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Preference for paintings is also affected by curvature

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Preference for paintings is also affected by curvature

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Abstract

Preference for curvature has been demonstrated using many types of stimuli, but it remains an open question whether curvature plays a relevant role in responses to original artworks. To investigate this, a novel set of paintings was created, consisting of three variations—curved, sharp-angled, and mixed—of the same 16 indeterminate subjects. The present research aimed to differentiate between liking and wanting decisions. We assessed liking both online (Study 1) and in the lab (Study 2, Task 2), using a continuous slider and a dichotomous forced choice, respectively. In both tasks, participants assigned higher ratings to the curved compared to the sharp-angled version of the paintings. Similarly, when participants were explicitly asked if they wanted to take the paintings home, they assigned higher wanting ratings to the curved version (Study 2, Task 3). However, when they were asked to act as a curator and select works they wanted for their gallery (Study 2, Task 4) and to make a physical effort to visually consume the painting (implicit wanting; Study 2, Task 1), no significant difference was found between the three sets of paintings. Finally, we found that explicit wanting decisions predicted liking for paintings, while implicit wanting and explicit liking predicted explicit wanting of the artworks in both the home and art contexts. This confirmed that it is possible to differentiate between liking and wanting responses to artistically relevant stimuli. We conclude that this theoretical distinction helps to explain previous conflicting results on the curvature effect, establishing a new line of research in the field of empirical aesthetics.

Introduction

Despite the fact that scientists and artists can hold diverging views on some fundamental matters, the interaction between science and art has flourished in recent decades, particularly in relation to the study of visual experience (Pepperell, 2012). Artists have traditionally paid great attention to visual experience and how it can be represented, as countless artworks in museums and art galleries demonstrate. Meanwhile, psychologists and neuroscientists are increasingly interested in art as a vehicle for the study of vision and visual processes (Arnheim, 1974; Huston et al., 2015; Tinio & Smith, 2015; Wade, 2016).

From the perspective of psychology and neuroscience, it is still open to debate the extent to which we prefer certain artworks because of their unique visual properties and distinctive psychological and neurological mechanisms (Skov & Nadal, 2018). The assumption that this might indeed be the case can explain the marginalization of empirical aesthetics within the broader field of psychology and neuroscience. But not only is it doubtful that this assumption has any empirical grounding, it also violates certain principles of evolution and naturalization of the human mind (Skov & Nadal, 2018). The general motivation for the present study is to test, in a particular aspect, whether appreciation of art requires ‘art-specific’ cognitive or neural mechanisms, or whether it relies on more general processes (Skov, 2019).

Preference is a cognitive function that some models assume to be art-specific or aesthetic-specific, as the application of the term ‘aesthetic preference’ shows (Nadal et al., 2008; Silvia & Barona, 2009; Vartanian & Goel, 2004; Zhang et al., 2006). However, the psychological literature contains many studies on preference where the term requires no additional adjectives or qualifications. According to Skov and Nadal (2018), there is no reason to use the adjective ‘aesthetic’ when referring to the appreciation of artworks since the processes involved are no different from other expressions of preference. We are not aware of any study that demonstrates unique mechanisms or processes for ‘aesthetic’ preference compared to preference in general. In the present study, we focused on contour preference, contour being a low-level visual feature. Visual preference for curved contours is a well-established and documented phenomenon (Corradi & Munar, 2020; Gomez-Puerto et al., 2016). It has been demonstrated in neonates (Fantz & Miranda, 1975), infants (Jadva et al., 2010; Ruff & Birch, 1974), adults (Bar & Neta, 2006; Corradi et al., 2018; Palumbo & Bertamini, 2016), different cultures (Gómez-Puerto et al., 2017), chicks (Fantz, 1961), rats (Harrington, 1966), and great apes (Munar et al., 2015). It has also been demonstrated in meaningless patterns (Bertamini et al., 2016; Corradi et al., 2018; Silvia & Barona, 2009), familiar objects (Bar & Neta, 2006; Corradi et al., 2018), car interior designs (Leder & Carbon, 2005), product designs (Westerman et al., 2012), furniture (Dazkir & Read, 2012), interior architectural spaces (Cho et al., 2018; Van Oel & Van den Berkhof, 2013; Vartanian et al., 2013, 2017), architectural façades (Ruta et al., 2018), interactive objects (Soranzo et al., 2018), and diagrams (Carbon et al., 2018). Evidence comes from child psychology, sexual science, general psychology, applied psychology, marketing, environmental psychology, experimental psychology, perception, and architecture. All the aforementioned studies, conducted in the most diverse research areas, seem to indicate the presence of similar cognitive and neural mechanisms underlying a preference for curvature. We hypothesized that the same mechanisms would be at work in art perception, resulting in a preference for artworks that display curved contours.

Even though the studies outlined so far discuss the curvature effect referring to the liking dimension, 'liking' was not always the term participants were asked to use for rating experimental stimuli. For example, Silvia and Barona (2009) and Cotter et al. (2017) asked participants to rate the pleasantness of specific polygons and arrays of circles and hexagons, but then used the liking concept in the results and discussion sections. Based on ratings of beauty, Carbon et al. (2018) also concluded that node-link diagrams with circular-arc edges are liked more than straight line diagrams. These examples show a broader tendency in psychology to interpret beauty and pleasantness judgments in terms of liking. This body of work reports conflicting results, undermining the coherence of previous findings on the curvature effect. These studies showed that preference for curvature can be modulated—and sometimes nullified—by a series of factors, including the affective valence of stimuli (Leder et al., 2011), different task requirements (Vartanian et al., 2013; Ruta et al., 2018), or experimental context (Zhang et al., 2006). Here, we advance the hypothesis that these findings can be explained by adopting the theoretical distinction between liking and wanting, as proposed by the *incentive salience theory* (Berridge et al., 2009; Berridge & Winkielman, 2003; Dai et al., 2010). Berridge and Robinson (1998) challenged the traditional hedonic perspective on reward, according to which people decide to invest their resources to pursue the outcome they like the most. Instead, the authors suggested that reward is a complex phenomenon, involving three distinct parallel components: *liking*—the hedonic pleasure felt during the consumption of an object, *wanting*—the motivation to obtain a reward, and *learning*—the experience and acquired knowledge that can modulate the reward response according to the context. They also showed that implicit liking and wanting reactions are regulated by different subcortical brain structures (Berridge et al., 2009). Wanting is produced by an interaction between the current physiological state of the individual and the encounter of a cue—real or imagined—associated with a reward that is relevant to the individual's current state. As a consequence, wanting could be potentially independent from any hedonic aspect of the reward, including expected pleasantness (Pool et al., 2016). This independence implies that people could either not mobilize effort to obtain a reward that they would like or mobilize effort to obtain a reward that they would not like (Pool et al., 2016). Even if implicit liking does typically occur for the same stimuli that people explicitly like, we also know that implicit liking reactions can influence people's behavior without them necessarily reporting a conscious experience of pleasure (Winkielman et al., 2005; Fischman & Foltin, 1992).

The incentive salience theory becomes even more relevant in the context of modern and contemporary art, where recent developments in this field (*learning*) moved away from the hedonic value of artworks (*liking*) toward valuing (*wanting*) more complex—and not necessarily pleasant—artifacts. The current study aimed to investigate whether curvature, as a low-level visual feature that seems to be associated with hedonic value, is a meaningful feature in the art domain. We hypothesized that curvature will influence not only liking, but also participants' implicit and explicit motivation for visual consumption of artworks. In order to test our hypotheses, one of the authors, Robert Pepperell, created 48 paintings grouped into 16 sets containing 3 paintings in each. Each set consisted of a curved, a sharp-angled, and a mixed version of the same painting. The paintings were originally created digitally on an iPad. Later, the designs were reproduced on wooden panels in acrylic paint and photographed to create the digital version used in this study. We designed two studies with the aim of assessing how much people liked and wanted each painting:

1. Study 1 was conducted online, during which participants rated each painting individually on four relevant psychological dimensions: liking, comfort, approachability, and attractiveness.
2. Study 2 was conducted in the laboratory, during which participants carried out four tasks in the following order:
    - Task 1 or implicit wanting: Presentation time was decided by participants who had to voluntary press a key for as long as they wished to see the painting on screen.
    - Task 2 or explicit liking: Participants were asked to make a dichotomous forced choice, selecting if they liked or disliked each painting.
    - Task 3 or explicit wanting in home context: Participants had to assess on a Likert scale how likely it was that they would want to bring each painting home.

- Task 4 or explicit wanting in the art context: Participants were asked to act as they were an art curator and assess on a Likert scale how likely it was that they would want to exhibit each painting in their gallery.

Based on the fact that we have no evidence, so far, of the existence of art-specific cognitive processes (Skov, 2019), we predicted that:

1. *Explicit liking* judgments will also show an advantage for curvature in the art domain, despite changes in task requirements.
2. *Implicit wanting* judgments will show an advantage for curvature.
3. *Explicit wanting* judgments will show the same pattern of results in both the home and the art context, with curved paintings being wanted more than the other two versions.
4. Art interest (*learning*) will modulate the curvature advantage when expressing explicit wanting judgments in the art context, possibly overriding the curvature effect.

Assessing 'liking' for curvature in artworks

Study 1: liking-relevant dimensions

The main aim of this study was to investigate whether curvature in contour, as a low-level visual feature, also played an important role in influencing preferences for artworks. We adopted four different psychological variables—liking, visual comfort, approach, and attractiveness—commonly used in the literature to assess preferences for visual stimuli.

Participants

Forty-one participants were recruited via Prolific (https://www.prolific.ac/), restricting their main language to English, as it was the survey language. They gave informed consent before taking part in the online study. The mean age was 30.7 years old (SD = 5.8, range from 19 to 39), and 65.8% were females. The average earnings were £3.75 per hour, which was paid via Prolific. In order to take part in the study, participants had to report to be using a screen bigger than 15" and to be sitting at a desk with the computer in front of them.

Stimuli

We used the 48 digital versions (HQ photographs) of the paintings created by one of the authors (http://robertpepperell.com/). The full database is available online in the Supplementary materials. The paintings were designed to present ambiguous forms that suggested certain objects but were not specifically recognizable. However, we were aware that participants might perceive objects in the forms that the artist had not intentionally included, as it happens, in the pareidolia phenomenon (Hadjikhan et al., 2009; Liu et al., 2014). The paintings were divided into 16 sets, each featuring three different versions of an artwork containing the same colors and similar shapes, with the exception that the contours of the shapes varied between the three versions. One version of the paintings had only curved and smooth contours, one had only sharp-angled contours, and the third had a mix of curved and sharp-angled contours (Figure 1).

Figure 1 The illustration above shows one of the 16 triplets used in the current study. From left to right: curved, mixed and angular version. The entire paintings' database is available online in the Supplementary materials.

Procedure

First, participants were asked to self-assess their art interest on a Likert scale from 1 to 5, where 1 corresponded to 'not at all' and 5 to 'very much.' Then, they were presented with one painting at a time and were asked to rate their agreement on four statements using a slider that varied from 0 to 100, where 0 was 'not at all' and 100 was 'very much.' Each statement investigated a dimension related to aesthetic appreciation: *'I like this painting,' 'I think this painting is comfortable to look at,' 'I think this painting is approachable,'* and *'I think this painting is attractive.'* Stimuli were presented in random order and remained on screen until participants responded. The experiment was approved by the Ethics Committee of the School of Art and Design, Cardiff Metropolitan University and was conducted in accordance with the Declaration of Helsinki (2008).

Data analysis

The effect of *contour* (curved, mixed, or sharp-angled), *art interest* (Likert scale from 1 to 5), *age*, *screen size* (12”, 15”, 17”, or 20”), and *sex* (male or female) on rating were analyzed using the same linear mixed effects model structure for each of the four psychological dimensions: liking, visual comfort, approach, and attractiveness. The four models contained the five fixed effects listed above and two-way interactions between *contour* and the other four predictors. In addition, we included random intercepts for within participants and within stimuli variation, as well as a random slope of *contour*. The analyses were carried out with the R environment for statistical computing (R Core Team, 2016), using the *lme* function from the *nlme* package (Pinheiro et al., 2020). The advantage of using mixed effects modeling is that it takes into account both between-subjects and within-subjects variation in the effects of independent variables on the dependent measures (Baayen et al., 2008). This approach is useful, especially when researching aesthetic appreciation, because it takes into account artworks’ and individuals’ variability (Silvia, 2007).

Results

We adopted a stepwise approach to model selection and used the *drop1* function from the *lme4* package (Bates et al., 2015) to identify the predictors that significantly improved each model. Mean ratings for each dimension, according to *contour* and *sex*, are reported in the Supplementary Materials. Results showed that *art interest* and *screen size* did not significantly improve any of the four models—producing a higher Akaike information criterion, AIC—and did not show any significant main effect on ratings. Therefore, *art interest* and *screen size* were excluded from the final models and will not be further discussed in this study.

