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The Beauty and the Self: A Common Mnemonic Advantage Between Aesthetic Judgment and Self-Reference

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A long-lasting debate in the field of esthetics is the extent to which beauty is inherent to the object of appreciation or to the subject contemplating it. Several studies suggest that physical features of an artwork influence esthetic judgment. Nevertheless, this objectivist approach fails to explain the idiosyncratic nature of esthetic experiences (AE). Recent models propose a multiprocess account of AE, integrating a subjective evaluation based on self-referential processing. Nevertheless, behavioral data supporting this hypothesis is scarce. We took advantage of the self-reference effect (SRE) in memory to test the hypothesis that esthetic judgment is based on self-related processes. We predicted that if esthetic judgment recruits self-referential processing, encoding artworks in this condition should produce a similar mnemonic advantage as the SRE. We showed that at least paintings receiving extreme esthetic judgments were as well recognized as those encoded in self-reference condition.

Keywords: esthetics judgment, beauty, self, memory

Supplemental materials: https://doi.org/10.1037/cns0000345.supp

A long-lasting and unresolved philosophical debate in the field of esthetics is the extent to which beauty is inherent to the object of appreciation or to the subject contemplating it (Levinson, 2003). In other words, is beauty fully, partly, or not at all in the eyes of the beholder? In recent years, the scientific interest for the foundation of esthetic experiences (AEs) has been renewed by the emerging field of neuroesthetic. Mirroring this philosophical and historical debate, there have been two main approaches explaining esthetic appreciation in the modern neuroesthetic research. The dominant research endeavor in this field, which we can call the objectivist approach, has focused mainly on the physical features of an artwork influencing

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The experiment reported in this article was not formally preregistered. Neither the data nor the materials have been made available on a permanent third-party archive; requests for the data or materials can be sent via email to the lead author at marco.sperduti@u-paris.fr.

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esthetic judgment. Another, more neglected, line of research has investigated the subjective factors modulating esthetic judgment.

Recent psychological and neurocognitive models seem to reconcile these opposing views, proposing a multiprocess account of AE based on perceptual, motor, emotional, motivational, and evaluative processes (Chatterjee & Vartanian, 2014; Kirsch et al., 2016; Leder et al., 2004; Leder & Nadal, 2014). For example, Leder and collaborators have proposed four main processing stages leading to esthetic judgment: perception, implicit memory integration, explicit classification, and cognitive mastering. Nevertheless, most of the experimental studies are grounded in cognitive models trying to isolate single key factors determining AE (e.g., Berlyne, 1971; Reber et al., 2004). In particular, they have focused on the perceptual level of analysis, trying to capture the physical characteristics of an artwork influencing AE, thus favoring an objectivist stance. This objectivist approach has shown that various physical properties of an object are reliable predictors of AE. The symmetry of an artwork is considered a stable and robust predictor of esthetic preference. Indeed, symmetry positively influenced esthetic preference for geometric shapes, and this effect was additionally resistant to familiarization (Tinio & Leder, 2009). In another study, a mild disruption in symmetry resulted in a significant decline in esthetic preference for geometric shapes (Gartus & Leder, 2013). Complexity also influences esthetic preference: Its effect on esthetic judgment has been found for abstract and representational artwork (Nadal, 2007; Osborne & Farley, 1970), or for geometric shapes (Tinio & Leder, 2009). In the same vein, esthetic preference was greater for photographs with higher level of fractal dimensions (Spehar et al., 2003). Regarding visual contrast, participants' preference for abstract and representational paintings was greater when the contrast was adjusted higher than the original level, compared to a lower than original contrast, independently of the participants' cultural and social status (van Dongen & Zijlmans, 2017). Another study, providing further understanding of this effect, suggested the existence of an "optimal level of contrast in paintings" most preferred by viewers (Dijkstra & van Dongen, 2017). Abstract paintings were most appreciated when the contrast was moderately higher than the original, but not excessively. Curvature and angularity are also properties that influence esthetic judgment. Higher preference for curved shapes and polygons over angular ones has been reported (Bertamini et al., 2016; Silvia & Barona, 2009). Esthetic judgment is also affected by the content of the artwork. Some studies observed a higher appreciation among the general population for representational compared to abstract art (Nadal, 2007; Sidhu et al., 2018), and more generally for real-world scenes compared to abstract images (Vessel & Rubin, 2010). Taken together, these findings show that the physical features of visual stimuli robustly modulate participants' esthetic judgments.

