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Justification:

The aim of this Master's Thesis is to assess the relation between the visual preference for curved contours and its relevance in art appreciation. The journal *Art & Perception* is an international high-quality platform to publish artwork research and develop the emerging bridge between art and human perception. Thus, this Master's Thesis shares its main goal with the journal *Art & Perception* which is to explore the links between the science of perception and the arts.

The Role of Curvature in Preference for Visual Artworks

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Abstract

Several studies have shown that people tend to prefer objects (Bar & Neta, 2006, 2007), rooms (Vartanian et al., 2013), and geometric figures (Bertamini & Palumbo, 2016; Silvia & Barona, 2009) with curved contours to similar sharp-angled ones (Gómez-Puerto, Munar, & Nadal, 2015). In a previous study we aimed to determine whether people's preference for curvature extends to their appreciation for artworks. The results showed a negative effect of mere exposure and a small effect of preference for curvature. In the present study we related both effects to investigate if participants were aware of curvature differences in abstract artworks. To this end, we created a set of stimuli that included two versions of indeterminate cubist artworks: the original paintings -with sharp angles- and versions that had been altered by rounding off 6 vertices in the center of the artworks. Participants were presented with both versions for 83 ms in random order, and asked to rate them according to liking on a 7-point Likert scale. Our results did not support our original hypothesis because the same negative mere exposure effect was found in all images. Further research should use simpler artworks with more evident differences and give the participants more time to appreciate the paintings.

Keywords: aesthetics, art, preference, curvature, mere exposure

Introduction

Many of the decisions we make on a day-to-day basis are influenced by our aesthetic judgments. The choice for a specific t-shirt in the morning or for a particular seating spot on a movie theater has a strong connection with our aesthetic preferences. Given the importance they have in our lives, it is unsurprising that the study of aesthetics and aesthetic judgments is one of the oldest topics in psychology. Developed originally by Gustav T. Fechner (1876), empirical aesthetics has grown in importance and in repercussion and has an important position in today's psychology research (Chatterjee, 2011, 2012).

Although the popular knowledge suggests that aesthetics and art are alike and the experience of art is generally conceived as a cultural sensorial event and related to a positive aesthetic experience (Palmer, Schloss & Sammartino, 2013) these are not equivalent: "The aesthetic judgment extends beyond works of art, since there is a beauty of nature as well as of art; and works of art give us more than the aesthetic judgment, since when we have decided as to the pleasingness or displeasingness of their impression we can go on to discuss the conditions of their origination, the relation between portrayal and portrayed, between form and contents, copy and model, etc., etc." (Külpe, 1879, p.88). Accordingly, Pearce et al. (2016) distinguish scientific approaches to art from scientific approaches to aesthetics. Nevertheless, they do note that most empirical research on aesthetics, including the present study, can be regarded as investigations of the aesthetic appreciation of artworks, in the sense that their aim is to understand the cognitive, perceptual and affective processes involved in the aesthetic experience while people contemplate artworks.

Leder and colleagues' (Leder, Belke, Oeberst and Augustin 2004; Leder & Nadal, 2014) model of aesthetic experience reviews and summarizes the knowledge of this research field without relying on any absolute definition of aesthetics. This model underlines the importance of memory, time, previous knowledge and the different processing stages in the aesthetic perception. It also explains how aesthetic appreciation produces both a cognitive and an emotional processing that can lead to positive, affective and self rewarding experiences. A recent review of this particular model (Leder & Nadal, 2014) brings out the current state of the different studies and evidences of empirical aesthetics. Both evolutionary and neurobiological perspectives need to integrate in order to create a global science of aesthetics. This approach could enable researchers to identify neural bases of known aesthetic processes and to investigate possible influential mechanisms in aesthetics whose effects are yet unknown, like genetics or hormones.

Preference for Curvature

When given the choice between two versions of the same object, one curved and the other one sharp-angled, humans tend to prefer the curved one (Munar, Gómez-Puerto, Call & Nadal, 2015), whenever there is no other influencing factor. This phenomenon receives the name of preference for curvature and has been observed in many contexts.