The results showed a significant main effect of *contour* on all psychological dimensions: liking ($\chi^2(2) = 7.4$, $p = .025$), comfort ($\chi^2(2) = 8.0$, $p = .018$), approachability ($\chi^2(2) = 11$, $p = .004$), and attractiveness ($\chi^2(2) = 8.4$, $p = .015$). Planned contrasts compared ratings for curved paintings with ratings for mixed and sharp-angled paintings, respectively. For liking, comfort, and attractiveness, curved paintings reported significantly higher ratings compared to both mixed (liking: $b = -2.02$, $t(1310) = -2.53$, $p = .029$, $r = 0.07$; comfort: b

= -2.28, $t(1310) = -2.19$, $p = .028$, $r = 0.06$; attractiveness: $b = -2.38$, $t(1310) = -2.9$, $p = .004$, $r = 0.08$), and sharp-angled ones (liking: $b = -3.04$, $t(1310) = -2.7$, $p = .018$, $r = 0.074$; comfort: $b = -3.86$, $t(1310) = -2.96$, $p = .003$, $r = 0.08$; attractiveness: $b = -3.15$, $t(1310) = -2.63$, $p = .008$, $r = 0.072$). For approachability, the results showed that curved paintings had significantly higher ratings only compared to sharp-angled ones ($b = -3.8$, $t(1310) = -3.5$, $p < .001$, $r = .0$), but not to mixed ones ($b = -1.73$, $t(1310) = -1.86$, $p = .06$, $r = .06$). Tukey post-hoc tests revealed that mean liking, comfort, and attractiveness ratings for the mixed versions were not significantly different from the sharp-angled ones ($p > .05$ for all comparisons). However, post-hoc comparison on approachability ratings showed that the mixed version was rated significantly higher compared to the sharp-angled one (difference = 2.06, SE = 0.7, $z = 2.77$, $p = .01$). There was a significant main effect of *sex* for liking ($\chi^2(1) = 7.9$, $p = .005$), comfort ($\chi^2(1) = 7.9$, $p = .005$), and approachability ($\chi^2(1) = 7.6$, $p = .006$), but not for attractiveness ($\chi^2(1) = 3$, $p = .08$), showing that male participants assigned higher ratings to the paintings overall compared to female ones, as illustrated in Figure 2.

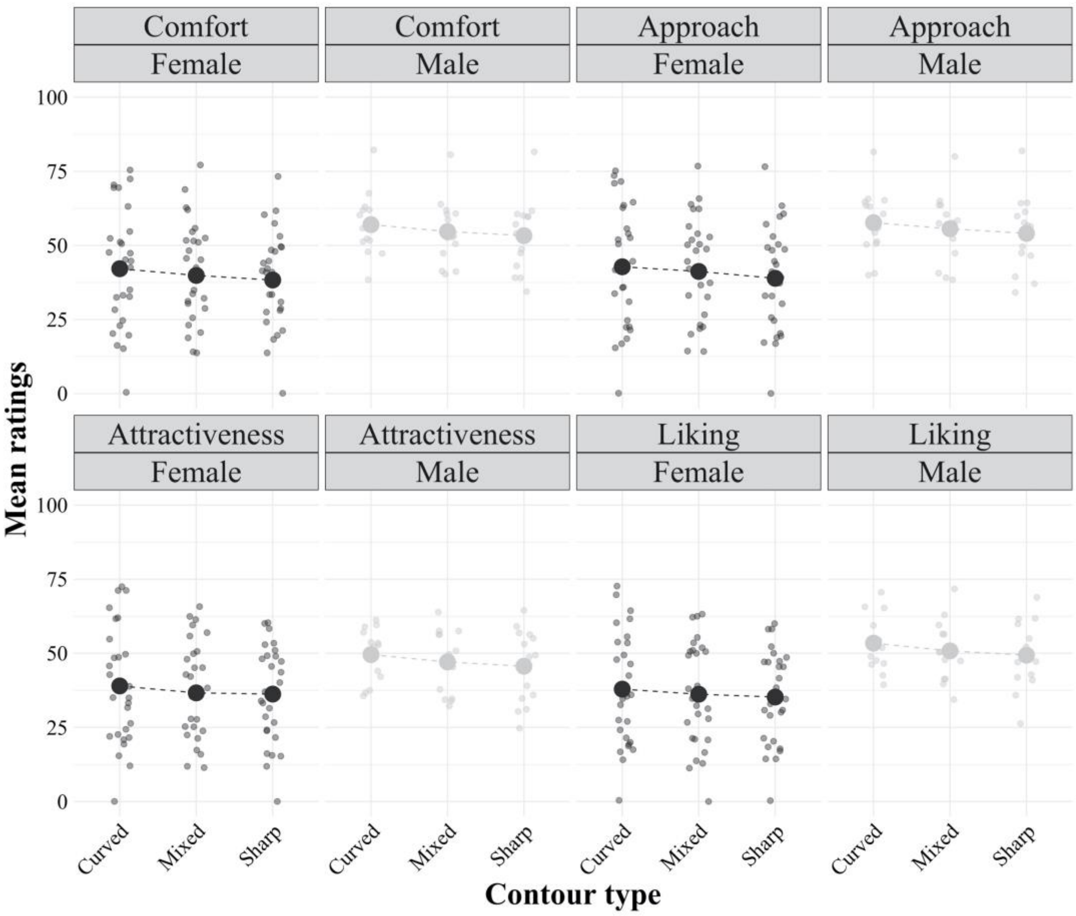

Figure 2. Mean ratings for each psychological variable (liking, comfort, approach, and attractiveness) according to painting version (curved, mixed, or sharp-angular) and participants' sex (female or male).

The results also showed a significant main effect of *age* for comfort ($\chi^2(1) = 10.36$, p = .001) and approachability ($\chi^2(1) = 8.5$, $p = .004$) ratings, meaning that ratings were significantly higher among the older participants, regardless of the painting's contour, as illustrated in Figure 3. No significant interactions between *contour* and *age* or *contour* and *sex* were found (see Supplementary materials for detailed output of all models).

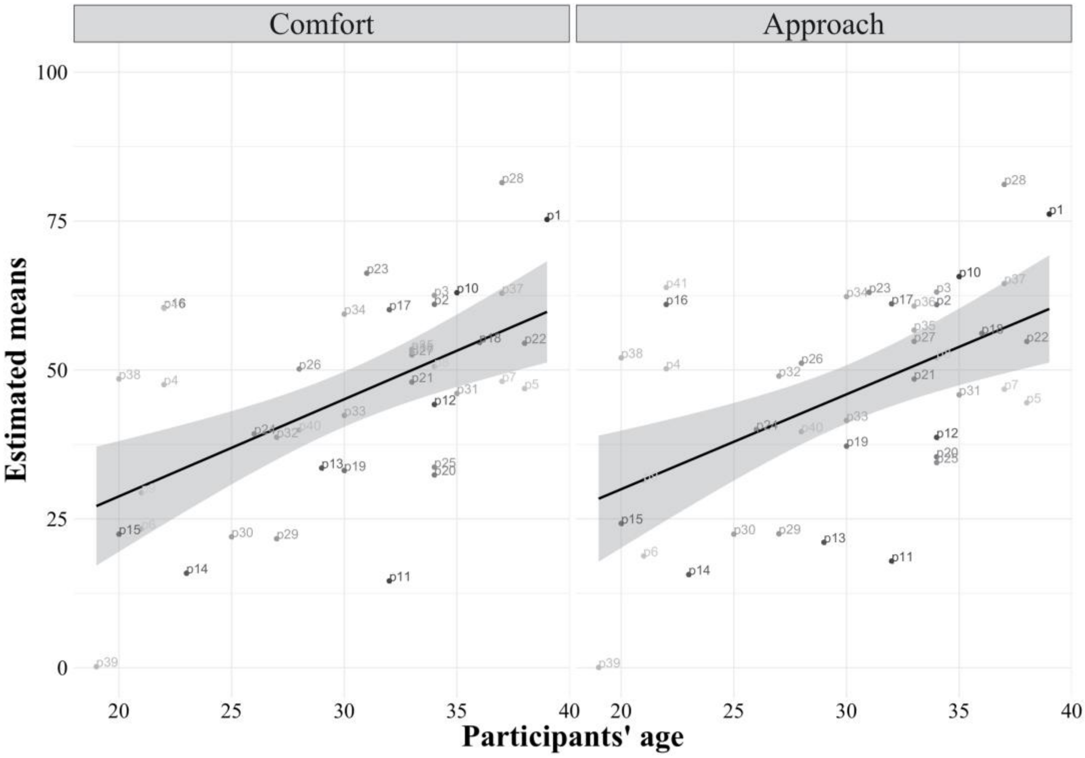

Figure 3. Relationship between comfort (on the left) and approach (on the right) and participants' age. Dots identify estimated means for each participant.

Finally, we found that the four psychological variables were highly correlated with each other, with the pairs comfort and approach and liking and attractiveness, having the highest correlation coefficients, as reported in Figure 4.

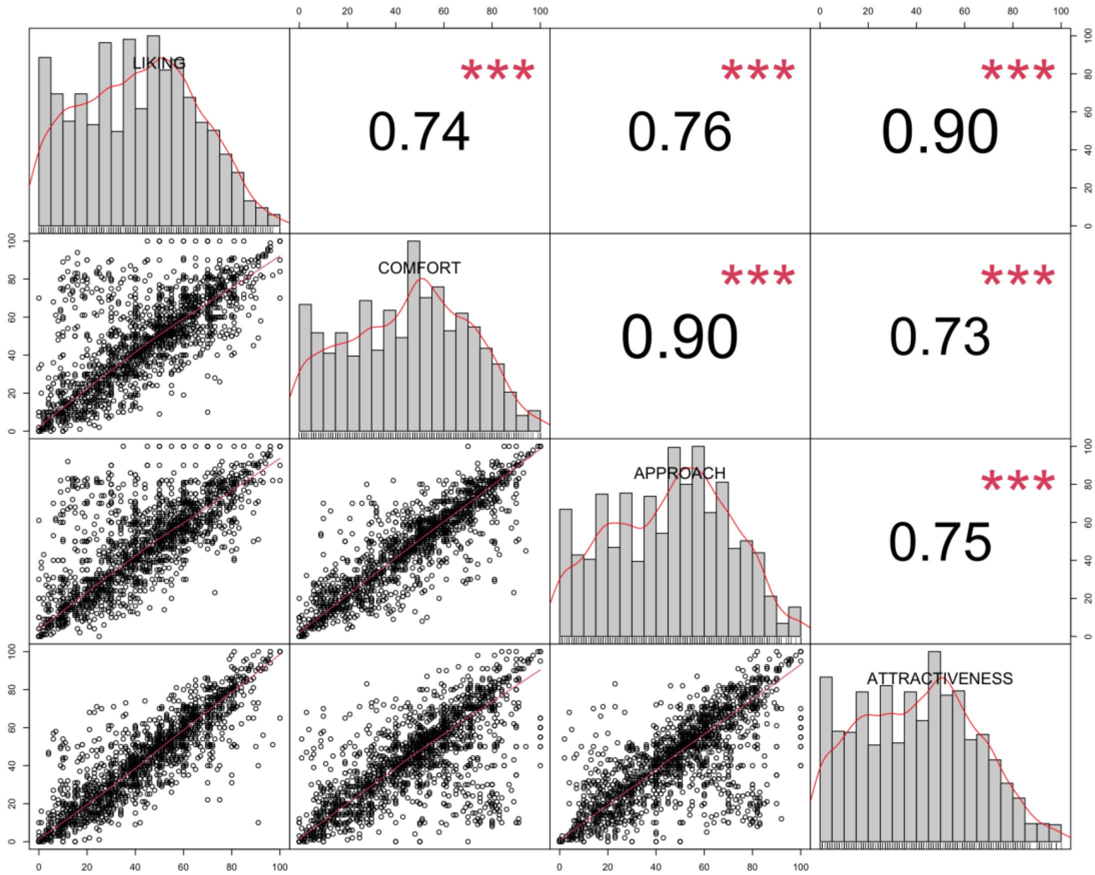

Figure 4. Correlation matrix between the four psychological variables measured in Study 1, from top-left to bottom-right: liking, comfort, approach, and attractiveness. Along the diagonal are the histograms for each variable's distribution; the top-right part of the figure shows the absolute value of the correlation coefficients; the bottom-left part of the figure illustrates the bivariate scatterplots, with a fitted line.

Discussion of Study 1

The liking dimension has been used extensively in empirical aesthetics and, particularly, in the study of preference for curvature (Bar & Neta, 2006, 2007; Carbon, 2010; Carbon et al., 2018; Palumbo & Bertamini, 2016; Ruta et al., 2018). The curvature effect has been studied using a variety of different methodologies: fast presentation times (80–120 ms), leaving the stimuli until participants' response, using liking/disliking forced choices, and continuous rating scales (Palumbo & Bertamini, 2016; Bertamini et al., 2016; Bar & Neta 2006, 2007). Ruta et al. (2018) extended the curvature effect to the architectural domain, using different task requirements. Leder et al. (2011) found that preference for curved object images can be modulated by the affective valence of the stimuli, reporting the curvature effect only for neutral or positive stimuli, but not for stimuli with negative emotional valence. Palumbo et al. (2015) further investigated the curvature effect using a multidimensional implicit association task (IAT) with three relevant semantic dimensions: danger, valence, and gender. The IAT results supported the hypothesis that abstract curved shapes were associated with safe and positive concepts and with female names. The authors suggested that liking for curvature might be explained by the link to the implicit meaning the visual feature recalled in the viewer (Palumbo et al., 2015). However, as discussed in the Introduction, liking was not always the term used by participants when asked to assess their preference for visual stimuli. In our study, we asked participants to rate paintings for liking alongside the other three psychological dimensions that have been used in the literature in relation to liking and investigated how they relate to each other.

