.g. Chinese ideographs). Tellingly, the effect is found even when the processing of the initial stimulus is irrelevant to the task, or occurs in the absence of awareness. However, no study has directly investigated the influence of induced emotions on the aesthetic evaluation of (representational) body stimuli.

Here, we expand previous research on aesthetic judgments of abstract artworks by investigating whether the subliminal presentation of emotionally charged images may modulate the conscious, aesthetic appreciation of body and abstract images. Since the sense of motion is a relevant dimension of aesthetic appreciations (Cazzato et al. 2012; Calvo-Merino et al. 2008; Cross and Ticini 2012), body and non-body stimuli with different degrees of dynamicity were used. Thus, the novel hypothesis tested in the present study is whether a subliminally presented stimulus which is associated with negative emotions (a key emotional component when experiencing the sublime) may trigger a shift in individuals' beauty evaluation, and vice versa, whether a positive prime might induce participants to experience a neutral image as less beautiful than what it was judged in other priming conditions. In other terms, we tested the possibility that subliminal primes might be able to "perturb" a perceiver and engage him in reacting to this emotional perturbation by modulating his aesthetic appreciation of a stimulus in an emotion-to-aesthetic direction-specific manner.

Materials and methods

Participants

Forty participants (16 males and 24 females) took part in the experiment (age 23.25 ± 2.5; years of education 16.98 ± 2.09). All participants reported normal or corrected-to-normal vision and were naive as to the purpose of the experiment. Participants gave their written informed consent to take part in the study, received a reimbursement for their participation and were debriefed on the purpose of the experiment at the end of the experimental procedure. Since it is known that expertise influences aesthetic evaluations and their emotional extent (Mulas et al. 2012; Leder et al. 2014), individuals with formal or informal expertise in visual arts (e.g. professional or amateur photographers, painters, sculptors) were excluded from the sample (four participants). More specifically, Leder et al. 2014 showed that experts tend to report a smaller explicit emotional reaction to art which is reflected also in less pronounced physiological responses as measured by the activity of a muscles involved in the expression of negative emotions (corrugator supercilii muscle), compared to individuals with no art experience. For this reason, we think that art experts and non-experts should be considered separately, especially when emotional reactions to aesthetic appreciation are directly implicated. Three participants were excluded as outlier in their responses in at least one of the considered dimensions (beauty and emotion's intensity/polarity) in the main analysis (see below, final sample 33 participants). Five participants were excluded as outlier on at least one considered dimension (beauty and emotion's intensity/polarity) in the follow-up analysis (see below, final sample 31 participants).

Stimuli

Twenty emotional pictures (10 positive and 10 negative) selected from the International Affective Picture System (IAPS; Lang et al. 1999) and showing a body image were used as primes. The positive and negative primes were matched according to their arousal value (arousal mean: positive = 5.66, negative = 5.88, $t = -.81$, $p = .43$) and were significantly different in terms of valence (valence mean: positive = 7.22, negative = 2.24, $t = 19.48$, $p < .001$). Moreover, we selected 10 emotional neutral pictures with the same criterion used for the positive and negative ones and used their scrambled versions as non-emotional control primes. (examples in Fig. 1c). Target stimuli were divided in two sets: Set1 and Set2, made up of 14 bodies (seven dynamic and seven static) and 14 abstract images (seven dynamic and seven static, half depicting males and half females) each (examples in Fig. 1a). During the body images selection, in order to avoid the activation of facial recognition and evaluation, pictures containing close views of faces were discarded; moreover, pictures depicting explicitly nude bodies were avoided to control for arousal. All stimuli were in grey scale, adjusted to the same resolution (72 pixels per inch), had a largest dimension of 11 cm, were presented at 63 cm distance

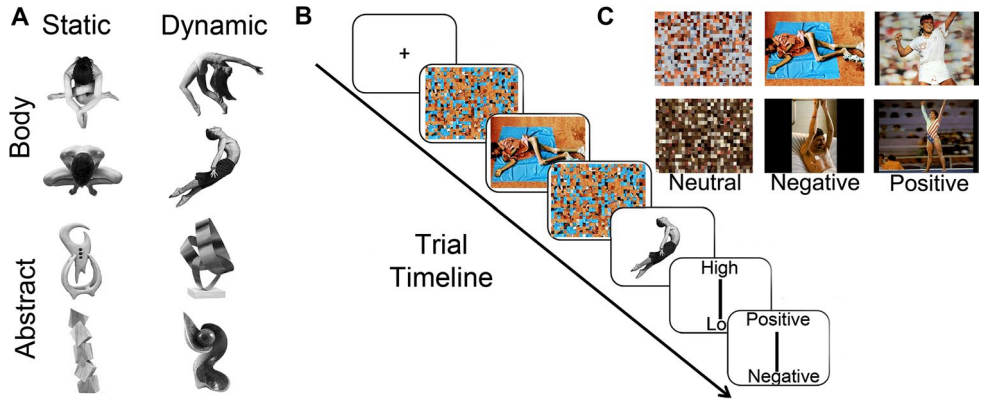

Fig. 1 Stimuli examples, Time Line of the experimental procedure and primes examples. **a** Stimuli examples. **b** Timeline of the experimental procedure: each trial started with a cue directing the attention to the centre of the screen (1000 ms), followed by a forward mask (scrambled version of the prime, 100 ms), the emotional prime (17 ms), a backward mask (100 ms), and then a target image for 1000 ms followed by the VAS, which lasted on the screen until a response was made. **c** Primes examples

to subtend 10° visual angles and were matched for brightness [means: abstracts = 229.21 luma (a weighted sum of linear RGB components) bodies = 229.39 luma, $t = .85$, $p = .40$], contrast (brightness standard deviation) of the entire image (white background plus figure; means: abstracts = 58.9 luma, bodies = 58 luma $t = -1.18$, $p = .24$), brightness (means: abstracts = 111.07 luma, bodies = 111.10 luma $t = .19$, $p = .84$) and contrast (means: abstracts = 50.96 luma, bodies = 49.50 luma $t = .39$, $p = .70$) of the figure alone.