In the early 1920s we can already find evidence (Poffenberger & Barrows, 1924) that different types of lines with dissimilar characteristics can arouse different kinds of emotional responses in the viewer. In addition, rounded body movements performed by magicians (Otero-Millán et al., 2011) produce a stronger misdirection, when compared

with more rectilinear body movements. Curvature in general seems to be a physical characteristic that does not require high level processing (Johnston & Passmore, 1994) and can be directly extracted from visual information on the retina, given the short time it's needed for the curvature to be detected. The curvature of an object or figure can also enhance its recognition speed. This was proven in a study (Álvarez, Blanco & Leirós, 2002) where open figures and closed ones had to be discriminated and both symmetrical and rounded figures were differentiated faster than the others.

One of the most known studies that underlined a clear preference for curvature in humans (Bar & Neta, 2006) compared equivalent objects in form and shape, one with round edges and contours and one with sharp ones. A clear preference towards the round objects was revealed, suggesting an important role of the object contours in the participant's preferences. Using a subset of the same stimuli, the preference for curved objects was replicated in humans and in great apes, although both groups differed in the magnitude and the manner in which this preference was evident (Munar et al., 2015). Nevertheless, this recent results suggest an interesting link between humans and other primates regarding the aesthetic preference for curvature.

Given the neutral valence of the stimuli used by Bar & Neta (2006), one question arises: Does valence affect the preference for curvature? In order to answer this question, day to day objects with neutral, positive and negative valence were compared (Leder, Tinio & Bar, 2011) and the curved objects were preferred when their valence was positive or neutral but there was no difference when the valence was negative. This reveals that valence was prioritized over the contour. Hess, Gryc & Hareli (2013) used images of objects and environments, both curved and sharp-angled as priming before the participants had to make social and moral judgments. After a sharp-angled image

was presented, participants took more risky decisions and labeled strangers as more aggressive than after a curved image.

Preference for curved elements over sharp-angled ones has also been found in pictures of halls and rooms (Vartanian et al., 2013) that presented elements like tables, chairs or shelves. The rooms were also divided regarding the height of the ceiling and their openness, but the preference for curved interiors and elements was present in all categories. Geometric figures (Silvia & Barona, 2009) with smooth edges also seem to be preferred by humans, as opposed to hexagons and more sharp-angled figures. A similar phenomenon occurs when rating pictures of car models (Carbon, 2010), although this particular finding, according to the author's proposal, could be affected by fashion and aesthetic tendencies that usually drive the changes in the car design industry.

Regarding the possible explanation of this preference, there is no general agreement. A possible interpretation was given by Bar & Neta (2007) when they discovered a larger activation of the amygdala while the participants were watching sharp-angled objects, than when they were seeing curved ones. The main hypothesis was that the preference for curved stimulus would be caused by the avoidance of sharp-angled stimulus being perceived as a threat. Thus, preference for curvature would be an imprecise name to describe a repulsion of sharpness.

However, Bertamini et al., (2015) suggested that perceiving sharp-angled stimuli as a threat is not enough to explain the preference for curved stimuli. The authors have observed that curved edges and forms can produce visual pleasure and favor approaching behavior. Thus, the threat hypothesis wouldn't be enough to explain this effect and the preference for curved forms would be caused by curvature itself.

The Role of Curvature in Preference for Visual Artworks

The present study explores the possibility that the preference for curvature is implicit in the appreciation of paintings. In previous experiments, the participants had to rate indeterminate cubist paintings created by Robert Pepperell (2011). Results showed a small tendency towards a preference for curvature and a negative effect of mere exposure.

The mere exposure effect was first described by Zajonc (1968). It is a psychological phenomenon that produces a preference for a stimulus that is already known. The effect can grow with repeated exposures to the same stimuli. It has been found in many different contexts (Monahan, Murphy & Zajonc, 2000). However, when trying to apply the mere exposure effect to artworks, the results have often been ambiguous (Leder et al., 2004; Stang, 1975). Thus, the finding of a negative effect of mere exposure in indeterminate paintings was unexpected and quite the opposite of what a mere exposure effect should be, but it's consistent with the general trend of artwork research.