Nevertheless, these studies seem to fail to capture the complexity of AE, insofar as they do not account for the widespread intuition that AE is, at least partly, subjective. An intuition that seems confirmed by experimental studies showing that there is low interindividual agreement on esthetic response to visual artistic stimuli, suggesting that AE has a strong subjective component (Vessel et al., 2012). Different sources might concur to such a variability. This is accounted by the multiprocess account proposed by Leder et al. (2004) and Leder and Nadal (2014). Indeed, by considering dimensions, such as the evaluative one, pertaining to elements unrelated to the object, this model account for AE beyond the simple elaboration of physical properties. Critically for the present work, the last stages of this model, cognitive mastering and evaluation, account for the subjective component of esthetics judgment. In particular, the authors propose that self-related information could be a gateway in understanding and evaluating an artwork. Anecdotally, they state that "[…] perceiver might be satisfied with the recognition of the train station in Monet's La Gare St Lazare, because 'he likes trains because they remind him of a journey'" (Leder et al., 2004, p. 499). Thus, they explicitly link AE with self-related processing associated to autobiographical information. The link between AE and the self seems to be sustained by the fact that esthetic taste is an important part of people' identity, their sense of *who they are* (Fingerhut et al., 2021; Vessel et al., 2013).

These observations echo neuroimaging findings showing that key regions of the default mode network (DMN) are activated during esthetic

judgment (Jacobsen et al., 2006; Kawabata & Zeki, 2004; Martín-Loeches et al., 2014; Vessel et al., 2012, 2019). In particular, the medial prefrontal cortex (mPFC) is of utmost relevance. Importantly, the DMN and the mPFC are known to underpin self-representation at different levels of abstraction (for a meta-analysis, see Martinelli et al., 2013). Nevertheless, it is necessary to avoid haphazardly associating two cognitive processes only on the basis of shared cortical activations. Behavioral data suggesting a possible link between the self and AE also exist. For example, a large corpus of literature demonstrates the importance of familiarity on the esthetic judgment of proverbs, human faces, and music (Bohrn et al., 2013; Bornstein, 1989; Park et al., 2010; Schubert, 2007; Verhaeghen, 2018). Moreover, it is interesting to note that some studies reported that esthetic judgment during incidental encoding lead to increased memory performance for representational and abstract art pictures (Nadal et al., 2006), for photographs of real-world scenes (Choe et al., 2017), and for paintings (Ishai et al., 2007). Some authors proposed that this effect could be due to increased self-related processing prompted by esthetic judgment (Choe et al., 2017). Indeed, it is well known that items requiring a self-related processing gain a robust mnemonic advantage, in comparison to other types of treatment (e.g., semantic processing), an effect known as self-reference effect (SRE) in memory (Conway, 2005; Cunningham et al., 2008; Kalenzaga et al., 2015; Leshikar et al., 2015; Sui & Humphreys, 2015; Symons & Johnson, 1997). Nevertheless, no study to date directly compared the mnemonic advantage produced by esthetic judgment and self-reference in order to investigate the potential existence of a common mechanism organizing AE and the self-representation.

To test this hypothesis, we asked participants to incidentally encode artworks in three conditions: an esthetic judgment condition, a self-referential judgment condition, and a control condition (judgment of symmetry). Our main hypothesis was that if AE is linked to self-referential processing, we should find a comparable mnemonic advantage for the self-referential and the esthetic judgment condition, compared to a control condition requiring judgment of low-level visual features. An exploratory and complementary hypothesis was that the mnemonic advantage for items encoded in the esthetic judgment condition should be modulated by participants' evaluation during encoding. In particular, accordingly to a recent study showing better memory performance for the location of paintings that elicited extreme AE, whether positive or negative (Babo-Rebelo et al., 2020), we made the hypothesis that paintings receiving judgments at the two poles would receive the greatest mnemonic advantage.