Target stimuli were divided in dynamic and static thanks to a previous experiment in which we asked 19 participants to rate the dynamicity of the same stimuli presented in this experiment. The ANOVA on the subjective ratings (provided along a visual analogue scale ranging from 0 (lowest intensity) to 100 (highest intensity)) concerning the motion implied in each body and abstract image showed: a main effect of Target Content ($F(1,18) = 31.40$, $p < .001$), indicating that body stimuli were judged as more dynamic, compared to the abstract ones (64.05 vs 47.40 %). It also revealed a significant main effect of Target Dynamicity ($F(1, 18) = 73.67$, $p < .001$), indicating that the dynamic stimuli were judged as more dynamic than the static ones (67.16 vs 44.79 %). The ANOVA on the dynamicity judgment lastly indicated a significant Target Content × Target Dynamicity interaction ($F(1,18) = 35.07$, $p < .001$). Bonferroni post hoc tests showed that both the abstract and body dynamic stimuli significantly differed from the static ones ($p < .01$ and $p < .001$ respectively), being judged as more dynamic and that dynamic body stimuli were judged more dynamic compared to abstract dynamic stimuli ($p < .001$).

Procedure

Participants were asked to evaluate (1) the subjective beauty and (2) the intensity/polarity of the emotion evoked by the target stimuli in separated experimental blocks. The emotion task was included to control for a direct effect of the emotional primes on the emotional reaction to target images. Participants answered on a visual analogic scale (VAS), ranging from 0 to 100. Extremes corresponded to extremely beautiful/extremely ugly for the beauty judgment, and extremely positive/extremely negative for the emotional judgment. Each trial started with a cue directing the attention to the centre of the screen (resolution of 1024 × 768 pixels, 60 Hz refresh rate), where a fixation cross appeared (1000 ms) followed by a forward mask (scrambled version of the prime, 100 ms), the emotional prime (17 ms), a backward mask (100 ms, scrambled version of the prime) and then the target image for 1000 ms followed by the VAS, which lasted on the screen until a response was made (Fig. 1b). In order to offline control for the prime presentation time, we added a counter function in the presentation script, which measured the time for which the prime lasted on the screen in each trial. When prompted to evaluate the target images, participants were requested to follow their initial impression, without meditating their response for too long. They were also told that, just before the target, they would see coloured puzzles (scrambled images) and that they should ignore them, while focusing their attention where the cue appeared at the beginning of each trial (to keep their visual and attentional focus on the portion of the screen where the prime would have appeared).

In order to prevent fatigue of the participants, we divided the experiment in two sessions, separated by a few minutes break. Participants evaluated targets' Set1 in the first session and targets' Set2 in the second session. The order of the sessions was counterbalanced across subjects. Every session was made up of 336 trials (168 trials per beauty and per emotion judgment). There were 14 trials per condition

(2 Abstract/Body × 2 Dynamic/Static × 3 Neutral/Negative/Positive Prime), so that each target was presented two times per condition. More importantly, this way, each target was preceded two times by the three types of emotional primes. We organized the positive and negative primes in groups of 14 per condition, repeating four primes two times, so as to be arousal-matched.

As a control condition, at the end of the priming experiment, in order to test whether the primes were actually being presented subliminally, we included a recognition task in which the masked primes were presented using the same timing and procedure used in the priming experiment and participants were asked to report whether they saw anything between the two masks, and if so, to provide details on what they had seen. We note that this is a strong control condition as the attention of participants is now directed to the primes, contrary to the case of the main experiment, where their attention was diverted from the primes and focused on the targets. We considered as correctly recognized primes the trials in which the participants identified completely or in part the image contained in the prime. All trials with consciously perceived primes in this control task were excluded in the follow-up analysis of the data from the main experiment (see below). Stimuli presentation and randomization were controlled by E-Prime2 software (Psychology Software Tools Inc., Pittsburgh, PA).

Data handling

We considered as dependent variables the beauty and the emotion judgments. We merged the trials from the two sessions in a unique analysis (336 trials for dependent variable, 28 trials per condition). For each of the above-mentioned measures, we calculated the individual mean in each condition. These values were entered in a within-subject ANOVA (see below). Each value that fell 2.5 SDs above or below each individual mean for each experimental condition was excluded as outlier value (on average, 1.23 ± .94 % of total, namely 8.26 ± 6.29 trials). At the group level, participants with an individual mean of 2.5 SDs above or below the group mean were excluded from the analysis; three participants were outliers according to this criterion in the first analysis (final sample 33 participants) and five in the follow-up analysis (final sample 31 participants). Moreover, to ascertain a subliminal presentation, we excluded each trial in which the prime was presented for more than 34 ms (two monitor's refreshes, on average, .39 ± .84 % of total, namely 2.61 ± 5.63 trials). We selected 34 ms because of earlier studies demonstrating effective masking of stimuli with affective valence, presented with this duration. Effective visual masking has been shown with 33 ms using happy or fearful faces (Rauch et al. 2000; Whalen et al. 1998), drug and sexual stimuli (Childress et al. 2008), 30 ms with angry faces (Morris et al. 1998, 1999) and 20 ms for happy or sad faces (Killgore and Yurgelun-Todd 2001, 2004) or combat/non-combat stimuli (Hendler et al. 2003). At target durations of 40 ms, instead, some subjects begin to visually recognize the targets fearful or happy faces (Sheline et al. 2001), combat/non-combat stimuli (Hendler et al. 2003) at levels above chance.

Beauty and emotion ratings were entered in separate analyses of variance (ANOVA) with Target Content (Body/Abstract) × Target Dynamicity (Dynamic/Static) × Prime Emotion (Neural/Negative/Positive) as within-subject factor. All tests of significance were based upon an α level of .05. When appropriate, post hoc tests were performed using the Bonferroni method.