Visual comfort

In the context of vision science, visual comfort is interpreted as the experience of a state of ease and satisfaction. Several studies have used this dimension in relation to preference for curvature (Hareli et al., 2016; Jiang et al., 2015; Ruta et al., 2018; Soranzo et al., 2018).

Aronoff (2006) reported that angular geometric patterns have the capacity to evoke discomfort as much as facial features. Jiang et al. (2015) provided evidence that shoes and sofas with curved logos were perceived as more comfortable than the same products with angular logos. Hareli et al. (2016) showed that sharp leaves were rated as less comforting compared to round leaves. Soranzo et al. (2018) manipulated contour, size, texture, and interactive features of real 3D objects and investigated whether the interaction with those objects influenced participants' aesthetic preference. Results revealed that comfort was a significantly recurring term in participants' feedback and that the curved objects were more comfortable to look at and touch compared to the sharp-angled ones.

Penacchio and Wilkins (2015) developed an algorithm to quantify visual stress in images based on their adherence to natural image statistics. In their recent study, Ruta et al. (2018) showed the potential of integrating image analysis in the field of empirical aesthetics. The authors applied the algorithm developed by Penacchio and Wilkins (2015) to their architectural stimuli, showing that results from image analysis were in line with the behavioral data (Ruta et al., 2018).

Attractiveness

Attractiveness is a concept usually related to facial and sexual pull, mate selection, and good fitness. The attractiveness dimension has also previously been used to study preference for curvature (Palumbo & Bertamini, 2016; Zhang et al., 2006). Round heads, round eyes, and round bodies are related to young individuals; that is, they are neotenic traits. There is evidence that men or women with neotenic traits appear more attractive. Palumbo and Bertamini (2016) suggested that attractiveness might be associated with arousing interest in aesthetics, following Berlyne's definition of 'appealing to the senses.'

Zhang et al. (2006) studied whether independent or interdependent self-construal attitudes modulated preference for curvature. In this study, participants were asked to rate the attractiveness of corporate logos, picture frames, and trademark symbols. The authors reported that curved features were more attractive in situations in which people sought harmony, but sharp-angled features were more attractive when they looked for individuality and toughness. Palumbo and Bertamini (2016) used rating scales to measure both liking and attractiveness of abstract polygonal shapes. They reported similar results from liking and attractiveness tasks, although the results from attractiveness showed a more complex pattern: liking decreased when more concavities were introduced within curved shapes but not attractiveness. The authors interpreted this pattern of results, suggesting a connection between attractiveness and arousal.

Approachability

The approachability dimension emphasizes its intrinsic link to primal interactions between an organism and its environment. Approach as a psychological variable has been studied in relation to different behaviors: the pursuit of pleasure, movements toward objects of interest, response toward salient stimuli, reference to the action's end, positive valence, conditioned appetitive drives, and a reduction in the negative state of tension (Elliot & Covington, 2001; Munar et al., 2014).

Many studies investigated approach-avoidance decisions in the context of architecture and built environments, highlighting differences between liking/beauty and approach decisions. Vartanian et al. (2013) showed that expertise modulated the curvature effect, with non-expert participants being more willing to enter curvilinear spaces compared to experts. On the other hand, Dazkir and Read (2012), in an online survey, found that university undergraduate students from design and art programs showed more desire to approach curvilinear simulated interior settings compared to rectilinear ones. Ruta et al. (2018) also collected approachability judgments for four versions of the same building (curved *vs.* sharp-angled *vs.* mixed *vs.* rectilinear) and did not find a significant effect of curvature, but they reported the rectilinear façade being significantly the least approachable façade compared to the other versions. Outside the architecture domain, Palumbo et al. (2015) and Bertamini et al. (2016) adapted a Stimulus Response Compatibility (SRC) task to test approach and avoidance reactions to curved and angular polygons. Results showed that participants were faster at approaching the curved shapes than at avoiding them, but no difference was found with the angular shapes between approaching and avoiding reaction times (Palumbo et al. 2015; Bertamini et al., 2016). The authors advanced the hypothesis that approach to curvature is not the result of avoidance for sharp-angled contours, as previously suggested (Bar & Neta, 2006), but might be due to the pleasantness of curved features *per se* (Palumbo et al. 2015; Bertamini et al., 2016).

The curvature effect has also been found across species when using the approach dimension. In Munar et al. (2015), a group of university students and a group of great apes—chimpanzees and gorillas—were presented with two images that, when chosen, simulated the act of approaching by increased size on screen. The results revealed that the human group and the great ape group shared a common preference for curved over sharp-angled versions of the same objects. Using the same experimental paradigm, Gómez-Puerto et al. (2017) found the same curvature advantage across Western and non-Western cultures. Corradi et al. (2018) found that the approach to curvature was greatest when real objects were presented for 84 ms, but it faded when participants were given unlimited viewing time, as in Munar et al. (2015). Corradi et al. (2019) uncovered a remarkable breadth of variation in individual preferences, showing that participants who were highly sensitive to curvature in real objects were also highly sensitive to curvature in abstract shapes.

Altogether, this evidence seems to suggest that: a) approach-avoidance decisions are a separate psychological dimension from beauty; and b) that people's approach decisions might be independent from the perceived pleasantness (liking) and hedonic qualities of the stimuli (Vartanian et al., 2013; Ruta et al., 2018). Despite the uniformity of the results reported by the four dimensions investigated in Study 1, we found that for the approach dimension was the only one where the curved paintings were not significantly different from the mixed ones. It is important to acknowledge that liking, comfort, attractiveness, and approach dimensions were highly correlated with each other, suggesting that explicit and self-assessment measures might not be the best methodology for detecting differences between those different psychological constructs.

Study 2: Assessing 'wanting' for curvature in artworks

We previously discussed how preference for curvature can vary according to the experimental context (Silvia & Barona, 2009; Vartanian et al., 2013, 2017) and the emotional valence of stimuli (Leder et al., 2011). According to Dai et al. (2010), perceivers can access conscious, separate mental representations of both liking and wanting dimensions. Moreover, they suggested that people can develop multiple preferences for the same object even within the same context. In their study about preferences for faces, the authors showed that participants were aware of the liking and wanting distinction and could consciously access a face's likability or incentive value at the same time (Dai et al., 2010). Taking into account Dai et al. (2010)'s theoretical and methodological framework, in Study 2 we designed four different tasks aiming to differentiate between explicit liking (Task 2) as opposed to implicit (Task 1) and explicit wanting (Task 3 and 4). The aims of this study were to test if:

1. Participants would make a bigger physical effort to visually consume the curved version of the paintings (Task 1);
2. Preference for curvature was still present when task requirements changed compared to Study 1 (Task 2); and
3. Participants' explicit wanting decisions differed if expressed in an art-relevant experimental context (art gallery) compared to a non-art-relevant one (home).

Participants

Fifty participants from the University of the Balearic Islands (UIB) took part in the study. The mean age was 20.44 years old (SD = 3.12, range from 18 to 38), and 86% were females. Participants were students from Psychology (41), Pedagogy (5), Physics (3), and Social Education (1). They took part in exchange for course credits. All had normal or corrected vision. They filled out and signed an informed consent form. The experiment was approved by the *Comitè d'Ètica de la Recerca* of the University of the Balearic Islands and was conducted in accordance with the Declaration of Helsinki (2008).

Stimuli

Study 2 was conducted in the laboratory facilities of the Psychology Department of the University of the Balearic Islands. The stimuli were the same as in Study 1 and were presented on a FullHD (1920 x 1080) computer screen using OpenSesame (Mathôt et al., 2012). All the images had the same size (1080 x 707 pixels).

Procedure

As described in the Introduction, Study 2 consisted of four tasks in total:

Task 1—implicit wanting

The rationale for this task was to implicitly ask participants to make an effort (continuous key pressing) if they wanted to continue looking at each painting. Every trial started with the following sequence of events: a fixation figure appeared on screen until the participant pressed the spacebar. Then, the digital painting was presented, and it remained on screen for as long as the participant continuously pressed the spacebar. When the spacebar was released, the artwork was replaced by the fixation figure, signaling the start of a new trial. Participants received the following instructions: *'When the fixation figure appears, you have to press the spacebar and you'll see a painting. You can see it as long as you want, while you continue pressing the spacebar. Later, we're not going to ask you anything about these paintings.'*

Task 2: explicit liking/disliking choices

During Task 2, participants were asked to make a dichotomous liking/disliking choice about each painting. At the beginning of the task, participants were provided with the following instructions: '*You have to answer whether you like or not the paintings. Every painting will appear for a brief period of time and, afterward, you'll have to indicate whether you liked it or not. Use the "z" and "m" to answer. It's very important that your answer as fast as possible.'* The artworks were presented after a fixation figure—a combination of a cross and a circle—(300 ms) and remained on the screen for 500 ms. Participants had to rate each artwork by pressing the 'z' or 'm' keys. The response key was counterbalanced between participants, so that half of the participants pressed the 'z' key to rate dislike and the 'm' key to rate like and the other half did the other way around. The 'like' and 'dislike' labels remained on the top of the screen during the trial duration to remind participants of the meaning of each key.

Personality test

After this task, participants filled up 12 items of the openness-to-experience scale of the NEO-FFI (McCrae & Costa, 2004).

Art interest

Participants filled out the same paper-and-pen custom experience and knowledge in visual art questionnaire as in Corradi et al. (2019), adapted from Chatterjee et al. (2010).

Task 3—explicit wanting (home)

The rationale behind Task 3 was to investigate explicit wanting judgments for artworks. We asked participants to assess the probability that they would take each artwork home by providing the following instructions: *'Imagine that you could take the painting. Would you want it for your home?'* Each painting was rated on a seven-point Likert scale, ranging from -3 to 3, where -3 meant that they would not want to take the painting home at all and 3 meant that they would certainly want that artwork at home.

Task 4—explicit wanting (gallery)

The rationale behind Task 4 was to investigate if it was possible to extend the wanting judgments collected during Task 3 to the art domain. To test this, we used the same procedure as Task 3, but with the main difference that participants were asked to act as if they were the curator of an art gallery. We asked participants to assess the probability that they would exhibit each artwork in a gallery by providing the following instructions: *'Imagine that you are the curator of a gallery and you have the opportunity to take the painting. Would you want it for your gallery?'*

Data analysis

We used linear mixed effects (Hox, 2010; Snijders & Bosker, 2012) to analyze the effects of *contour* (curved *vs.* mixed *vs.* sharp-angled), *trial sequence* (from 1 to 48), *openness to experience*, and *art interest* as fixed factors on *inspection time* (Task 1), *liking/disliking response* (Task 2), *liking/disliking response time* (Task 2), *wanting ratings* (Tasks 3 and 4), or *wanting response time* (Tasks 3 and 4)—depending on the task. We built five different models in total, with the results from Tasks 3 and 4 analyzed together. All models were set up as maximal models, following Barr et al. (2013)'s guidelines. The models took into account as many random effects as possible in order to reduce Type-1 error and prevent statistical power losses. All models contained the following interactions: between *contour* and *trial sequence*, *contour* and *openness*, and *contour* and *art interest*, except for the model for Tasks 3 and 4, which had *task* (home *vs*. gallery) as an additional fixed effect. In addition, we included random intercepts for within participants and within stimuli variation, as well as a random slope for the interaction between *contour* and *trial sequence*. The analyses were carried out within the R environment for statistical computing (R Core Team, 2016), using the *lme4* package (Bates et al., 2015).

Results

Task 1—Implicit wanting

In Task 1, we analyzed the effects of *contour* in interaction with *trial sequence*, *openness*, and *art interest* on *inspection time*. The results of the model revealed no significant difference between curved and sharp-angled *contours* ($t(2389) = -.18$, $p = .858$) and between curved and mixed *contours* ($t(2389) = .65$, $p = .513$) on *inspection time*, meaning that the average time that people spent looking at the three versions of the digital paintings was, overall, the same. No other significant main effects (*trial sequence* and *openness*) or interactions (between *contour* and *trial sequence*, *openness,* and *art interest,* respectively) were found (see Supplementary materials for detailed analysis output).

Task 2—Explicit liking

In this model, we analyzed the effect of the interactions between *contour* and *trial sequence*, *openness, art interest*, and *task* on the dichotomous *liking/disliking response* people gave to each painting. We calculated Q1, Q3, and the interquartile range (IQR) for every participant response time. Response times under Q1 - 1.5 IQR were considered short responses, and those over Q3 + 1.5 IQR were considered long responses. These short and long trials were excluded from the subsequent analyses (289 trials, 12% of all responses).