Material and Method

Participants

Thirty participants (27 women; mean age 20.7 ± 2.76 years) were recruited for this study. The participants were undergraduate students in psychology at the University Paris Cité. They all had a normal or corrected to normal vision. No participant showed art expertise, based on the Esthetic Fluency Scale (Silvia, 2007; Smith & Smith, 2020; mean score 11.63 ± 4.69 out of 40). All participants were informed of the academic nature of the study and accepted that their responses would be processed anonymously. After the nature of the procedure had been fully explained, all participants gave written informed consent before carrying out the study. The protocol was carried out following the local ethical standards.

Material

Visual Stimuli

One hundred pieces of visual art were selected from the WikiArt data base, across nine different artistic styles representing some of the most important styles between the 16th and 20th century: nordic renaissance, baroque, rococo, romanticism, realism, symbolism, expressionism, impressionism, and postimpressionism. We only selected color and representational paintings with a landscape width–height ratio. We excluded painting including easily recognizable elements (e.g., artist's signature, writings). A complete list of the painting is presented in the Supplemental Materials 1. Among the selected 100 pieces, 60 were used as target stimuli during the encoding phase. The remaining 40 were used as lures in the recognition phase, and were visually paired with some of the target stimuli in terms of content (people, animals,

landscape, style, etc.) and color schemes, in order to make sure they were not dissimilar. The two groups of stimuli did not show any significant differences concerning their physical features: *lightness* (targets mean = 93.28 ± 40.53; lures mean = 101.5 ± 40.79; $t[98] = -1.00$, $p = .321$); contrast (targets mean = 50.60 ± 11.11; lures mean = 48.8 ± 9.90; $t[98] = 0.82$, $p = .415$).

Encoding Phase

There were three within-subject experimental conditions (encoding conditions): an esthetic judgment condition, a self-referential judgment condition, and a symmetry judgment condition (control). In the esthetic judgment condition, the participants were asked to judge their appreciation of the stimuli ("Judge how beautiful the image is for you") on a scale from 0 to 10. In the self-referential judgment condition, the participants were asked to judge to what degree the stimuli reminded them personal memories ("Judge how much the image reminds you of a personal memory") on a scale from 0 to 10. In the symmetry judgment condition, the participants were asked to judge the level of symmetry of the paintings ("Judge how symmetric the image is") on a scale from 0 to 10. Participants were not informed of the following memory test (incidental encoding).

Before the beginning of the encoding phase, a painting not employed in the experimental task (i.e., Viktor Vanetsov's "The Bard Bayan," which is about a Slavic mythological scene) has been used to instruct participants. The self-reference condition was explained to the participants with the example painting in the following way:

> Although it is improbable that you have experienced the event represented in this painting, it is possible that the painting reminds you personal memories such as a friendly hillside picnic, a museum visit where you may have seen similar paintings, a scene of a movie, or even a visual representation of a story that you have read.

For the symmetry condition, we simply asked participants to judge the symmetry of the same painting and to justify their answer to assure that they correctly understand what we meant for symmetry.

Each condition contained 20 images presented in a block. The distribution of the 60 target stimuli across the encoding conditions was counterbalanced between participants, so that each item was presented in each experimental condition. The order of blocks was randomized across participants. In each block, a trial started with a fixation cross for 500 ms that was followed by the presentation of a stimulus for 3 s.[1] Once the stimulus presentation ended, the rating scale appeared on the screen, and the participants had to enter their score according to the experimental condition. There was no time limit for the evaluation. Once the participants responded, the next trial started. The end of the block was signaled by the presentation of the written instructions for the next block.

Recognition Phase

During the recognition phase, all target stimuli were presented intermixed with 40 lure stimuli in a random order (100 stimuli in total). After the presentation of the fixation cross (500 ms), each stimulus was presented for 3 s. Once the stimulus presentation was over, participants had to indicate if they had seen the picture before. They could choose between three different responses appearing on the screen: "Yes," "Maybe," and "No." If the answer was either "Yes" or "Maybe," *for both targets and lures*, participants were asked to respond to a source memory question, indicating in which encoding condition they had seen the image (esthetic judgment, self-referential judgment, or symmetry judgment condition). There was no time limit to answer. Once the recognition response was entered, the fixation cross appeared, followed by the next trial.