Results

Beauty judgment

The ANOVA on *beauty* judgment showed a significant main effect of Prime Emotion ($F(2,64) = 3.62$, $p = .032$, $\eta p^2 = .10$). Bonferroni post hoc tests indicated a significant difference between positive and negative primed aesthetic judgment ($p = .028$), with higher beauty ratings for the negative prime condition, compared to the positive one (56.83 vs 56.13 %). The ANOVA on *beauty* judgment also showed a significant main effect of Target Content ($F(1,32) = 18.7$, $p < .001$, $\eta p^2 = .37$), indicating that the body stimuli were judged as more beautiful, compared to the abstract ones (61.02 vs 51.92 %). It also revealed a significant main effect of Target Dynamicity ($F(1,32) = 26.1$, $p < .001$, $\eta p^2 = .45$), indicating that the dynamic stimuli (60.11 vs 52.83 %) were aesthetically more appreciated, compared to the static ones. Moreover, the ANOVA showed a significant Target Content × Target Dynamicity interaction ($F(1,32) = 7.81$, $p = .009$, $\eta p^2 = .20$). Bonferroni post hoc tests indicated a significant difference between the dynamic abstracts and dynamic bodies judgment, with higher ratings for the dynamic bodies compared to the abstract images ($p < .001$); a significant difference between the dynamic and static bodies, with higher ratings for the dynamic bodies compared to the static ones ($p < .001$) and a significant difference between the dynamic and static abstracts indicating that the dynamic abstracts were judged as more beautiful, compared to the static ones ($p = .016$). No other main effect or interaction reached statistical significance (all $ps > .67$; Table 1).

Emotional judgment

Conversely to what was found on the beauty judgement, the Prime Emotion did not reach statistical significance as main

Table 1 All the results of the ANOVA on beauty and emotional judgment in the main analysis

Effect	*F*	df	*P*	η^2
Beauty judgment				
Main effect of Target Content	18.69	1.32	<.001	.369
Main effect of Target Dynamicity	26.1	1.32	<.001	.449
Main effect of Prime Emotion	**3.62**	**2.64**	**.032**	**.102**
Interaction Target Content × Target Dynamicity	7.81	1.32	.009	.196
Interaction Target Content × Prime Emotion	.25	2.64	.783	.008
Interaction Target Dynamicity × Prime Emotion	.35	2.64	.705	.011
Interaction Target Content × Target Dynamicity × Prime Emotion	.41	2.64	.669	.012
Emotional judgment				
Main effect of Target Content	11.65	1.32	.002	.267
Main effect of Target Dynamicity	29.97	1.32	<.001	.484
Main effect of Type of Prime Emotion	.84	2.64	.437	.026
Interaction Target Content × Target Dynamicity	15.44	1.32	<.001	.325
Interaction Target Content × Prime Emotion	.27	2.64	.766	.008
Interaction Target Dynamicity × Prime Emotion	.44	2.64	.645	.014
Interaction Target Content × Target Dynamicity × Prime Emotion	.53	2.64	.592	.016

Bold indicates the most relevant result from the present study

Only in the beauty analysis, the main effect of Prime Emotion turns out to be statistically significant

effect on the emotional judgment ($F(2,64) = .84$, $p = .44$). The ANOVA on *emotional* judgment showed a significant main effect of Target Content ($F(1,32) = 11.65$, $p = .002$, $\eta p^2 = .27$), indicating that body stimuli were judged as more positively emotional, compared to abstract ones (57.67 vs 51.88 %). It also revealed a significant main effect of Target Dynamicity ($F(1,32) = 29.97$, $p < .001$, $\eta p^2 = .48$), indicating that the dynamic stimuli were judged as more positively emotional than the static ones (59.17 vs 50.38 %). As for the beauty judgment, the ANOVA on *emotional* judgment indicated a significant Target Content × Target Dynamicity interaction ($F(1,32) = 15.44$, $p < .001$, $\eta p^2 = .33$). Bonferroni post hoc tests indicated a significant difference between the dynamic abstracts and dynamic bodies judgment, with higher ratings for the dynamic bodies compared to the abstract images ($p < .001$) and a significant difference between the dynamic and static bodies, with higher rating for the dynamic bodies compared to the static ones ($p < .001$). No other main effect or interaction reached statistical significance (all $ps > .59$; Table 1).

Control task and exclusion of recognized primes

In order to control whether the above effects might be due to conscious perception of some prime images, we performed a control task and run the same analyses on beauty and emotion ratings after having excluded trials preceded by a prime that might have been consciously perceived by each participants. Importantly, in order to have the strongest control possible over conscious perception, during the recognition task, participants were explicitly asked to pay attention to the presentation of the prime image between the two masks (unlike in the main task). We analysed the recognition task by collecting the number of trials in which the subjects correctly recognized the entire image of the prime, or only a part of it (on average, 12.74 ± 9.99 % of total, namely 2.55 ± 2 trials). To control for the subliminal perception of the prime, we considered the raw data of the two dependent variables again and we excluded from each subject mean the trials in which a prime that was recognized in the control task had appeared (on average, 8.73 ± 6.70 % of total, namely 58.65 ± 45.05 trials). In other words, we considered only the trials in which we are reasonably sure the prime remained perceptually subliminal at an individual level. Once we had deleted these trials, we calculated the individual mean in each condition and, as we did for the previous analyses, we excluded: (i) each value that fell 2.5 SDs above or below each individual mean for each experimental condition; (ii) each trial in which the prime was presented for more than 34 ms and; (iii) at the group level, participants with an individual mean 2.5 SDs above or below the group mean (five participants excluded). These values were entered in two separate within-subject ANOVAs, one for the beauty and the other for emotion rating conditions.