The results showed that *contour* had a significant main effect on *liking/disliking response* (χ^2 = 11.93, *p* = .003), as illustrated by Figure 5. Post-hoc paired comparisons showed that participants preferred the curved version (.54, 95% CI [.48, .60]) significantly more than the sharp-angled one (.41, 95% CI [.40; .52]), (*OR* = 1.73, *p* = .007), but not compared to the mixed version (.46, 95% CI [.40, .52]), (*OR* = .71, *p* = .86). The difference between mixed and sharp-angled paintings was also not significant (*OR* = 1.23, *p* = .38). There was a significant main effect of *trial sequence* (χ^2 = 6.76, *p* = .009), meaning that participants tended to like the artworks more as the task progressed (β = 0.01, *SE* = 0.01). There was also a significant main effect of *openness* (χ^2 = 10.41, *p* = .001), meaning that, overall, participants who reported having higher levels of openness to experience also liked the paintings more overall (β = 0.03, *SE* = 0.02). *Art interest* did not have a significant main effect (χ^2 = 1.35, *p* = .245). None of the interactions between *contour* and the other predictors showed a significant effect (see Supplementary materials for detailed analysis output).

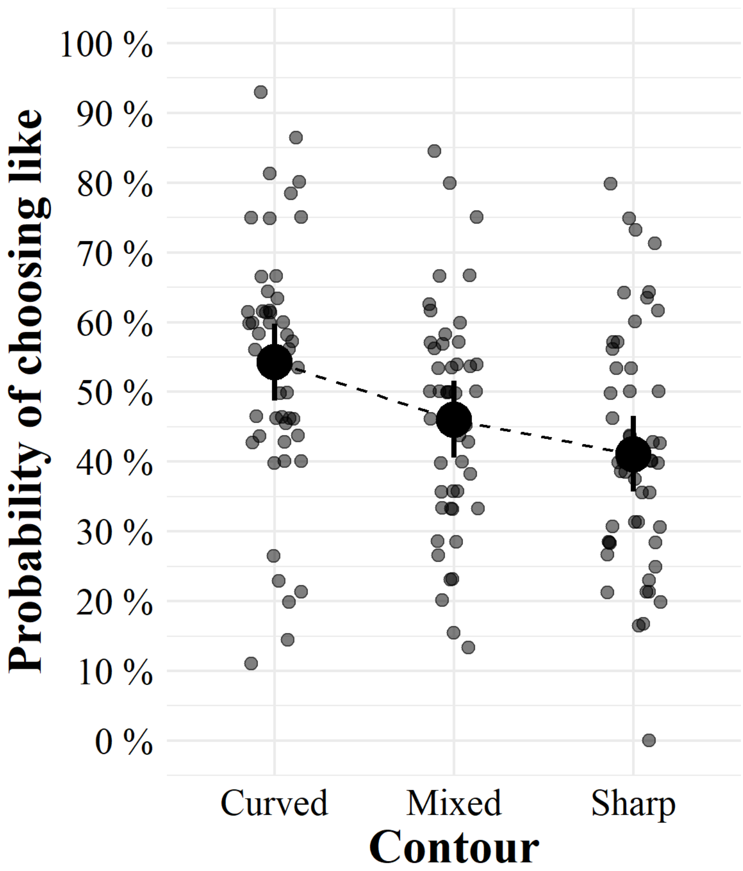

Figure 5. Probability of choosing 'like' in Task 2 of Study 2, according to the painting version.

We were also interested in analyzing the *response time* for this task to investigate if liking for curvature had an effect on processing speed and ease, resulting in faster reaction times. We used the same model structure as the one we used for analyzing the *liking/disliking response*. Only *trial sequence* reported a significant main effect on Task 2's *response time* (*t(2096)* = 3.22, *p* = .004), meaning that, overall, participants were faster assigning their liking/disliking response to paintings as the task progressed (β = -1.66, *SE* = 0.58). The interaction between *art interest* and mixed stimuli (*contour*) was statistically significant (*t(2096)* = 2.34, *p* = .019), meaning that people who scored higher in art interest took significantly more time responding to the paintings with mixed contours compared to the curved ones (β = 4.10, *SE* = 1.75). No other significant main effects (*contour*) or interactions (between *contour* and *trial sequence, openness,* and *art interest*) were found (see Supplementary materials for detailed analysis output).

Tasks 3 and 4—explicit wanting (home and gallery)

We jointly analyzed the data collected from Tasks 3 and 4 because we wanted to compare whether task instructions about home and the gallery had an effect on participants' wanting decisions. We therefore added to this model a new predictor, *task* (home *vs.* gallery), to identify Tasks 3 and 4, respectively, testing participants' wanting decisions to take paintings home and to a hypothetical art gallery. In this model, we analyzed the effect of the interactions between *contour* and *trial sequence, openness, art interest,* and *task* on *wanting* ratings (from -3 to 3).

The results revealed a significant main effect of *task* ($t(4782) = 5.62$, $p < .001$), meaning that overall participants assigned artworks higher wanting ratings in the task about the *gallery* (*M* = 0.42, *SE* = 0.12) compared to the one about *home* (*M* = -0.25, *SE* = 0.12). Analysis revealed a statistically significant difference between the scores assigned to curved and sharp-angled *contour* ($t(4782) = -2.28$, $p = .023$), meaning that overall, the curved paintings obtained higher ratings (*M* = 0.09, *SE* = 1.15) compared to the sharp-angled ones (*M* = -0.26, *SE* = 0.15), but not compared to the mixed ones (*M* = -0.10, *SE* = 0.15). The interaction between *art interest* and the difference between curved and sharp-angled *contours* was also significant ($t(4782) = -2.22$, $p = .026$). The higher people scored on *art interest*, the more they reported wanting curved paintings ($\beta = 0.021$, *SE* = 0.015). On the other hand, wanting for the sharp-angled versions was very similar between people with different levels of *art interest* ($\beta = -0.004$, *SE* = 0.015). As illustrated in Figure 7, there was a significant interaction between *contour* and *task* driven by the difference between curved and sharp-angled paintings ($t(4782) = 2.17$, $p = .03$), with the latter scoring significantly lower than the curved ones in the home condition ($M_{home/sharp} = -0.67$, $SE_{home/sharp} = 0.15$, $M_{home/curved} = -0.17$, $SE_{home/curved} = .15$, $z = 2.957$, $p = .034$). Moreover, it is interesting to report that sharp-angled paintings obtained significantly higher wanting scores in the gallery compared to the home condition ($M_{home/sharp} = -0.67$, $SE_{home/sharp} = 0.15$, $M_{gallery/sharp} = 0.16$, $SE_{gallery/sharp} = .15$, $z = -8.7$, $p < .001$; full post hoc comparisons are available in Supplementary materials). No other significant main effects (*trial sequence, openness, art interest*) or interactions (between *contour* and *trial* *sequence* and *openness*, respectively) were found (see <u>Supplementary materials</u> for detailed analysis output).

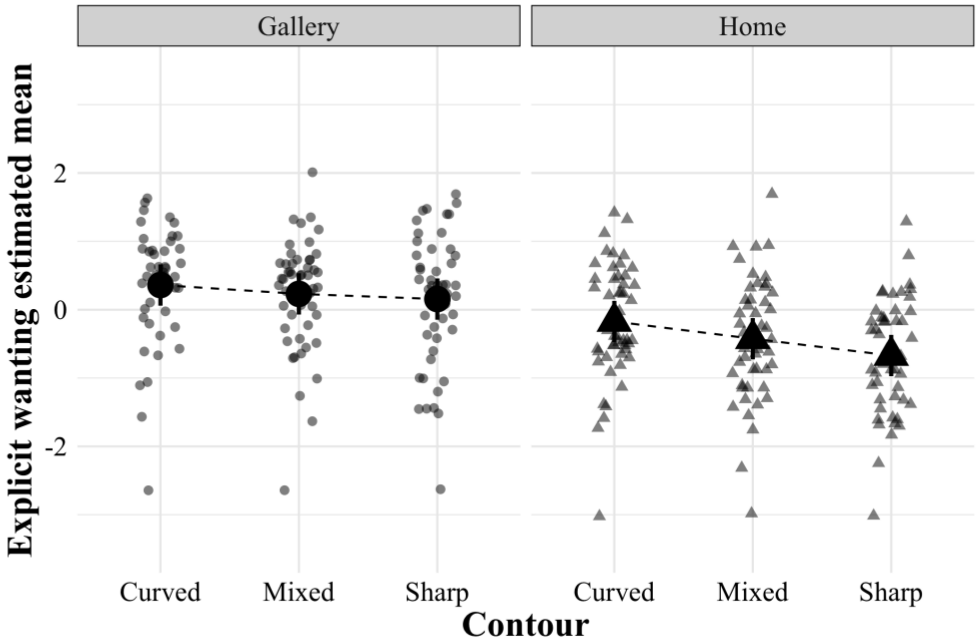

Figure 6. Estimated means of explicit wanting ratings according to the painting version and experimental condition (art gallery and home), according to paintings' contour type.

We also analyzed *response time* with the same model. Significance was reached only by *trial sequence* ($t(4785) = -7.29$, $p < .001$) and *task* ($t(4785) = -3.17$, $p = .002$). As previously found in Task 1, participants were faster to choose their wanting ratings as the task progressed (β = -11.70, *SE* = 1.61). Interestingly, participants were faster in Task 4 (*M* = 1502 ms, *SE* = 84) compared to Task 3 (*M* = 1616 ms, *SE* = 84), meaning that they were faster in responding to the hypothetical question about the gallery compared to the one about their house.

Relationship between the four different measures

With the aim of exploring the relationship between the four measures (implicit wanting, liking, explicit wanting for home, and explicit wanting for gallery), we used four exploratory models. Every model predicted one of the four measures from the other three.

All the models included participant and stimulus as random effects. The total explanatory power of the models was moderated or substantial; that is, the conditional R2 values were between .21 and .52. The parts related to the fixed effects alone (marginal R2) were between .003 and .26. The details of these models are in the Supplementary Materials. Here, we highlight the most relevant results.

- The implicit wanting measure did not predict the liking response (β = 0.003, 95% CI [-.02, .03], $t(2393) = 0.51$, $p = .727$).
- The liking measure significantly predicted both explicit wanting responses (Figure 7): *home* (β = 0.27, 95% CI [.23, .30], $t(2393) = 15.51$, $p < .001$) and *gallery* (β = 0.24, 95% CI [.16, .31], $t(2393) = 5.89$, $p < .001$).

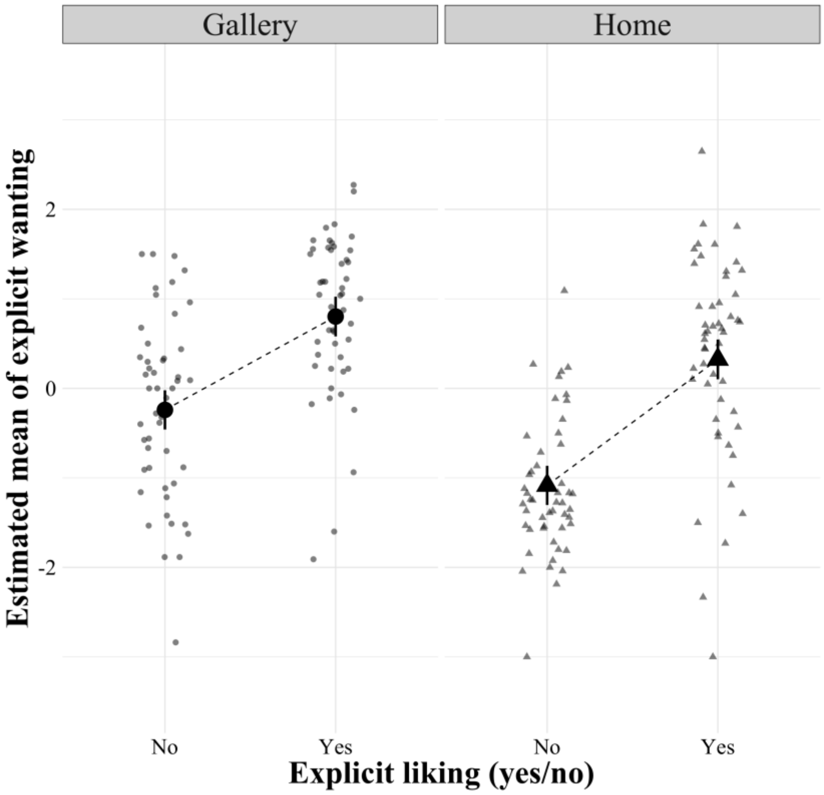

Figure 7. Estimated mean of explicit wanting ratings as a function of explicit liking ratings (Yes and No), according to experimental condition (art gallery and home).

- The implicit wanting measure significantly predicted the explicit wanting response in the *home* condition (β = 0.05, 95% CI [.01, .09], $t(2393) = 2.26$, $p = .024$) (Figure 8), but not in the *gallery* condition (β = 0.07, 95% CI [-.03, .16], $t(2393) = 1.39$, $p = .165$).