The present study aimed to investigate further both the small trend of preference for curvature and the negative mere exposure effect found in the previous research. The same stimuli (Pepperell, 2011) were used. The images were divided in two groups: distracters and targets. The experiment consisted in two phases. The distracter images were presented twice, one time in each phase. The negative effect of mere exposure was expected to occur in distracter artworks. The target paintings had two versions: the original and the modified one. One of them was shown in the first phase and the other in the second. The main angles were rounded to create the modified version. Thus, the main hypothesis established that, if the participant perceived both images of a target pair

to be different, no mere exposure effect should be found and the potential difference between versions would be caused by the curved/sharp edges. On the other hand, if the target pairs showed the same mere exposure effect than the distracters, that would suggest that both versions were perceived as the same image and no preference for curvature would be shown. The images were presented during a very restricted presentation time (83 ms) to ensure a low level processing (Leder et al., 2004) and participants were also asked to rate the ambiguity of the images as a control measure.

Method

Participants

Thirty-nine psychology students (8 men) from the University of the Balearic Islands constituted the participant sample of this study. Their mean age was 21.77 years (SD=3.51) and they participated in this study in return for credit in a psychology course.

Stimuli

The images presented in this study were indeterminate paintings that featured numerous lines and sharp angles. The pool of images used in this experiment belonged to a larger pool of cubist-inspired indeterminate paintings created by artist Professor Robert Pepperell (2011). In contrast with traditional abstract compositions, this indeterminate artworks offer an effect that is achieved by rendering forms without the necessary visual clues to recognize any kind of object (Ishai, Fairhall & Pepperell, 2007). Thus, they are paintings that propose many possible images but none of them can be fully indentified. Seventy-six paintings were randomly selected for this experiment.

Half of them were color paintings and were converted to black and white to match the other half. All of the images had the same resolution (450 x 600), had BMP file format and were presented with OpenSesame (Mathôt, Schreij & Theeuwes, 2012).

Thirty-eight paintings were randomly selected as targets. The six more salient angles in the center of each painting were rounded with Photoshop CS5 to obtain an alternate version of the image. This version was considered the curved one, whereas the original image was considered to be the sharp one. *Figure 1* shows a pair of target paintings. The other 38 images of the pool were considered distracters and no alternative version of them was created.

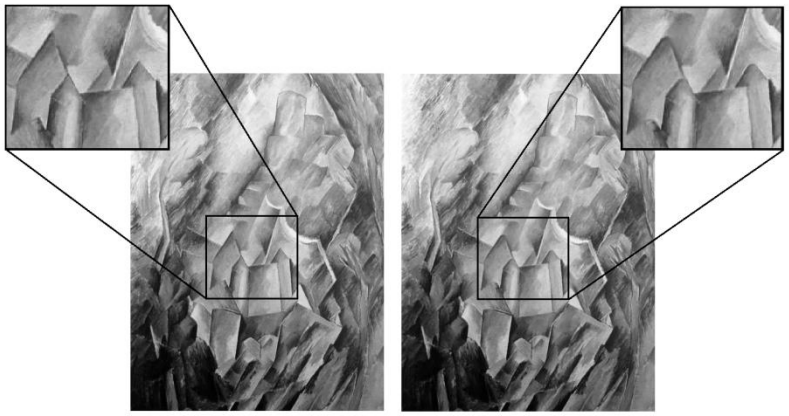

Figure 1. Pair of target artworks. Original to the left and alternate version to the right.

Procedure

In the first part of this study, participants had to view the indeterminate paintings and to decide how much they liked them. For that purpose, participants used the linear numeric keypad of a QWERTY keyboard. The numbers from 1 to 7 were covered by round stickers with numbers between "-3" and "3". A rating of "-3" meant that they did

not like the image at all and a rating of "3" meant that they liked the image very much. They were also encouraged to use the values in between for a more accurate rating.

The main experiment consisted of 152 individual trials that were divided into two phases. Before each phase, some example trials were presented to ensure the correct comprehension of the instructions. The distracter paintings were presented twice, once in each phase. The two versions of the target paintings, the original version and the modified one, were randomly presented on one of the two phases. Both the presentation order of the two phases and the presentation order of the images in each phase were random for each participant.

Each trial began with a cross and a circle as a fixation point. After 300 ms, a painting was presented for 83ms. Next, a blank rectangle replaced the image and remained onscreen until the participant answered. A rating scale, featuring the numbers between "-3" and "3" with matching sad/happy faces, was presented underneath the blank rectangle until the participant pressed a key. The subsequent trial was presented one second after the participant's response. *Figure 2* shows the timeline of a generic trial.