Beauty judgment

The main effect of Prime Emotion remained significant in this analysis ($F(2,60) = 4.58$, $p = .014$, $\eta p^2 = .13$). Bonferroni post hoc tests showed a significant difference between positive and negative primed aesthetic liking

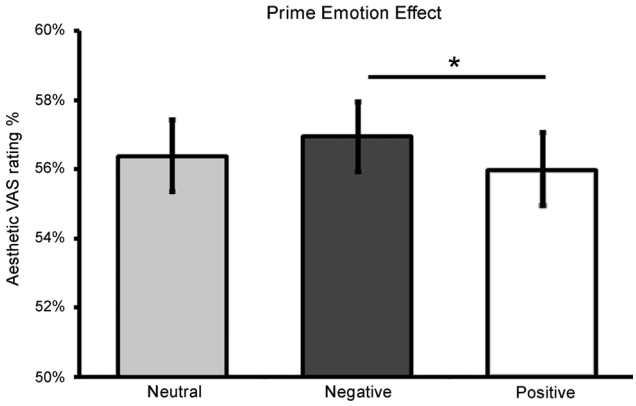

Fig. 2 Graph showing the main effect of the emotional prime on the aesthetic judgement. This graph reports the mean of the aesthetic judgment derived from the significant main effect of the Type of Prime ($F(2,60) = 4.58$, $p = .014$, $\eta p^2 = .13$) (considering only the actually subliminal perceived primes). Bonferroni post hoc tests showed a significant difference between positive and negative primed aesthetic liking ($p = .011$). *Error bars* show s.e.m

($p = .011$) with higher means for the negative prime condition, compared to the positive one (56.95 vs 55.98 %) (Fig. 2). The ANOVA on *beauty* judgment confirmed the significant main effect of Target Content ($F(1,30) = 16.37$, $p < .001$, $\eta p^2 = .35$) with body stimuli rated as more beautiful than abstract ones (60.42 vs 52.45 %). Also the main effect of Target Dynamicity resulted to be significant ($F(1,30) = 25.22$, $p < .001$, $\eta p^2 = .46$) with dynamic stimuli rated as more beautiful than static ones (59.83 vs 53.04 %). The stimulus Content and Dynamicity interacted significantly between them ($F(1,30) = 7.4$, $p = .01$, $\eta p^2 = .2$), and Bonferroni post hoc tests showed that dynamic bodies were judged as more beautiful than all other stimuli (all $ps < .001$). No other main effect or interaction reached statistical significance (all $ps > .73$; Table 2)

Emotional judgment

As for the analysis on the entire data set, the ANOVA on *emotional* judgment did not show a significant main effect of the Prime Emotion ($F(2,60) = .48$ $p = .62$). This ANOVA showed a significant main effect of Target Content ($F(1,30) = 9.33$, $p = .005$, $\eta p^2 = .24$) with body stimuli rated as more beautiful than abstract ones (57.32 vs 51.70 %). Moreover, the main effect of stimulus Dynamicity resulted significant ($F(1,30) = 25.95$, $p < .001$ $\eta p^2 = .46$) with dynamic stimuli rated as more positive than negative ones (58.43 vs 50.60 %). The interaction between Stimulus Content and Dynamicity reached statistical significance ($F(1,30) = 13.71$, $p < .001$, $\eta p^2 = .31$) with dynamic bodies being judged as evoking more positive emotions than all other conditions (all $ps < .001$). No other main effect or interaction reached statistical significance (all $ps > .72$; Table 2).

Discussion

We explored whether the emotional (negative or positive) valence of a subliminal stimulus might change the subjective aesthetic evaluation of subsequent probe images. More specifically, we tested whether subliminal emotionally

Table 2 All the results of the ANOVA on beauty and emotional judgment in the follow-up analysis

Effect	*F*	df	*P*	η^2
Beauty judgment				
Main effect of Target Content	16.37	1.30	<.001	.353
Main effect of Target Dynamicity	25.22	1.30	<.001	.457
Main effect of Prime Emotion	**4.58**	**2.60**	**.014**	**.132**
Interaction Target Content × Target Dynamicity	7.4	1.30	.01	.198
Interaction Target Content × Prime Emotion	.19	2.60	.83	.006
Interaction Target Dynamicity × Prime Emotion	.10	2.60	.903	.003
Interaction Target Content × Target Dynamicity × Prime Emotion	.32	2.60	.73	.01
Emotional judgment				
Main effect of Target Content	9.33	1.30	.005	.237
Main effect of Target Dynamicity	25.95	1.30	<.001	.464
Main effect of Prime Emotion	.48	2.60	.622	.016
Interaction Target Content × Target Dynamicity	13.71	1.30	<.001	.314
Interaction Target Content × Prime Emotion	.23	2.60	.795	.008
Interaction Target Dynamicity × Prime Emotion	.15	2.60	.859	.005
Interaction Target Content × Target Dynamicity × Prime Emotion	.33	2.60	.724	.01

Bold indicates the most relevant result from the present study

Only in the beauty analysis, the main effect of Prime Emotion turns out to be statistically significant

charged body primes, which are known to activate a dedicated neural network where the amygdalae and occipito-temporal regions are important nodes (Candidi et al. 2011, 2015; Candidi and Aglioti 2015), may mediate the aesthetic judgments of body and abstract-content stimuli. Based on the notion that the implied dynamicity of a stimulus may influence its aesthetic evaluation, we used stimuli rated as high and low in implied motion. Moreover, not only we asked participants to rate the probes' beauty, but also to rate the intensity and polarity of the emotion elicited by them. This allowed us to control whether any effect of the emotional priming was specific for the aesthetic, and absent for the emotional, evaluation of the stimuli. The main finding is that the emotional valence of the prime influenced the subjective aesthetic evaluation of target images both when these represented body images as well as abstract-content stimuli. Confirming previous evidence, the results showed significantly higher beauty and more positive emotional ratings for stimuli (either representational or not) perceived as dynamic, compared to static ones. Furthermore, concerning to the degree of the figurative expressiveness of the target stimuli, our results showed higher beauty ratings for images depicting bodies, compared to abstract-content ones. These findings are in line with previous studies showing a tendency to prefer representative images over abstract ones (Hekkert and van Wieringen 1996; Pihko et al. 2011). The present results also confirm that dynamic body stimuli are considered as more beautiful and positively emotional than both static bodies and dynamic abstract stimuli. Although body and abstract stimuli differ in many dimensions and their plain comparison is impossible, once low-level visual features of the two kinds of stimuli are matched, the present pattern of results may suggest that a combination of the form of the stimuli and the motion they imply plays a role in their aesthetic evaluation. In keeping with embodied aesthetics theories (Freedberg and Gallese 2007), this last evidence suggests that, while the possibility to simulate body related movements may increase the aesthetic judgment of both body and abstract stimuli, still dynamic body images' appreciation might increase more strongly than that of abstract ones since the latter triggers less direct forms of sensorimotor simulation (i.e. the simulation of the movements of the artist during the creation of the art piece).