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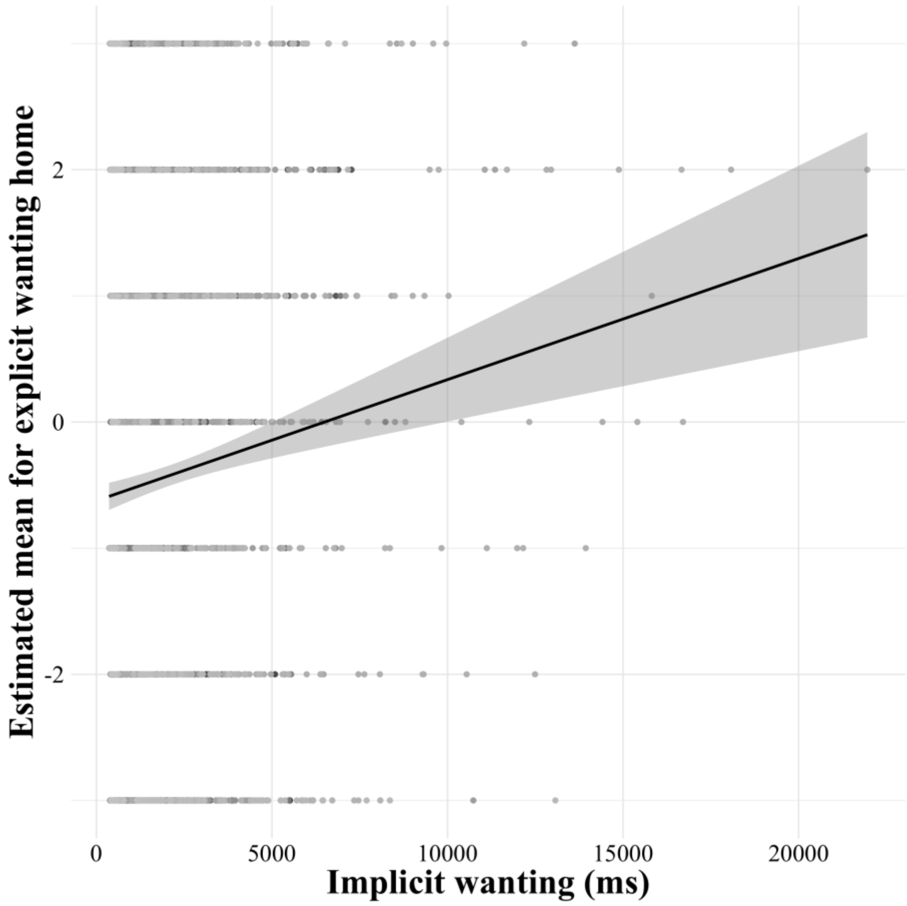

Figure 8. Explicit wanting in the home condition as a function of implicit wanting.

Discussion of Study 2

In this study, we aimed to differentiate between liking and wanting responses to art as an essential part of aesthetic experience and artistic encounters (Berridge, 2009; Berridge & Robinson, 2003; Dai et al., 2010; Robinson & Berridge, 1993, 2001). The rationale behind this methodological choice was to shed some light on previous conflicting results showing that: 1) liking and wanting are two separate cognitive processes; 2) preference for curvature changes according to task requirements (Leder et al., 2011; Vartanian et al., 2013; Zhang et al., 2006). We also found that curved paintings were liked more in Task 2 of Study 2, despite the different task requirements (like/dislike) compared to Study 1 (rating on a 0 to 100 slider). However, implicit and explicit wanting ratings in the art gallery context did not report a significant advantage for curvature, even though participants reported wanting more curved paintings for their homes. This pattern of results experimentally confirmed that: 1) liking and wanting are two different components of the aesthetic experience, probably corresponding to separate cognitive mechanisms; 2) participants were able to switch between likability and incentive value of the same stimulus as well as holding multiple preferences for the same object at the same time, in line with Dai et al. (2010). Moreover, we found that implicit wanting only predicted some explicit wanting ratings, but not liking ones. A further confirmation of the liking/wanting differentiation can be found in the fact that the openness-to-experience personality trait did not significantly influence wanting decisions, while it was a significant predictor for liking.

But how shall we interpret the different wanting judgments participants made in the *home* and *art* experimental context? We know that curved contours are more easily associated with positive and safe words (Palumbo et al., 2015), two concepts strictly related to the idea of home. Based on this evidence, we advance the hypothesis that when asked to make a more personal judgment about wanting to bring an artwork home (*home context*), participants might have been influenced more by the hedonic properties as well as the implicit valence of the paintings' low-level visual properties (e.g., curvature). In line with this interpretation, we found that the implicit wanting ratings significantly predicted explicit wanting ratings in the home condition, but not in the art gallery condition. On the other hand, when asked to assess their wanting for the artworks in an art-relevant context (*art context*), explicit and implicit wanting measures showed the same pattern of results, at the expense of the curvature advantage. These results might also be interpreted in light of the fact that the sharp-angled contours are a key visual feature of the futuristic art movement (*learning*), and therefore participants might have perceived them as more appropriate to be exhibited in the context of an art gallery. We advance the hypothesis that in the art gallery context, the sharp-angled paintings acquired a higher *incentive salience* value, therefore canceling the curvature effect, whose hedonic properties significantly influenced liking and wanting in the home context.

General Discussion

In this study, we investigated the hypothesis that the well-established preference for curvature might also be significant in the art domain. At the same time, we reported how previous literature showed that preference for curvature is not always present (Zhang et al., 2006; Leder et al., 2011; Ruta et al., 2018; Vartanian et al., 2013). We aimed to extend the curvature effect to the art domain and differentiate between liking and wanting judgments as key components of aesthetic experience. We defined liking as the hedonic pleasure during visual consumption or observation of a stimulus that can be measured using self-reports; and wanting as the motivation to look at a certain painting that can be measured by the actions that lead to the visual consumption or observation of the image (Berridge et al., 2009; Berridge & Winkielman, 2003; Dai et al., 2010).

We showed that curvature is also a relevant low-level feature in the art domain and that it positively influenced participants' liking judgments across different assessments and task requirements. Our results are in line with many previous studies that used the same psychological dimensions selected in the present study: liking (Bar & Neta, 2006, 2007; Bertamini et al., 2016; Carbon et al., 2018; Leder et al., 2011; Palumbo & Bertamini, 2016; Ruta et al., 2018), comfort (Aronoff, 2006; Jiang et al., 2015; Hareli et al., 2016; Soranzo et al., 2018), attractiveness (Palumbo & Bertamini, 2016; Zhang et al., 2006), and approachability (Bertamini et al., 2016; Corradi et al., 2019, 2018; Dazkir & Read, 2012; Gomez-Puerto et al., 2017; Munar et al., 2015, 2014; Palumbo et al., 2015; Ruta et al., 2018; Vartanian et al., 2017).

Regarding the wanting judgments, implicit wanting, measured as the physical effort to 'visually consume' each painting, did not show any significant differences between the three versions of paintings. It is possible that the design of the task was not sufficiently sensitive to capture differences in implicit wanting for the three sets of paintings. However, using exploratory models between measures, we found that implicit wanting predicted explicit wanting in the home context, but not in the gallery context. According to Koranyi et al. (2017), a wanting response has to contain the core features of wanting, that is, motivation to approach, obtain, and consume a desired stimulus. The authors indicated that when using implicit measures, stimuli should satisfy a current need, and the responses have to have consummatory consequences (Koranyi et al., 2017). As we did not test the initial 'need for art' of our participants at the beginning of the study, we were not able to test the validity of this hypothesis. Therefore, we need to acknowledge that our task alone might have not been enough to create the sufficient 'need for art' state in the participants to motivate their visual consumption of the paintings. In the future, it would be interesting to control or experimentally manipulate participants' initial 'need for visual consumption of artistic stimuli' as well as further investigate individual differences (such as personality traits or expertise) as relevant variables potentially interacting with implicit wanting.

On the other hand, we manipulated the imagined context of the task to measure explicit wanting, asking participants to assess how much they wanted to take the paintings home or to an art gallery. Results showed that, overall, participants assigned significantly higher ratings to paintings when they were asked to act as an art curator compared to when they had to judge if they wanted the paintings for their homes. The curvature effect was modulated by our experimental manipulation, showing a positive significant effect on explicit wanting in the task about the home scenario, but not about the gallery. These results provide evidence for the hypothesis that a stimulus-relevant context significantly influences the motivational component of preference for curvature, even if it is just imagined by participants.

Pool et al. (2016) suggested that explicit and implicit wanting rely on linked but different psychological mechanisms with implicit wanting being implicitly associated with cue-triggered motivational reactions that are potentially independent from hedonic aspects of reward; and explicit wanting being associated with expectations about the pleasantness of the reward (Pool et al., 2016; Meissner et al., 2019). In line with this, we found that implicit wanting did not report the curvature effect, while explicit wanting was partially in line with explicit liking. The effect was modulated by the experimental context (home *vs.* art gallery context). One possible explanation for the difference between the home and art conditions is that in the home scenario, people's judgments might have been more explicitly influenced by the hedonic impact of reward as well as the implicit affective valence of curved stimuli (Palumbo et al., 2015), as the significant relationship between the implicit ratings and the home condition ratings show. It is reasonable to assume that participants assessed their motivation to add an artwork to their homes based on the pleasure that the painting would bring in their daily life (Pool et al., 2016; Meissner et al., 2019) and according to the implicit positive and safe associations they might have made looking at the curved paintings (Palumbo et al., 2015). A second factor to take into account is the semantic difference between the two hypothetical contexts (home *vs.* gallery) and their relevance to our stimuli. The preference construction perspective

(Lichtenstein & Slovic, 2006) theorizes context as a flexible instance and takes into account the malleability of preferences: people may have one preference at a time toward an object, but as the context changes, their preferences might also change. As a consequence, participants might have easily associated the sharp-angled artworks with key characteristics of futuristic paintings and judged it to be more appropriate to exhibit these paintings in a gallery. Finally, the significantly higher wanting ratings reported by all three versions of the artworks in the art gallery compared to the home context might be due to the fact that people recognized the artistic value of all the stimuli, regardless of the contour. These results show how in an art-relevant context (*learning*), the well-established preference for curvature can lose its well-established (*liking*) advantage and how sharp-angled contours, commonly 'disliked' in psychological research, acquire a different incentive salience when participants simply imagined making their judgments in a different context (*wanting*).

To summarize, our findings were in line with previous studies on preference for curvature that used other types of stimuli: (a) all the studies using explicit liking found the curvature effect (Bar & Neta, 2006, 2007; Bertamini et al., 2016; Carbon, 2010; Carbon et al., 2018; Palumbo & Bertamini, 2016); (b) two studies using a non-semantic behavioral implicit liking task also showed the effect (Bertamini et al., 2016; Palumbo et al., 2015); (c) some studies found diverging results when using explicit liking (beauty judgments) and explicit wanting (approachability) tasks (Vartanian et al., 2013, 2017; Ruta et al., 2018); and (d) we did not find any study using a non-semantic behavioral wanting implicit task. Our study replicated the curvature effect in the art domain, showing that similar processes and mechanisms apply to both artistic and non-artistic stimuli, but also highlighting the complexity of liking and wanting judgments in the artistic domain. As Skov and Nadal (2018) indicated, *'scientific aesthetics needs to sink its foundations deep into the general psychology and neuroscience of reward, perception and meaning and extract knowledge, concepts, methods and models that are relevant to understanding the experience of art and aesthetics.'* The current study provides a complex view on aesthetic experience, supporting evidence to the view that the psychological and neurological mechanisms of preference are shared between art and non-art perception (Skov, 2019) and that incentive salience of visual stimuli is modulated by learning in a specific stimulus-relevant context.

Limitations

There were a number of limitations to the present study. First, we used only the digital versions of the paintings as stimuli. In the future, we aim to replicate these results using real artworks, as the digital version can have some distinctive effects that might be difficult to identify at the moment. Moreover, it will be critical to run future studies in the usual places to exhibit paintings, that is, galleries or museums.

We also have to bear in mind that in this study, we used indeterminate paintings that have specific characteristics. They represent colors and shapes that resemble but do not directly match known objects. We aim to extend our results with other types of paintings, such as abstract or figurative ones.

As we have seen, wanting and liking are two distinct processes and, according to Berridge and Robinson (1998), wanting is intrinsically implicit. The systematic review by Pool et al. (2016) described how wanting and liking have been measured across studies investigating human reward. One of their recommendations to measure the wanting process is that it should be made during or after the perception of a real or vividly imagined cue but not after the 'consumption' of the stimulus. In painting perception, it is not easy to define the cue that triggers the wanting process. A direct dialogue between the scientific and artistic community might be beneficial not only to identify and define such cues, but also to test the incentive salience theory hypothesis in the art domain. Besides the evaluative movement assessment (EMA) used in Dai et al. (2010), the wanting implicit association test (Koranyi et al., 2017) seems to be a good tool to measure implicit wanting based on the idea of a truly motivational wanting quality, which allows assessment of stimulus-response compatibility effects between target stimuli and responses.

Finally, participants belong to specific populations and have different interests or expertise in art. Future research will aim to extend this type of study beyond the populations that represent our samples.

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Author contributions

Conception and design of the experiments for Study 1: NR, RP. Conception, design and performing of the experiments for Study 2: NR, JV, EGC, CR. Analysis of the data: NR (Study 1 and Study 2), GC (Study 2), JV (Study 2). Writing of the paper: NR, EM. Provision of critical feedback and helping shape the final manuscript: RP, GC, EGC.

References

Arnheim, R. (1974). *Art and visual perception: A psychology of the creative eye*. University of California Press.