Procedure

The experiment was conducted at the MC^{2}Lab, located at the Institute of Psychology of the Université Paris Cité. Participants were invited to an experimental room, where they were seated at approximately 40 cm in front of a 14-in. computer screen (1,920 × 1,080, 60 Hz). The screen was adjusted to maximum brightness for all participants. The experiment, implemented in PsychoPy (Version 3.1.1; Peirce, 2007), was conducted in three phases for all participants in this order: the encoding phase, the retention interval, and the recognition phase. The duration

[1] Time presentation was chosen based on timings used in Martín-Loeches et al. (2014) and Vessel et al. (2019).

of the retention interval was about 30 min (30.32 ± 8.13 min). During this phase, participants filled in four questionnaires[2] and watched an 8-min short film. All the above listed material except for the Esthetic Fluency Scale was used solely as a way to guarantee a sufficiently long retention interval. The results for these questionnaires were thus not analyzed.

Data Analysis

The first two sets of analyses model the item (yes responses) and source recognition (a binary variable: correct or incorrect response) as a function of the encoding condition (three levels: beauty, self-reference, and symmetry) using mixed logistic models (participants and items were entered as random factors). Marginal means-based contrasts were then estimated to allow us exploring the pairwise differences between the levels. In the second part, we additionally modeled the effect of the rating during encoding (a continuous variable ranging from 0 to 10), in each condition, for item and source recognition, allowing to investigate possible nonlinearity using second order polynomials.

Data processing was carried out with R (https://www.r-project.org/) and the *easystats* suite (Lüdecke et al., 2019; Makowski, Ben-Shachar, & Lüdecke, 2019). The whole analysis was performed under the Bayesian framework using Markov chain Monte Carlo sampling with the *rstanarm* package (Goodrich et al., 2018; http://mc-stan.org/). To assert effect significance, we used the probability of direction (effects were considered "significant" when $pd > 97\%$), a Bayesian equivalent of the p value (Makowski, Ben-Shachar, Chen, & Lüdecke, 2019). For clarity, only the relevant effects will be described in the text, but the full reproducible analysis script (containing the full description of all models along with complementary results and figures as well complete descriptive statistics) is available in the Supplemental Materials 2.

Results

Effect of Condition

The mixed logistic model predicting the item recognition had a total explanatory power (Bayes R^2; Gelman et al., 2019) of 22%, from which 3% (marginal R^2) were related to the effect of the condition alone. Within this model, the self-reference condition led to a significantly higher item recognition probability than the beauty (difference = 0.91, 95% confidence interval [CI] [0.61, 1.23], $pd = 100\%$) and the symmetry (difference = 1.10, 95% CI [0.80, 1.40], $pd = 100\%$) conditions. The difference between the latter two was not significant (difference = 0.18, 95% CI [−0.08, 0.46], $pd = 90.75\%$). See Figure 1 (A1).

The mixed logistic model predicting the source recognition had a total explanatory power of 5%, from which 1% was related to the effect of the condition alone. Within this model, the symmetry condition led to higher source recognition probability as compared to beauty (difference = −0.46, 95% CI [−0.93, −0.02], $pd = 98.00\%$) and self-reference (difference = −0.67, 95% CI [−1.11, −0.25], $pd = 99.95\%$). There was no difference between the self-reference and the beauty conditions (difference = 0.21, 95% CI [−0.18, 0.57], $pd = 85.62\%$) (see Figure 1 B1).