Emotional roots of aesthetics

Previous studies investigating the influence of induced emotions on art appreciation have used abstract artworks as targets (Flexas et al. 2013; Eskine et al. 2012) possibly because their ambiguity make their evaluation less stable and easy to remember, leaving more variability susceptible to be biased by the emotional modulation. It is worth noting that changes in the aesthetic judgment of body images may be difficult to modulate since (i) the well-delineated features of the stimulus, (ii) the dedicated and widespread occipito-temporal-parietal-premotor neural network that represents them, (iii) the tendency to associate this kind of stimuli with situations we meet in our daily life, might induce people to have a more stable aesthetic judgment concerning these stimuli. For these reasons, we suggest that the effect we found might reflect an interaction between the emotions induced by the prime in the participants and the evaluation of the target itself, more than a mere projection of an affective reaction to a stimulus (prime) over another one (target) as in the classical misattribution procedure. However, in our daily life, we evaluate a series of non-abstract, representational stimuli among which the body is particularly relevant for socio-emotional behaviour. From an ontological point of view, the body represents a stimulus towards which we are used to make aesthetic evaluations since our birth. The biological importance of the perception (and also the aesthetic evaluation) of other people's body is possibly reflected in the development of a diffused brain network involved in the representation of different features of the observed body such as its form and motion, including occipito-temporal, parietal, premotor, motor and subcortical regions (Berlucchi and Aglioti 2010).

Our results revealed that, by presenting a negative and a positive emotional image it was possible to influence in opposite directions the following subjective aesthetic evaluation not only of abstract images, but also of images depicting bodies. Importantly, these results held true for subliminally presented primes. More specifically, the unconscious perception of negative emotional primes significantly increased subjects' subsequent beauty evaluation, compared to the unconscious perception of positive emotional primes, while the perception of neutral primes left the aesthetic judgement between the judgment following the presentation of positive and the negative ones. Importantly, the influence of the negative/positive primes over the aesthetic evaluation of the target images did not extend to their emotional evaluation, thus indicating that the modulation did not reflect a mere emotional activation or that the affective misattribution effect did not impact "merely" an emotional dimension. Finding a rebound from negative emotions to positive aesthetic evaluations and vice versa is in line with, and expands, evidence from a previous study in which participants evaluated abstract artworks in a significantly more positive way after having watched scaring videos compared to happy ones (Eskine et al. 2012). This emotional-to-aesthetic "rebound effect" might reflect a mechanism in which the attempt to inhibit a specific emotion leads to enhancement of the emotion itself (Gross 1998; Gross and Levenson 1997; Gross and John 2003). However, different explanations may account for such a contrast effect (Kobylińska and Karwowska 2014). In

this study, we show how an induced emotion leads to an aesthetic evaluation with a valence that is opposed to the emotion itself (from negative emotions to positive aesthetic evaluations). Crucially, in a previous study Kobylińska (2001), by using a subliminal affective prime procedure, showed the existence of two types of influences elicited by a subliminal prime presentation on the consecutive subjective judgments: the "assimilation effect", in which the direction of the evaluation is congruent to the direction of the unconscious affective prime and the "contrast effect", in which the direction of the evaluation is opposite to the direction of the unconscious affective prime. Studies show a contrast effect for extremely salient primes (Glaser and Banaji 1999; Vianello et al. 2009; Herr et al. 1983) compared to primes with intermediate salience that resulted instead in an assimilation effect. In particular, Kobylińska (2001), Kobylinska and Karwowska (2007) used different prime durations in order to manipulate their salience. They reported an assimilation effect for prime presentation of 4 ms, while they reported a contrast effect for 16 ms of prime presentation. However, while the duration of our prime stimuli is in keeping with the above interpretation, there is also evidence that assimilation effects may occur with 17 ms and longer priming exposition (Flexas et al. 2013; Hermans et al. 2001; Wong and Root 2003; Rotteveel et al. 2001).

Another interpretation of the contrast effect is that it might be mediated by interactions between affect and cognition (Kobylińska and Karwowska 2007, 2014). A study by Goldlewska and Ohme (2001), for example, showed that the effect of the influence of implicit information differs according to the level of complexity of the judgment that people were asked to make. More specifically, these authors found an assimilation effect for simple judgments (preference ratings) and a contrast effect for judgment requiring more cognitive engagement (concept represented). Our finding of a rebound effect only for the aesthetic judgment might be explained by the fact that aesthetic experience stems from an initial sensory encoding of a stimulus (Kawabata and Zeki 2004; Leder et al. 2004), but arise only after its explicit elaboration, linked to the evaluation of the characteristics of the work as its content, its expressive style, and its meaning, involving diffuse brain regions classically associated with higher-level cognitive functions (Vartanian and Goel 2004; Lacey et al. 2011). This effect can easily be recognized in our personal experience with art appreciation. For example, looking at the painting "Atala au tombeau" by Girodet de Roussy–Trioson, we might experience a rebound effect, namely we begin by experiencing negative feelings and end with positive judgment. In this regard, the observer's attention is caught by the extremely deep strength of painful feelings deriving from the image of death (negative emotion), but at the same time these negative feelings turn into a perception of great beauty (positive judgment). Indeed, Burke already hypothesized that our sense of sublime depends on negative emotions, which paradoxically enhance our appreciation: in his words "whatever therefore is terrible, with regard to sight, is sublime too" (Burke 1757). We suggest that the emotional prime effect we found might be linked to the experience of the sublime because, although the emotional primes were presented subliminally, the pattern of results shows a direction-specific effect of emotions on aesthetic judgment. More specifically, we show that when participants were induced with a negative emotional state, this state "perturbed" them and affected their evaluation of the target image, thus making participants "emotionally engaged" with their perception. Furthermore, the subliminal primes were able to "perturb" the perceiver and engage him in reacting to this perturbation in an emotion-to-aesthetics direction-specific manner. This engagement resulted in making them judge the target images as more beautiful after a negative prime, just like what happens during the experience of the sublime in art, where an artwork that elicits negative feelings (a terrible image) is paradoxically perceived as beautiful. Notably, we also found that the opposite effect is true: subliminally priming in a positive way a target image (either abstract or bodily) results in a decrease in its rated beauty with respect to when it is preceded by a subliminal negative prime. Thus, as suggested elsewhere (Schopenhauer 1844; Ishizu and Zeki 2014), we assume that the sublime might be thought of as a continuum, not an on–off condition, which is subjected to opposing forces by positive and negative emotions. This evidence suggests that the relation between emotions and aesthetics is even more specific than previously thought. Indeed, previous studies using similar paradigms to the one used in the present research found an aesthetic modulation after the presentation of negative material (scaring videos) only (Eskine et al. 2012).