Aronoff, J. (2006). How we recognize angry and happy emotion in people, places, and things. *Cross-Cultural Research*, *40*(1), 83–105. https://doi.org/10.1177/1069397105282597

Baayen, R. H., Davidson, D. J., & Bates, D. M. (2008). Mixed-effects modeling with crossed random effects for subjects and items. *Journal of Memory and Language*, *59*(4), 390–412. https://doi.org/10.1016/j.jml.2007.12.005

Bar, M., & Neta, M. (2006). Humans prefer curved visual objects. *Psychological Science*, *17*(8), 645–648. https://doi.org/10.1111/j.1467-9280.2006.01759.x

Bar, M., & Neta, M. (2007). Visual elements of subjective preference modulate amygdala activation. *Neuropsychologia*, *45*(10), 2191–2200. https://doi.org/10.1016/j.neuropsychologia.2007.03.008

Barr, D. J., Levy, R., Scheepers, C., & Tily, H. J. (2013). Random effects structure for confirmatory hypothesis testing: Keep it maximal. *Journal of Memory and Language, 68*(3), 255–278. https://doi.org/10.1016/j.jml.2012.11.001

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models using lme4. *Journal of Statistical Software*, *67*(1), 1–48. https://doi.org/0.18637/jss.v067.i01

Berridge, K. C. (1999). Pleasure, pain, desire, and dread: Hidden core processes of emotion. In D. Kahneman, E. Diener, & N. Schwarz (Eds.), *Well-being: The foundations of hedonic psychology* (pp. 525–557). Russell Sage Foundation.

Berridge, K. C. (2009). Wanting and Liking: Observations from the Neuroscience and Psychology Laboratory. *Inquiry*, *52*(4), 378–398. https://doi.org/10.1080/00201740903087359

Berridge, K. C., & Kringelbach, M. L. (2015, May). Pleasure Systems in the Brain. *Neuron*. Cell Press. https://doi.org/10.1016/j.neuron.2015.02.018

Berridge, K. C., & Robinson, T. E. (1998). What is the role of dopamine in reward: Hedonic impact, reward learning, or incentive salience? *Brain Research Reviews*, *28*(3), 309–369. https://doi.org/10.1016/S0165-0173(98)00019-8

Berridge, K. C., & Robinson, T. E. (2003, September). Parsing reward. *Trends in Neurosciences*. Elsevier Ltd. https://doi.org/10.1016/S0166-2236(03)00233-9

Berridge, K. C., Robinson, T. E., & Aldridge, J. W. (2009). Dissecting components of reward: "liking", "wanting", and learning. *Current Opinion in Pharmacology*, *9*(1), 65–73. https://doi.org/10.1016/j.coph.2008.12.014

Berridge, K. C., & Winkielman, P. (2003). What is an unconscious emotion? The case for unconscious "liking". *Cognition & Emotion*, *17*(2), 181–211.

Bertamini, M., Palumbo, L., Gheorghes, T. N., & Galatsidas, M. (2016). Do observers like curvature or do they dislike angularity? *British Journal of Psychology*, *107*(1), 154–178. https://doi.org/10.1111/bjop.12132

Carbon, C.-C. (2010). The cycle of preference: Long-term dynamics of aesthetic appreciation. *Acta Psychologica*, *134*(2), 233–244. https://doi.org/10.1016/j.actpsy.2010.02.004

Carbon, C.-C., Mchedlidze, T., Raab, M. H., & Wächter, H. (2018). The power of shape: How shape of node-link diagrams impacts aesthetic appreciation and triggers interest. *I-Perception*, *9*(5), 204166951879685. https://doi.org/10.1177/2041669518796851

Chatterjee, A., Widick, P., Sternschein, R., Smith, W. B., & Bromberger, B. (2010). The assessment of art attributes. *Empirical Studies of the Arts*, *28*, 207–222.

Cho, J. Y., Lee, J., & Yoo, J. (2018). Culture or expertise: creativity, preference, and formal attributes of interior design by Americans and Koreans. *Creativity Research Journal*, *30*(4), 418–427. Retrieved from http://10.0.4.56/10400419.2018.1530915

Corradi, G., Belman, M., Currò, T., Chuquichambi, E. G., Rey, C., & Nadal, M. (2019). Aesthetic sensitivity to curvature in real objects and abstract designs. *Acta Psychologica*, *197*(October 2018), 124–130.

https://doi.org/10.1016/j.actpsy.2019.05.012

Corradi, G., & Munar, E. (2020). The Curvature Effect. In M. Nadal & O. Vartanian (Eds.), *The Oxford Handbook of Empirical Aesthetics*. Oxford University Press. https://doi.org/10.1093/oxfordhb/9780198824350.013.24

Corradi, G., Rosselló, J., Vañó, J., Chuquichambi, E., Bertamini, M., & Munar, E. (2018). The effects of presentation time on preference for curvature of real objects and meaningless novel patterns. *British Journal of Psychology*. https://doi.org/DOI:10.1111/bjop.12367

Cotter, K. N., Silvia, P. J., Bertamini, M., Palumbo, L., & Vartanian, O. (2017). Curve appeal: Exploring individual differences in preference for curved versus angular objects. *I-Perception*, *8*(2), 1–17. https://doi.org/10.1177/2041669517693023

Dai, X., Brendl, C. M., & Ariely, D. (2010). Wanting, liking, and preference onstruction. *Emotion*, *10*(3), 324–334. https://doi.org/10.1037/a0017987

Dazkir, S. S., & Read, M. A. (2012). Furniture form and their influence on our emotional responses toward interior environments. *Environment and Behavior*, *44*(5), 722–732. https://doi.org/10.1177/0013916511402063

Elliot, A. J., & Covington, M. V. (2001). Approach and avoidance motivation. *Educational Psychology Review*, *13*(2), 73–92. https://doi.org/10.1023/A:1009009018235

Fantz, R. L. (1961). The origin of form perception. *Scientific American*, *204*(5), 66–72. https://doi.org/10.1038/scientificamerican0561-66

Fantz, R. L., & Miranda, S. B. (1975). Newborn-infant attention to form of contour. *Child Development*, *46*(1), 224–228. https://doi.org/10.2307/1128853

Gomez-Puerto, G., Munar, E., & Nadal, M. (2016). Preference for curvature: A historical and conceptual framework. *Frontiers in Human Neuroscience, 9*(January), 1–8. https://doi.org/10.3389/fnhum.2015.00712

Gomez-Puerto, G., Rosselló, J., Corradi, G., Acedo-Carmona, C., Munar, E., & Nadal,

M. (2017). Preference for curved contours across cultures. *Psychology of Aesthetics, Creativity, and the Arts*, *12*(4), 432–439. https://doi.org/10.1037/aca0000135

Gómez-Puerto, G., Rosselló, J., Corradi, G., Acedo-Carmona, C., Munar, E., & Nadal, M. (2017). Preference for Curved Contours Across Cultures. *Psychology of Aesthetics, Creativity, and the Arts*. https://doi.org/10.1037/aca0000135

Hadjikhan, N., Kveraga, K., Naik, P., & Ahlfors, S. P. (2009). Early (M170) activation of face-specific cortex by face-like objects. *NeuroReport*, *20*(4), 403–407. https://doi.org/10.1097/WNR.0b013e328325a8e1

Hareli, S., David, S., Lev-Yadun, S., & Katzir, G. (2016). Money in your palm: Sharp shaped vegetation in the surroundings increase the subjective value of houses. *Journal of Environmental Psychology*, *46*, 176–187. https://doi.org/10.1016/j.jenvp.2016.04.014

Harrington, G. M. (1966). Form preference in rats. *Psychonomic Science*, *6*(1), 13–14. https://doi.org/10.3758/BF03327933

Havermans, R. C. (2012). How to tell where “liking” ends and “wanting” begins. *Appetite*, *58*(1), 252–255. https://doi.org/10.1016/j.appet.2011.10.013

Hox, J. J. (2010). *Multilevel analysis. Techniques and applications*. Routeledge.

Huston, J. P., Nadal, M., Mora, F., Agnati, L., & Cela-Conde, C. J. (2015). *Art, aesthetics and the brain*. Oxford Univerisity Press.

Jadva, V., Hines, M., & Golombok, S. (2010). Infants’ preferences for toys, colors, and shapes: Sex differences and similarities. *Archives of Sexual Behavior*, *39*(6), 1261–1273. https://doi.org/10.1007/s10508-010-9618-z

Jiang, Y., Gorn, G. J., Galli, M., & Chattopadhyay, A. (2015). Does your company have the right logo? How and why circular- and angular-logo shapes influence brand attribute judgments. *Journal of Consumer Research*, *42*(5), 709–726. https://doi.org/10.1093/jcr/ucv049

Koranyi, N., Grigutsch, L. A., Algermissen, J., & Rothermund, K. (2017). Dissociating implicit wanting from implicit liking: Development and validation of the Wanting Implicit Association Test (W-IAT). *Journal of Behavior Therapy and Experimental Psychiatry, 54,* 165–169. https://doi.org/10.1016/j.jbtep.2016.08.008

Leder, H., & Carbon, C.-C. (2005). Dimensions in appreciation of car interior design. *Applied Cognitive Psychology*, *19*(5), 603–618. https://doi.org/10.1002/acp.1088

Leder, H., Tinio, P. P. L., & Bar, M. (2011). Emotional valence modulates the preference for curved objects. *Perception*, *40*(6), 649–655. https://doi.org/10.1068/p6845

Lichtenstein, S., & Slovic, P. (2006). *The construction of preference*. Cambridge University Press.

Liu, J., Li, J., Feng, L., Li, L., Tian, J., & Lee, K. (2014). Seeing Jesus in toast: Neural and behavioral correlates of face pareidolia. *Cortex*, *53*(1), 60–77. https://doi.org/10.1016/j.cortex.2014.01.013

Mathôt, S., Schreij, D., & Theeuwes, J. (2012). OpenSesame: An open-source, graphical experiment builder for the social sciences. *Behavior Research Methods*, *44*(2), 314–324. https://doi.org/10.3758/s13428-011-0168-7

McCrae, R. R., & Costa, P. T. (2004). A contemplated revision of the NEO five-factor inventory. *Personality and Individual Differences*, *36*, 587–596.

Munar, E., Gómez-Puerto, G., Call, J., & Nadal, M. (2015). Common visual preference for curved contours in humans and great apes. *Plos One*, *10 (11): e*. https://doi.org/10.1371/journal.pone.0141106

Munar, E., Gómez-Puerto, G., & Gomila, A. (2014). The evolutionary roots of aesthetics: An approach-avoidance look at curvature preference. In A. Scarinzi (Ed.), *Embodied aesthetics* (pp. 3–17). Brill.

Nadal, M., Munar, E., & Capó, M. À. (2008). Towards a framework for the study of the neural correlates of aesthetic preference. *Spatial Vision*, *21*(3–5), 379–396. https://doi.org/10.1163/156856808784532653

Palumbo, L., & Bertamini, M. (2016). The curvature effect: A comparison between preference tasks. *Empirical Studies of the Arts*, *34*(1), 35–53. https://doi.org/10.1177/0276237415621185

Palumbo, Ruta, N., & Bertamini, M. (2015). Comparing angular and curved shapes in terms of implicit associations and approach/avoidance responses. *Plos One*, *10*(10), e0140043. https://doi.org/10.1371/journal.pone.0140043

Penacchio, O., & Wilkins, A. J. (2015). Visual discomfort and the spatial distribution of Fourier energy. *Vision Research*, *108*, 1–7. https://doi.org/10.1016/j.visres.2014.12.013

Pepperell, R. (2012). The perception of art and the science of perception. *Human Vision and Electronic Imaging XVII*, *8291*, 829113. https://doi.org/10.1117/12.914774

Pinheiro J, Bates D, DebRoy S, Sarkar D, R Core Team (2020). _nlme: Linear and Nonlinear Mixed Effects Models_.

Pool, E., Sennwald, V., Delplanque, S., Brosch, T., & Sander, D. (2016). Measuring wanting and liking from animals to humans: A systematic review. *Neuroscience and Biobehavioral Reviews*, *63*, 124–142. https://doi.org/10.1016/j.neubiorev.2016.01.006

R Core Team (2016). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/.

Robinson, T. E., & Berridge, K. C. (1993, September). The neural basis of drug craving: An incentive-sensitization theory of addiction. *Brain Research Reviews*. Elsevier. https://doi.org/10.1016/0165-0173(93)90013-P

Robinson, T. E., & Berridge, K. C. (2001, January). Incentive-sensitization and addiction. *Addiction*. John Wiley & Sons, Ltd. https://doi.org/10.1046/j.1360-0443.2001.9611038.x

Ruff, H. A., & Birch, H. G. (1974). Infant visual fixation: The effect of concentricity, curvilinearity and number of directions. *Journal of Experimental Child Psychology*, *17*, 460–473.

Ruta, N., Mastandrea, S., Penacchio, O., Lamaddalena, S., Bove, G. (2018). A comparison between preference judgments of curvature and sharpness in architectural façades. *Architectural Science Review, 0*(0), 1–11. https://doi.org/10.1080/00038628.2018.1558393

Silvia, P. J. (2007). An Introduction to Multilevel Modeling for Research on the Psychology of Art and Creativity. *Empirical Studies of the Arts*, *25*(1), 1–20. https://doi.org/10.2190/6780-361T-3J83-04L1

Silvia, P. J., & Barona, C. M. (2009). Do people prefer curved objects? Angularity, expertise, and aesthetic preference. *Empirical Studies of the Arts*, *27*(1), 25–42. https://doi.org/10.2190/EM.27.1.b

Skov, M. (2019). Aesthetic Appreciation: The View From Neuroimaging. *Empirical Studies of the Arts*, *37*(2), 220–248. https://doi.org/10.1177/0276237419839257

Skov, M., & Nadal, M. (2018). Art is not special : an assault on the last lines of defense against the naturalization of the human mind. *Review Neuroscience*, 16–19. https://doi.org/https://doi.org/10.1515/revneuro-2017-0085

Snijders, T. A. B., & Bosker, R. J. (2012). *Multilevel analysis. An introduction to basic and advanced multilevel modeling*. Sage Publications.