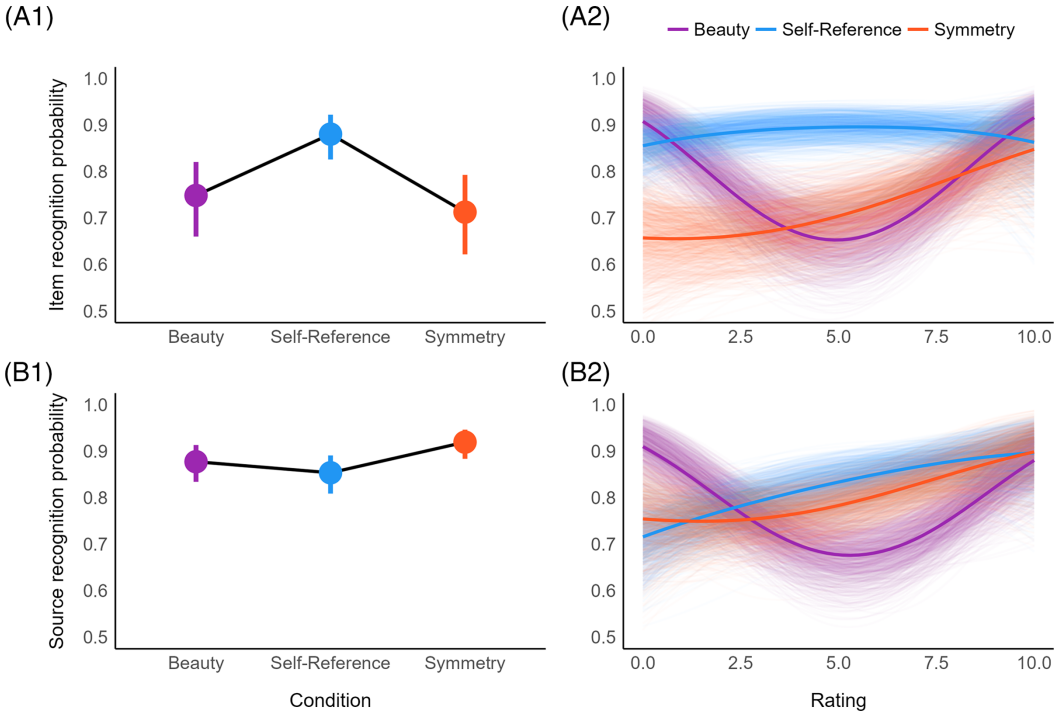
Effect of Rating

The mixed logistic model predicting the item recognition had a total explanatory power of 24%, from which 5% were related to the condition and the rating. Within this model, only the rating of symmetry displayed a significant linear positive relationship with the probability of item recognition (median = 12.50, 95% CI [2.79, 23.14], $pd = 99\%$). However, the rating of beauty had a significant quadratic relationship (median = 24.29, 95% CI [14.02, 36.62], $pd = 100\%$), with extreme ratings (low and high ratings) leading to a higher probability of item recognition. Additionally, contrast analysis confirmed that at the rating extremities (0 and 10), the difference in recognition probability between the beauty and the self-reference was not significant (difference at 0 = 0.55, 95% CI [−0.34, 1.52], $pd = 87.92\%$; difference at 10 = 0.55, 95% CI [−0.60, 1.69], $pd = 82.85\%$; see Figure 1 A2).

[2] The Desire for Aesthetics Scale (Lundy et al., 2010), the Aesthetic Fluency Scale (Silvia, 2007; Smith & Smith, 2020), the Tellegen Absorption Scale (Tellegen & Atkinson, 1974), and the Autism Quotient (Auyeung et al., 2008).

Figure 1

The Estimated Probability of Item (Up) and Source (Bottom) Recognition Averaged by Conditions (A1, B1) and Its Modulation by the Rating (A2, B2)



Note. The error bars represent the 95% credible intervals (CI). Thin lines represent individual posterior draws (i.e., the possible effects), and the thick line shows the median effect. See the online article for the color version of this figure.

The mixed logistic model predicting the source recognition had a total explanatory power of 12%, from which 3% were related to the condition and the rating. Within this model, both the ratings of symmetry (median = 16.62, 95% CI [136, 24.59], *pd* = 99.95%) and self-reference (median = 16.50, 95% CI [106, 27.70], *pd* = 100%) displayed a significant linear positive relationship with the probability of source recognition. The rating of beauty had a significant quadratic relationship (median = 20.06, 95% CI [8.23, 32.13], *pd* = 100%), with extreme ratings leading to a higher probability of source recognition (see Figure 1 B2).