In conclusion, this study deepens our knowledge about the influences of emotions and the emergence of an aesthetic experience. We found a clear link between implicit emotions and aesthetic evaluation which is in line with previous research on abstract work. Tellingly, we extend the notion of the passage from implicit agony to explicit ecstasy by showing that the effect of negative emotions over the aesthetic evaluation can be found not only using abstract stimuli but also representational body images and that also an opposite modulation can be observed where positive emotions lead to negative aesthetic evaluations.

Acknowledgments We wish to thank Marco Gandolfo for participants recruitment. SMA is funded by the EU Information and Communication Technologies Grant FP7-ICT-2009-5 (VERE project [257695]) and the Italian Ministry of Health (Grant RC11.G and RF-2010-2312912). MC is funded by Sapienza University, Rome, (C26A13ZJN4).

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The experimental protocol was approved by the ethics committee of the Fondazione Santa Lucia and was carried out in accordance with the ethical standards of the 1964 Declaration of Helsinki and its later amendments.

Informed consent Informed consent was obtained from all individual participants included in the study.

References

Aglioti SM, Minio-Paluello I, Candidi M (2012) The beauty of the body. Rendiconti Lincei 23:281–288. doi:10.1007/s12210-012-0169-1

Baumgarten AG (1783) Metaphysik (translated into English by Meier GM, with notes by Eberhard JA), 2nd edn. Frommann-Holzboog, Stuttgart

Berlucchi G, Aglioti SM (2010) The body in the brain revisited. Exp Brain Res 200:25–35. doi:10.1007/s00221-009-1970-7

Burke E (1757) A philosophical enquiry into the origin of our ideas of the sublime and beautiful. R and J Dodsley, London

Calvo-Merino B, Jola C, Glaser DE, Haggard P (2008) Towards a sensorimotor aesthetics of performing art. Conscious Cogn 17:911–922. doi:10.1016/j.concog.2007.11.003

Calvo-Merino B, Urgesi C, Orgs G, Aglioti SM, Haggard P (2010) Extrastriate body area underlies aesthetic evaluation of body stimuli. Exp Brain Res 204:447–456. doi:10.1007/s00221-010-2283-6

Candidi M, Aglioti SM (2015) Visual and sensorimotor contributions to the esthetic appraisal of body form, motion, and emotion. Eur Psychol 20:16–26. doi:10.1027/1016-9040/a000221

Candidi M, Stienen BM, Aglioti SM, de Gelder B (2011) Event-related repetitive transcranial magnetic stimulation of posterior superior temporal sulcus improves the detection of threatening postural changes in human bodies. J Neurosci 31:17547–17554. doi:10.1523/JNEUROSCI.0697-11.2011

Candidi M, Stienen BM, Aglioti SM, de Gelder B (2015) Virtual lesion of right posterior superior temporal sulcus modulates conscious visual perception of fearful expressions in faces and bodies. Cortex. doi:10.1016/j.cortex.2015.01.012

Cazzato V, Siega S, Urgesi C (2012) "What women like": influence of motion and form on esthetic body perception. Front Psychol 3:235. doi:10.3389/fpsyg.2012.00235

Cela-Conde CJ, Ayala FJ, Munar E, Maestú F, Nadal M et al (2009) Sex-related similarities and differences in the neural correlates of beauty. Proc Natl Acad Sci USA 106:3847–3852. doi:10.1073/pnas.0900304106

Chatterjee A (2012) Neuroaesthetics: growing pains of a new discipline. In: Shimamura AP, Palmer SE (eds) Aesthetic science: connecting minds, brains, and experience. Oxford University Press, New York, pp 299–317

Chatterjee A, Vartanian O (2014) Neuroaesthetics. Trends Cognit Sci 18:370–375

Childress AR, Ehrman RN, Wang Z, Li Y, Sciortino N et al (2008) Prelude to passion: limbic activation by "unseen" drug and sexual cues. PLoS ONE 3:e1506. doi:10.1371/journal.pone.0001506

Chirumbolo A, Brizi A, Mastandrea S, Mannetti L (2014) Beauty is no quality in things themselves': epistemic motivation affects implicit preferences for art. PLoS ONE 9:e110323. doi:10.1371/journal.pone.0110323

Cross ES, Ticini LF (2012) Neuroaesthetics and beyond: new horizons in applying the science of the brain to the art of dance. Phenom Cogn Sci 11:5–16. doi:10.1007/s11097-010-9190-y

Cupchik GC, Vartanian O, Crawley A, Mikulis DJ (2009) Viewing artworks: contributions of cognitive control and perceptual facilitation to aesthetic experience. Brain Cogn 70:84–91. doi:10.1016/j.bandc.2009.01.003