Soranzo, A., Petrelli, D., Ciolfi, L., & Reidy, J. (2018). On the perceptual aesthetics of interactive objects. *Quarterly Journal of Experimental Psychology*, 174702181774922. https://doi.org/10.1177/1747021817749228

Tinio, P. P. L., & Smith, J. K. (2015). *The Cambridge handbook of the psychology of aesthetics and the arts*. Cambridge University Press. https://doi.org/10.1017/CBO9781139207058

Van Oel, C. J., & Van den Berkhof, F. W. D. (2013). Consumer preferences in the design of airport passenger areas. *Journal of Environmental Psychology*, *36*, 280–290. https://doi.org/10.1016/j.jenvp.2013.08.005

Vartanian, O., & Goel, V. (2004). Neuroanatomical correlates of aesthetic preference for paintings. *Neuroreport*, *15*(5), 893–897. https://doi.org/10.1097/01.wnr.00001

Vartanian, O., Navarrete, G., Chatterjee, A., Fich, L. B., Leder, H., Modrono, C., … Skov, M. (2013). Impact of contour on aesthetic judgments and approach-avoidance decisions in architecture. *Proceedings of the National Academy of Sciences of the United States of America*, *110*, 10446–10453. https://doi.org/10.1073/pnas.1301227110

Vartanian, O., Navarrete, G., Chatterjee, A., Fich, L. B., Leder, H., Rostrup, N., … Skov, M. (2017). Preference for curvilinear contour in interior architectural spaces: Evidence from experts and nonexperts preference. *Psychology of Aesthetics, Creativity, and the Arts*, *13*(1), 110–116. https://doi.org/10.1037/aca0000150

Wade, N. (2016). *Art and illusionists*. Springer International Publishing. https://doi.org/10.1007/978-3-319-25229-2

Westerman, S., Gardner, P. H., Sutherland, E. J., White, T., Jordan, K., Watts, D., & Wells, S. (2012). Product design: Preference for rounded versus angular design elements. *Psychology & Marketing*, *29*(August), 595–605. https://doi.org/10.1002/mar

Zhang, Y., Feick, L., & Price, L. J. (2006). The impact of self-construal on aesthetic preference for angular versus rounded shapes. *Personality and Social Psychology Bulletin*, *32*(August), 794–805. https://doi.org/10.1177/0146167206286626

Figure1

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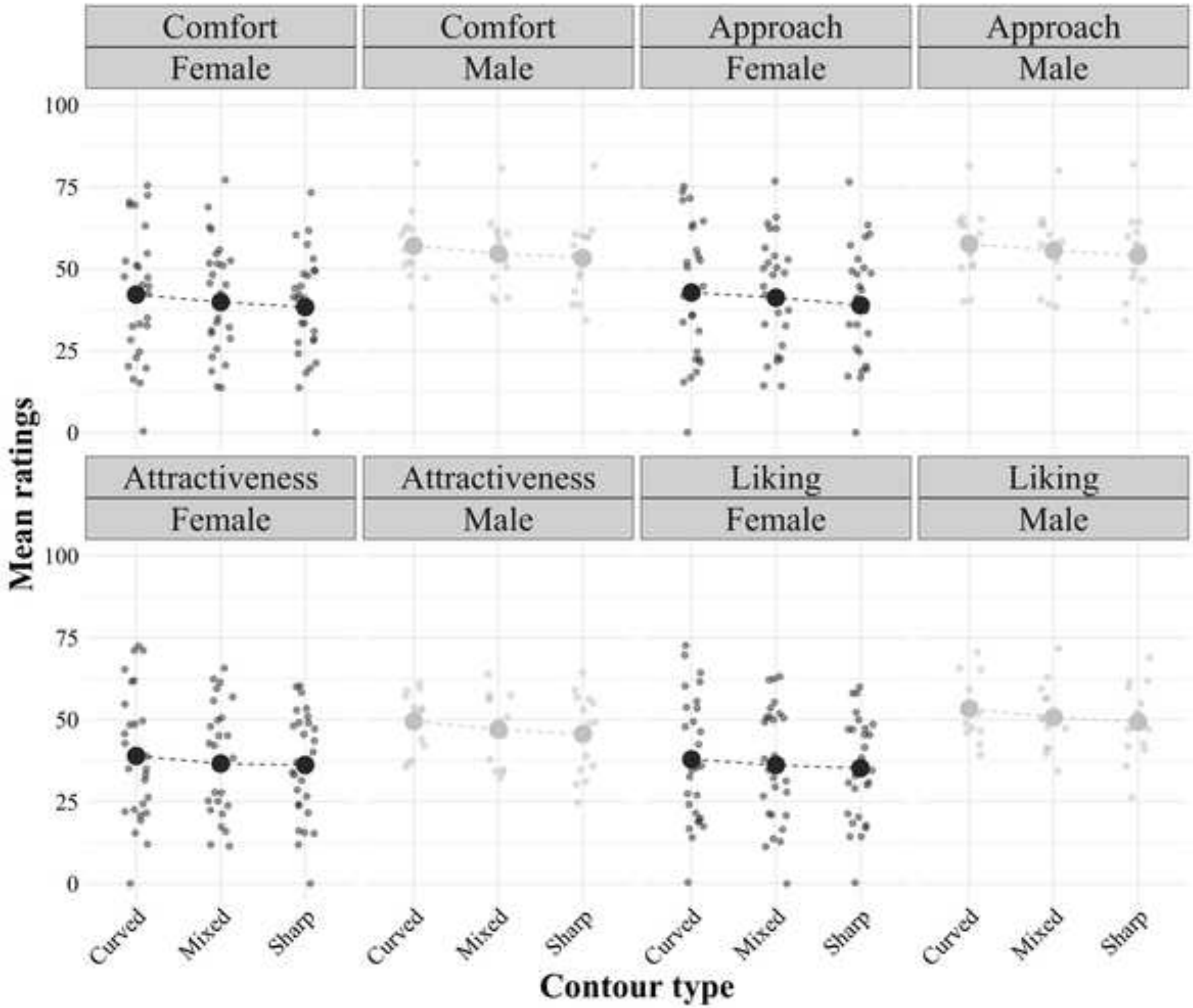
Figure2


Comfort
Female
Comfort
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Approach
Female
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Male
Attractiveness
Female
Attractiveness
Male
Liking
Female
Liking
Male
Mean ratings
100
75
50
25
0
Curved
Mixed
Sharp
Contour type

Figure3

Click here to access/download;Figure;Fig3_ComfApproachAge.jpg

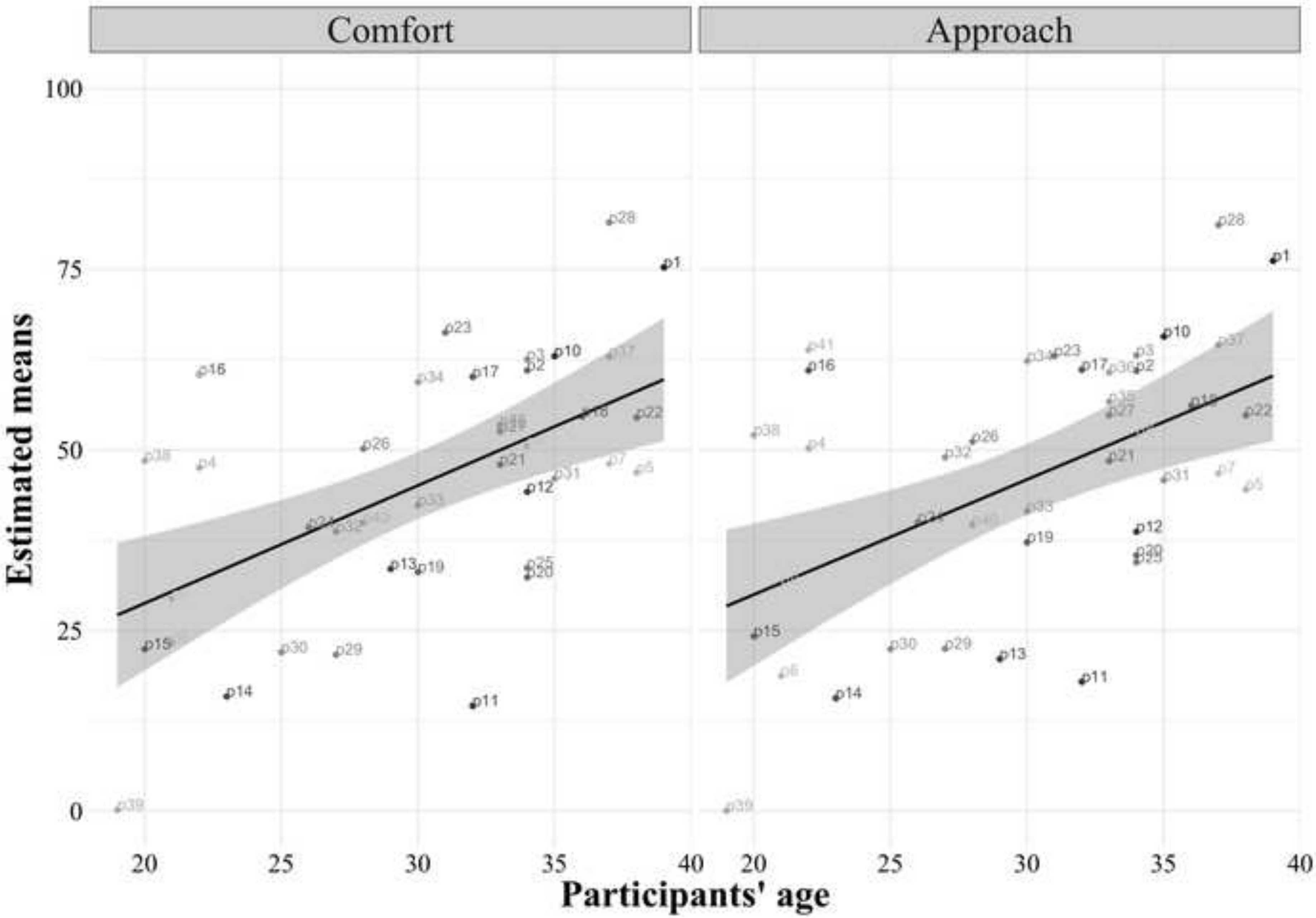
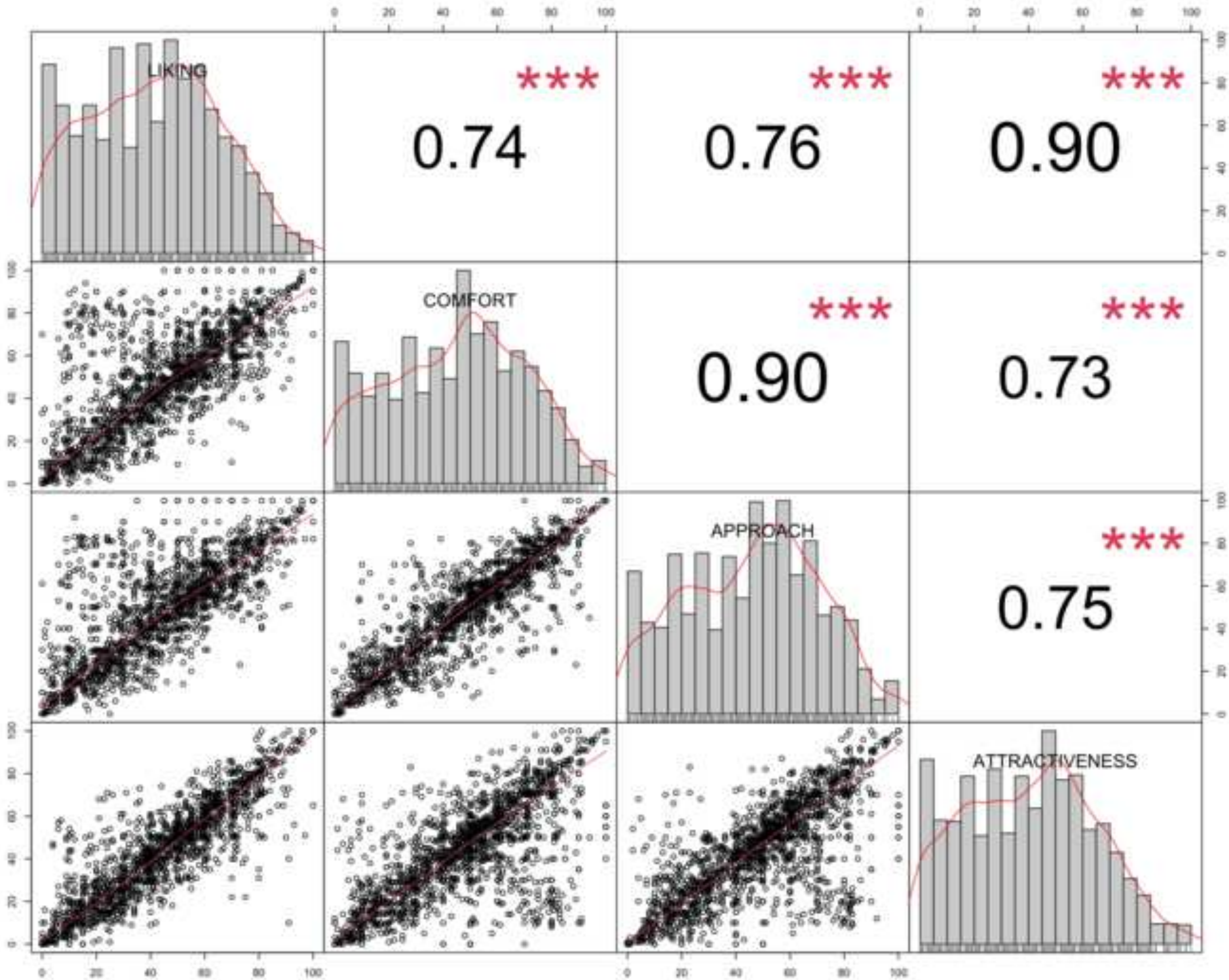