Discussion

In this study, we investigated the relationship between AE and the self at the behavioral level. We tested the hypothesis that AE is grounded on self-reference by examining the common mnemonic advantage produced by incidentally encoding esthetic visual stimuli under esthetic judgment, self-reference judgment, and a control condition (symmetry judgment). Given that self-referential encoding produces robust mnemonic advantage (Conway, 2005; Cunningham et al., 2008; Kalenzaga et al., 2015; Leshikar et al., 2015; Sui & Humphreys, 2015; Symons & Johnson, 1997), we expected that comparable results would be observed for esthetic encoding, owing to the potential shared mechanism. The main results do not confirm our principal hypothesis, since, generally, items encoded in the esthetic judgment condition do not show the expected mnemonic advantage. Nevertheless, items in the esthetic judgment condition were as well recognized as those encoded in self-reference condition when participants gave extreme judgments on the beauty scale during encoding, thus confirming our more exploratory hypothesis.

First of all, we replicated the SRE in memory. Indeed, items encoded in this condition were generally better recognized than the other two conditions (esthetics and symmetry judgments). This result confirms the effectiveness of our experimental manipulation. Most interestingly, items encoded in the esthetic judgment condition, although they were not generally better recognized, showed the same recognition probability of items encoded in the self-reference condition, when participants had given an extreme judgment (very high or very low) during encoding. Several studies reported a positive link between esthetic evaluation and memory. For example, Nadal et al. (2006) reported that esthetic preference was higher for artworks that have left stronger memory traces. Similar results have been observed by Ishai et al. (2007) reporting that the higher the appreciation of the stimuli during encoding, the more probable their recognition was. In the same vein, Choe et al. (2017) showed that rating esthetic value during an incidental encoding task boosted memory performances, compared to an intentional encoding condition or to a search task. Finally, a recent study reported better memory performance for the location of paintings that elicited extreme AE, whether positive or negative (Babo-Rebelo et al., 2020). Although these results suggest that in general esthetic judgment enhances memory performance, at first glance, this effect seems to vary between studies. Indeed, memory can be facilitated independently of the extent of the rating during encoding (Choe et al., 2017), can linearly vary with the rating (Ishai et al., 2007), or can be associated with extreme (positive or negative) judgments. This heterogeneity could be linked to the type of esthetic judgment required. Indeed, Ishai et al. (2007) asked participants how strongly the paintings affected them. This measure can capture both positive and negative aspect of the AE. Babo-Rebelo et al. (2020) employed liking and intensity rating (the squared liking rating), the latter being a more robust predictor of subsequent memory. In this light, one hypothesis would be that the absolute intensity of AE, more than the valence, determines the subsequent memory enhancement. Our findings seem to be coherent with this hypothesis. Moreover, we showed, for the first time, that the memory enhancement for items receiving extreme esthetic rating is comparable to that produced by self-reference. Our results contribute to strengthen the proposal that the memory advantage produced by AE is linked to the recruitment of self-referential processing (Choe et al., 2017), even if alternative explanations linked to emotional reaction to esthetic stimuli cannot be ruled out (see below).

Interestingly, some neuroimaging studies seem to be coherent with the hypothesis that intense AE recruits brain regions involved in self-referential processing. For example, Vessel et al. (2012) asked participants to rate how strongly paintings move them while recording their brain activity with functional magnetic resonance imaging (fMRI). They identified two brain networks showing different patterns of activity. The activity in the first network, composed by sensory regions, increased linearly with participants' rating. The second network, mainly encompassing region of the DMN, showed increased activity only for the most moving stimuli. This was particularly true for the mPFC. Interestingly, in another study, the mPFC showed a nonlinear pattern of activity when participants were asked to judge their appreciation of a human face and body stimuli (Martín-Loeches et al., 2014). Indeed, this region showed increased activation for both ugly and beautiful stimuli, compared to neutral ones (Martín-Loeches et al., 2014). Again, these results suggest that strong AE, whatever their valence, recruit brain regions underpinning self-representation. Our behavioral data seems to corroborate the suggestion that at least strong AE can activate an individual's sense of self (Vessel et al., 2013), involving either an apprehension of the object as conveying one's deep identity (in the case of positive valence) or its very opposite (in the case of negative valence).