Di Dio C, Gallese V (2009) Neuroaesthetics: a review. Curr Opin Neurobiol 19:682–687. doi:10.1016/j.conb.2009.09.001

Di Dio C, Macaluso E, Rizzolatti G (2007) The golden beauty: brain response to classical and renaissance sculptures. PLoS ONE 2:e1201. doi:10.1371/journal.pone.0001201

Downing PE, Jiang Y, Shuman M, Kanwisher N (2001) A cortical area selective for visual processing of the human body. Science 293:2470–2473. doi:10.1126/science.1063414

Epstein R, Kanwisher N (1998) A cortical representation of the local visual environment. Nature 392:598–601. doi:10.1038/33402

Eskine KJ, Kacinik NA, Prinz JJ (2012) Stirring images: fear, not happiness or arousal, makes art more sublime. Emotion 12:1071–1074. doi:10.1037/a0027200

Flexas A, Rosselló J, Christensen JF, Nadal M, Olivera La Rosa A et al (2013) Affective priming using facial expressions modulates liking for abstract art. PLoS ONE 8:e80154. doi:10.1371/journal.pone.0080154

Freedberg D, Gallese V (2007) Motion, emotion and empathy in esthetic experience. Trends Cognit Sci 11:197–203. doi:10.1016/j.tics.2007.02.003

Furnham A, Walker J (2001) The influence of personality traits, previous experience of art, and demographic variables on artistic preference. Personal Individ Differ 31:997–1017. doi:10.1016/S0191-8869(00)00202-6

Glaser J, Banaji MR (1999) When fair is foul and foul is fair: reverse priming in automatic evaluation. J Pers Soc Psychol 77:669–686. doi:10.1037/0022-3514.77.4.669

Godlewska M, Ohme RK (2001) Efekt kontrastu w paradygmacie afektywnego poprzedzania. Stud Psychol 39:61–79

Gross JJ (1998) Antecedent- and response-focused emotion regulation: divergent consequences for experience, expression, and physiology. J Pers Soc Psychol 74:224–237. doi:10.1037/0022-3514.74.1.224

Gross JJ, John OP (2003) Individual differences in two emotion regulation processes: implications for affect, relationships, and well-being. J Pers Soc Psychol 85:348–362. doi:10.1037/0022-3514.85.2.348

Gross JJ, Levenson RW (1997) Hiding feelings: the acute effects of inhibiting negative and positive emotion. J Abnorm Psychol 106:95–103. doi:10.1037/0021-843X.106.1.95

Hekkert P, van Wieringen PCW (1996) The impact of level of expertise on the evaluation of original and altered versions of post-impressionistic paintings. Acta Psychol 94:117–131. doi:10.1016/0001-6918(95)00055-0

Hendler T, Rotshtein P, Yeshurun Y, Weizmann T, Kahn I et al (2003) Sensing the invisible: differential sensitivity of visual cortex and amygdala to traumatic context. Neuroimage 19:587–600. doi:10.1016/S1053-8119(03)00141-1

Hermans D, De Houwer J, Eelen P (2001) A time course analysis of the affective priming effect. Cogn Emot 15:143–165. doi:10.1080/02699930125768

Herr PM, Sherman SJ, Fazio RH (1983) On the consequences of priming: assimilation and contrast effects. J Exp Soc Psychol 19:323–340. doi:10.1016/0022-1031(83)90026-4

Hume D (1757) Four dissertations. A Millar, London

Ishizu T, Zeki S (2011) Toward a brain-based theory of beauty. PLoS ONE 6:e21852. doi:10.1371/journal.pone.0021852

Ishizu T, Zeki S (2014) A neurobiological enquiry into the origins of our experience of the sublime and beautiful. Front Hum Neurosci 8:891. doi:10.3389/fnhum.2014.00891

Jacobs RHAH, Renken R, Cornelissen FW (2012) Neural correlates of visual aesthetics—beauty as the coalescence of stimulus and internal state. PLoS ONE 7:e31248. doi:10.1371/journal.pone.0031248

Jacobsen T, Schubotz RI, Hofel L, Cramon DYV (2005) Brain correlates of aesthetic judgments of beauty. Neuroimage 29:276–285. doi:10.1016/j.neuroimage.2005.07.010

Kant I (1790/1987) Kritik der Urteilskraft (translated into English by Pluhar WS as Critique of judgment). Hacket Publishing Co, Indianapolis

Kanwisher N, McDermott J, Chun MM (1997) The fusiform face area: a module in human extrastriate cortex specialized for face perception. J Neurosci 17:4302–4311

Kawabata H, Zeki S (2004) Neural correlates of beauty. J Neurophysiol 91:1699–1705. doi:10.1152/jn.00696.2003

Killgore WD, Yurgelun-Todd DA (2001) Sex differences in amygdala activation during the perception of facial affect. NeuroReport 12:2543–2547. doi:10.1097/00001756-200108080-00050

Killgore WD, Yurgelun-Todd DA (2004) Activation of the amygdala and anterior cingulate during nonconscious processing of sad versus happy faces. Neuroimage 21:1215–1223. doi:10.1016/j.neuroimage.2003.12.033

Klauer KC, Musch J (2003) Affective priming: findings and theories. In: Musch J, Klauer KC (eds) The psychology of evaluation: affective processes in cognition and emotion. Erlbaum, Malwah, pp 7–49

Kobylińska D (2001) Czas ekspozycji utajonych afektywnych bodz´ców poprzedzaja¸cych a efekt asymilacji lub kontrastu w ocenianiu bod´zca docelowego. In: Jarymowicz M (ed) Pomi¸edzy afektem a intelektem—poszukiwania empiryczne. Wydawnictwo IP. PAN, Warszawa, pp 73–81

Kobylinska D, Karwowska D (2007) The influence of lateral implicit visual affective stimuli on the evaluation of neutral stimuli in humans. Acta Neurobiol Exp 67:93–102