Figure4


LIKING
COMFORT
APPROACH
ATTRACTIVENESS
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0.90
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20
40
60
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100

Figure5

Click here to access/download;Figure;Fig5_LikeContour.png

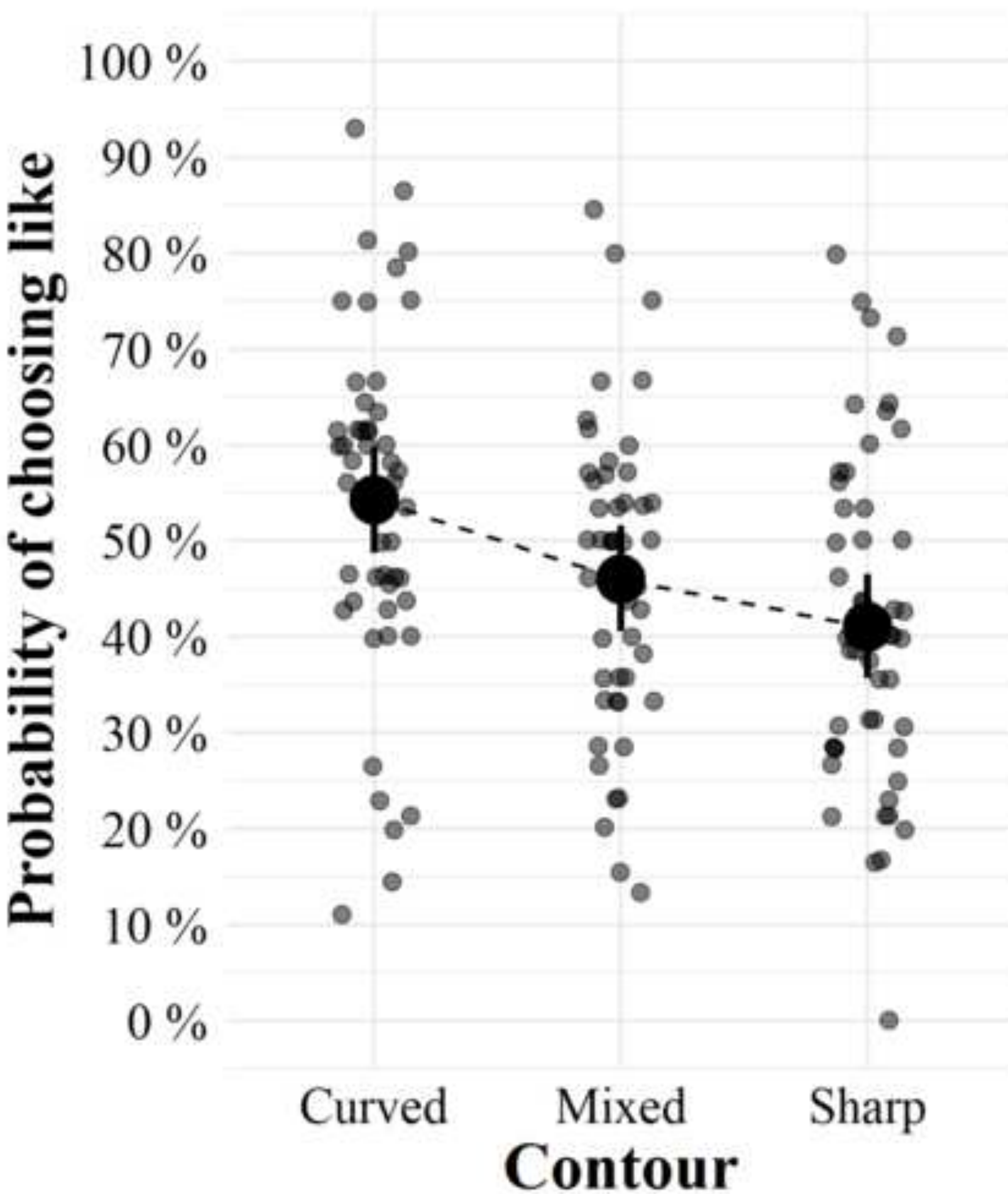

Figure6

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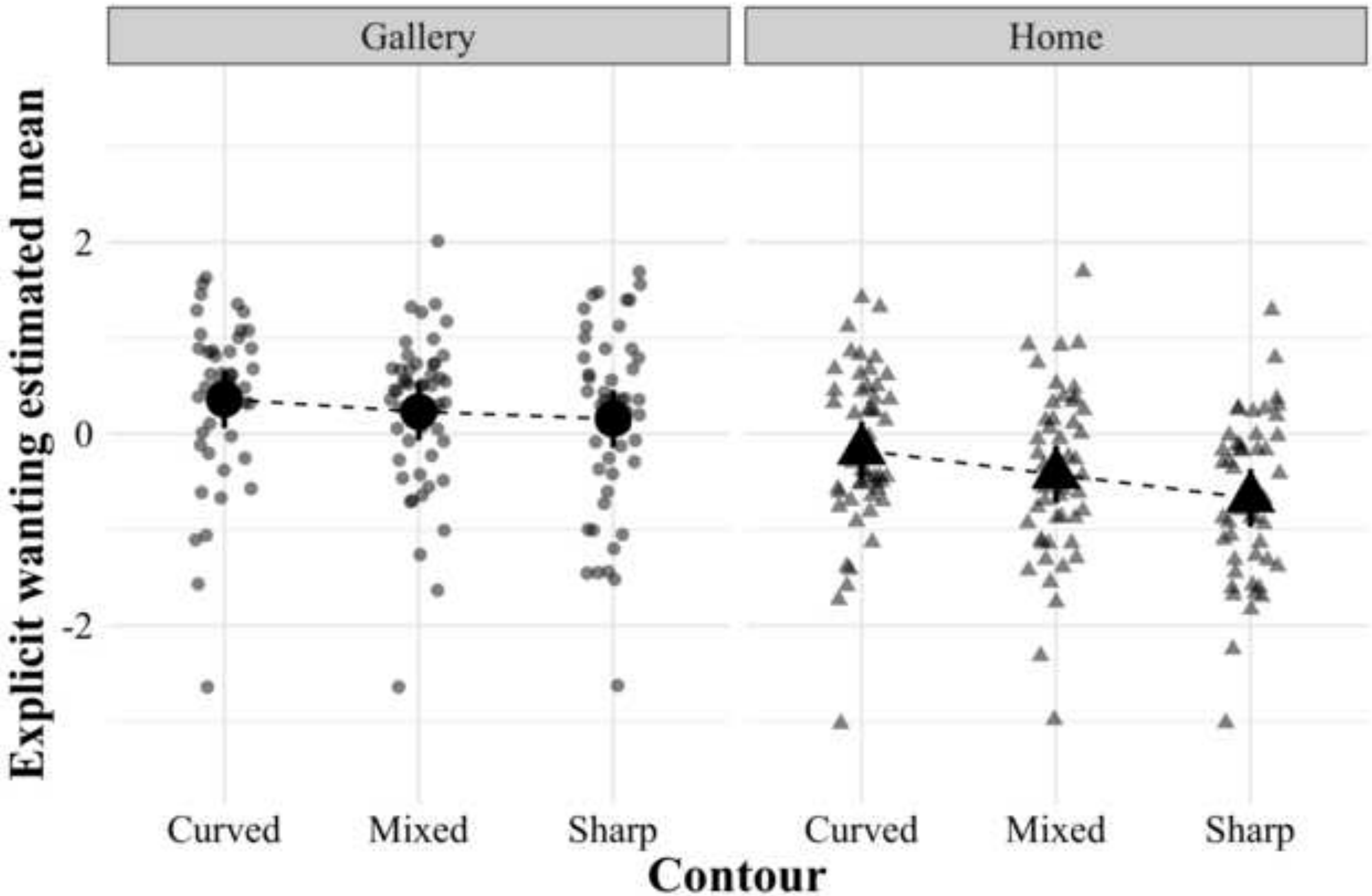
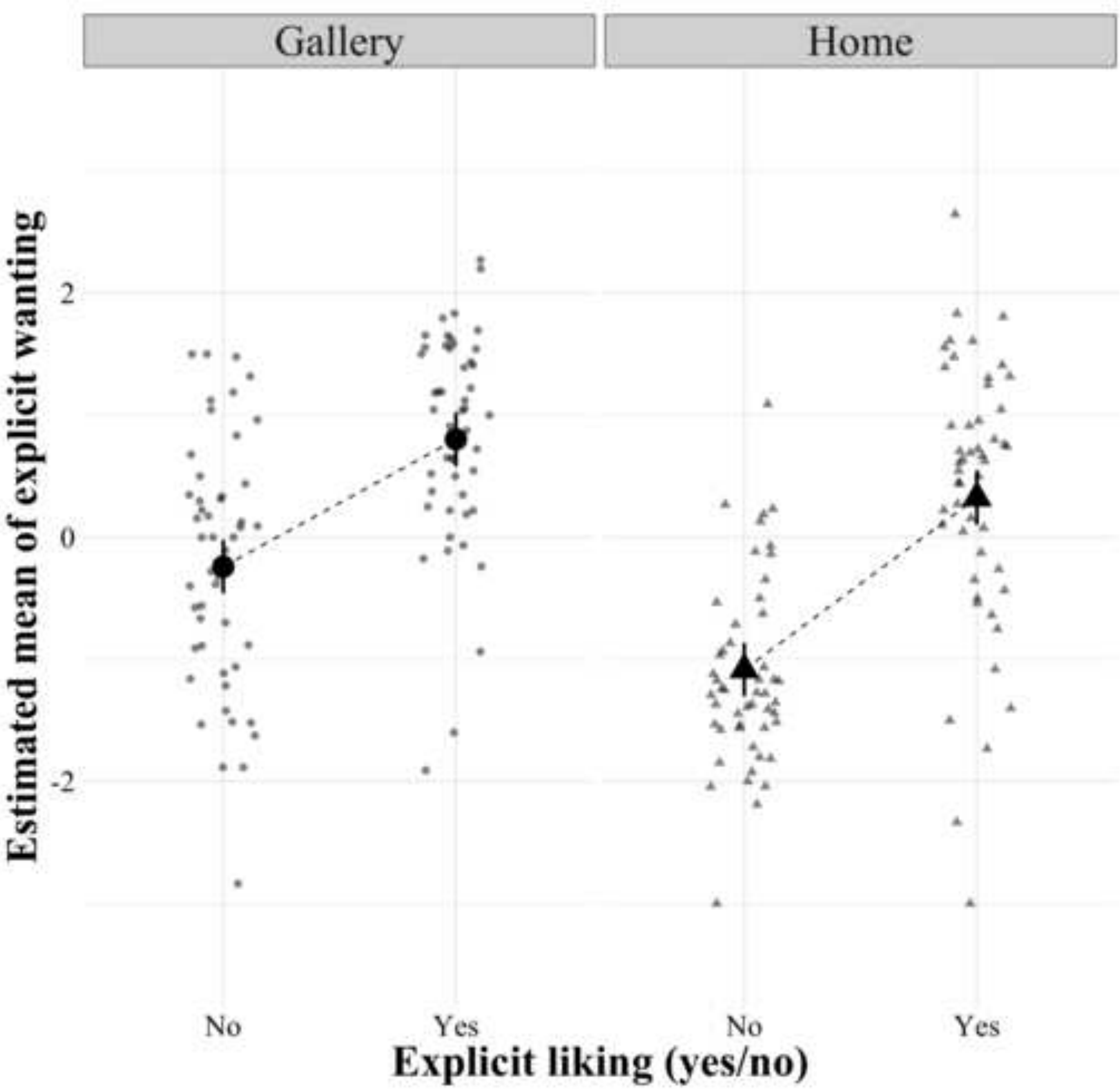


Figure7


Gallery
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Estimated mean of explicit wanting
2
0
-2
No
Yes
No
Yes
Explicit liking (yes/no)

Figure8

Click here to access/download;Figure;Fig8_Exp2_watingCorr.png