One alternative explanation for our results could be that the reported effect is not due to esthetic judgment per se, but would be linked to the emotional reaction associated with highly esthetically moving stimuli. In particular, since the same pattern of results is found for esthetically pleasing and unpleasing stimuli, this emotional effect could be linked more to the arousal component than the valence. Indeed, emotional evaluation is central to AE (Chatterjee & Vartanian, 2014), and comes into play at almost every processing level during AE (Leder et al., 2004; Leder & Nadal, 2014). In addition, emotional content is known to facilitate memory

(Adelman & Estes, 2013; Leppänen et al., 2007; Meng et al., 2017; Schaefer et al., 2009; Sharot & Phelps, 2004). Further studies should explore the relation between AE and the self, disentangling the potential effects of emotional content not controlled in the present work.

We also reported that judgment of symmetry showed a linear relationship with subsequent recognition probability. This can be due to the well-known link between symmetry and esthetic preference as mentioned in the introduction (Gartus & Leder, 2013; Tinio & Leder, 2009). Probably, stimuli judged as highly symmetric were also implicitly judged as beautiful, and produced the same mnemonic advantage. Beyond this indirect effect, symmetry could directly contribute to the goodness of organization that has been shown to predict image memorability (Goetschalckx et al., 2019). Further studies should use different control conditions not pertaining to judgment of features that are known to be associated with esthetic evaluation.

Concerning source memory, the results were less clear. Indeed, for this measure we reported an unexpected finding. Source memory was higher in the symmetry condition, compared with both beauty and self-reference conditions. The latter two conditions not differing. A speculative, but intriguing, hypothesis could be that beauty and self-reference were encoded as more similar leading to an higher source memory confusion errors between these conditions that corresponded to a general decrease in performance. Moreover, we found that contrary to item memory, source memory probability in the self-reference condition showed a linear relationship with rating during encoding. The link between self-reference rating at encoding and memory performance, in particular concerning source memory, is understudied. Nevertheless, a recent study (Culcea & Freitas, 2017) reported that increases in subjective ratings of importance of trait adjectives (to what extent a personality trait is important in getting to truly know someone) resulted in higher source accuracy for words seen in reference to the self, compared to other. Thus, it is possible that in our study, artworks receiving higher rates on self-reference, for which participants were able to recall personal memories, become in some way "important" and facilitate source memory. Nevertheless, the comparison between the two studies is not straightforward considering important methodological differences concerning the material and the experimental task. Moreover, to what extent the linear trend is specific to source memory is not clear, since Culcea and Freitas (2017) did not directly test this effect on item memory. In general, our results on source memory are less straightforward to interpret. Indeed participants showed a high rate of correct answers (see Supplemental Materials 2), this was likely due to the blocked presentation of conditions possibly facilitating the source memory task.

In conclusion, we presented here behavioral results corroborating previous neuroimaging findings suggesting that intense AEs are strictly linked to self-referential processing. Here we only focused on mnemonic processes, but it is well known that self-reference can affect information processing at different levels including perceptual identification (Sui et al., 2012). Future studies addressing the link between self-prioritization and AEs could further shed light on the link between AEs and the self. These results, together with other lines of evidence, contribute to support the idea that beauty, but also ugliness, is (at least partly) in the eye of the beholder, and give a cognitive explanation to intersubjective variability in esthetic appreciation. Nevertheless, with our behavioral study we cannot rule out alternative explanations linked to the emotional responses to artworks. Future studies should employ behavioral and neuroimaging techniques to disentangle the role of these different mechanisms (self-reference, emotion) in the mnemonic advantage produces by extreme AE.

Beyond the fundamental theoretical interest in the field of neuroesthetics, our results could have some implications for clinical research. Indeed, some studies reported that patients suffering from Alzheimer's disease showed a preserved stability of esthetic preferences, even if they not have explicit memory for the artworks (Halpern et al., 2008; Silveri et al., 2015). Even if these findings could be explained by preserved abilities to process low-level visual features influencing esthetic judgment (e.g., symmetry, contrast, etc.) or a stability in emotional reaction toward artworks, one intriguing, but speculative hypothesis is that AE could be a window to preserved portions of the self in these patients.

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