Kobylińska D, Karwowska D (2014) Exploring the effects of suboptimal affective priming: enhancement and minimization. Front Psychol 5:499. doi:10.3389/fpsyg.2014.00499

Kuhn S, Gallinat J (2012) The neural correlates of subjective pleasantness. Neuroimage 61:289–294. doi:10.1016/j.neuroimage.2012.02.065

Lacey S, Hagtvedt H, Patrick VM, Anderson A, Stilla R et al (2011) Art for reward's sake: visual art recruits the ventral striatum. Neuroimage 55:420–433

Lang PJ, Bradley MM, Cuthbert BN (1999) The international affective pictures system (IAPS): technical manual and affective ratings. University of Florida, Gainsville

Leder H, Belke B, Oeberst A, Augustin D (2004) A model of aesthetic appreciation and aesthetic judgments. Br J Psychol 95:489–508. doi:10.1348/0007126042369811

Leder H, Bär S, Topolinski S (2012) Covert painting simulations influence aesthetic appreciation of artworks. Psychol Sci 23:1479–1481. doi:10.1177/0956797612452866

Leder H, Gerger G, Brieber D, Schwarz N (2014) What makes an art expert? Emotion and evaluation in art appreciation. Cogn Emot 28:1137–1147. doi:10.1080/02699931.2013.870132

Malach R, Reppas JB, Benson RR, Kwong KK, Jiang H et al (1995) Object-related activity revealed by functional magnetic resonance imaging in human occipital cortex. Proc Natl Acad Sci USA 29:8135–8139

Massaro D, Savazzi F, Di Dio C, Freedberg D, Gallese V et al (2012) When art moves the eyes: a behavioral and eye-tracking study. PLoS ONE 7:e37285. doi:10.1371/journal.pone.0037285

Morris JS, Ohman A, Dolan RJ (1998) Conscious and unconscious emotional learning in the human amygdala. Nature 393:467–470. doi:10.1038/30976

Morris JS, Ohman A, Dolan RJ (1999) A subcortical pathway to the right amygdala mediating "unseen" fear. Proc Natl Acad Sci USA 96:1680–1685

Mulas V, Troffa R, Caddeo P (2012) Differences between experts and non-experts in photographic perception and assessment. Cogn Process 13:275–279. doi:10.1007/s10339-012-0456-x

Murphy ST, Zajonc RB (1993) Affect, cognition, and awareness: affective priming with optimal and suboptimal stimulus exposures. J Pers Soc Psychol 64:723–739. doi:10.1037/0022-3514.64.5.723

Nadal M, Munar E, Marty G, Cela-Conde CJ (2010) Visual complexity and beauty appreciation: explaining the divergence of results. Empirical Stud Arts 28:173–191. doi:10.2190/EM.28.2.d

Palmer SE, Schloss KB, Sammartino KJ (2013) Visual aesthetics and human preference. Annu Rev Psychol 64:77–107. doi:10.1146/annurev-psych-120710-100504

Peelen MV, Downing PE (2005) Selectivity for the human body in the fusiform gyrus. J Neurophysiol 93:603–608. doi:10.1152/jn.00513.2004

Pihko E, Virtanen A, Saarinen VM, Pannasch S, Hirvenkari L et al (2011) Experiencing art: the influence of expertise and painting abstraction level. Front Hum Neurosci 5:94. doi:10.3389/fnhum.2011.00094

Pitcher D, Charles L, Devlin JT, Walsh V, Duchaine B (2009) Triple dissociation of faces, bodies, and objects in extrastriate cortex. Curr Biol 19:319–324. doi:10.1016/j.cub.2009.01.007

Rauch SL, Whalen PJ, Shin LM, McInerney SC, Macklin ML et al (2000) Exaggerated amygdala response to masked facial stimuli in posttraumatic stress disorder: a functional MRI study. Biol Psychiatry 47:769–776

Rotteveel M, de Groot P, Geutskens A, Phaf RH (2001) Stronger suboptimal than optimal affective priming? Emotion 1:348–364. doi:10.1037/1528-3542.1.4.348

Schopenhauer A (1844) Die Welt als Wille und Ausstellung (translated as The world as will and representation, Vol I. Transl. Payne EFJ, translator (1969)). Dover Publications, New York

Sheline YI, Barch DM, Donnelly JM, Ollinger JM, Snyder AZ et al (2001) Increased amygdala response to masked emotional faces in depressed subjects resolves with antidepressant treatment: an fMRI study. Biol Psychiatry 50:651–658

Umiltà MA, Berchio C, Sestito M, Freedberg D, Gallese V (2012) Abstract art and cortical motor activation: an EEG study. Front Hum Neurosci 6:311. doi:10.3389/fnhum.2012.00311

Urgesi C, Berlucchi G, Aglioti SM (2004) Magnetic stimulation of extrastriate body area impairs visual processing of nonfacial body parts. Curr Biol 14:2130–2134. doi:10.1016/j.cub.2004.11.031

Urgesi C, Candidi M, Fabbro F, Romani M, Aglioti SM (2006) Motor facilitation during action observation: topographic mapping of the target muscle and influence of the onlooker's posture. Eur J Neurosci 23:2522–2530. doi:10.1111/j.1460-9568.2006.04772.x

Vartanian O, Goel V (2004) Neuroanatomical correlates of aesthetic preference for paintings. NeuroReport 15:893–897. doi:10.1097/00001756-200404090-00032

Vianello M, Galliani EM, Da Carlo NA (2009) Implicit contrast and explicit assimilation effects following subtle and blatant advertising. Test Psychom Methodol Appl Psychol 16:129–139

Whalen PJ, Rauch SL, Etcoff NL, McInerney SC, Lee MB et al (1998) Masked presentations of emotional facial expressions modulate amygdala activity without explicit knowledge. J Neurosci 18:411–418

Wong PS, Root JC (2003) Dynamic variations in affective priming. Conscious Cogn 12:147–168. doi:10.1016/S1053-8100(03)00007-2