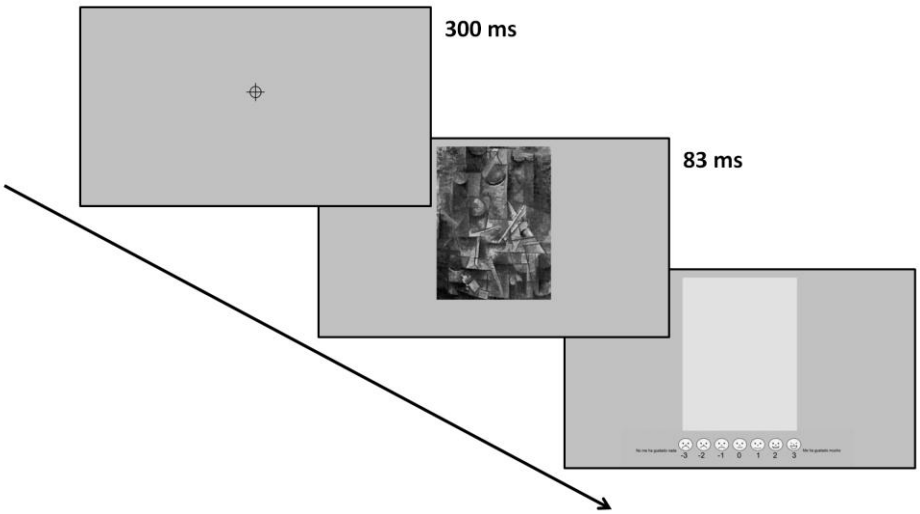

Figure 2. Trial sequence.

In the second part of this experiment, after the two main phases, participants were asked to rate the ambiguity of the paintings with a similar rating scale. This time "-3" meant that the image was not ambiguous at all and "3" meant that the painting was very ambiguous. After the fixation point, both the abstract painting and the rating scale were presented and remained in the screen until the participant made his choice. No faces accompanied the numbers of the rating scale. The ambiguity block consisted in 114 trials and contained all of the images of the main experiment: 38 distracters, 38 original targets and 38 modified targets.

Data Analyses

The effects of *exposure* (first vs. second phase) and *image category* (target vs. distracter) on participant's *response* and *response time*, were analyzed using linear mixed effects modeling. Such modeling accounts for between-subjects and within-

subjects variation in the effects of independent variables on the dependent measures (Baayen, Davidson & Bates, 2008). This is especially useful when researching aesthetic appreciation, because it often varies from artwork to artwork and from person to person (Silvia, 2007).

Both the model for the *responses* and the model for the *response times* were set up as maximal models, following Barr, Levy, Scheepers and Tily (2013) guidelines. Thus, the models take into account as many random effects as possible in order to reduce Type-1 error and prevent statistical power losses. Both models include the same variables and have the same structure, but their dependent variables are the participants' *response* and the participants' *response time*, respectively. The models included 4 fixed effects: the interaction between *exposure* and *image category*, the interaction between *exposure* and *ambiguity ratings*, *age* and *gender*. In addition, random intercepts and slopes for the interaction between *exposure* and *image category* within participants and random intercepts and slopes for *exposure* within image pairs, were included in the model.

The analyses were carried out within the R environment for statistical computing (R Development Core Team, 2008), using the "lme4" package (Bates, Maechler & Bolker, 2013).

Results

A study of outliers was performed before running both models. The response time of each trial was compared to the mean of the corresponding participant and trials with extremely long or short response times were eliminated. The criteria for this selection was the following: a response time is considered extreme if its value is smaller

than 1.5 times the inter-quartile range (IQR) below the first quartile or larger than 1.5 times the IQR above the third quartile. Through this process, a total of 266 trials (4.38 %) were eliminated from the data.

Before running the models all continuous independent variables were centered. Age was centered so that the mean age was considered 0 and reaction time was centered for each participant individually so that their mean would be 0 and their reaction times would be positive if higher that their mean or negative if lower. Participants' *response* and ambiguity ratings were also centered by considering values between -3 and 3 instead of the more common Likert-style that ranges from 1 to 7.

Linear mixed effects modeling of participants' *responses* reveals an overall non-significant trend to give a positive rating to the images [β = 0.25; t = 1.86; p = .068]. The model also shows an effect of *image category*, whereby targets (m = 0.32; 95% CI [0.09, 0.54]) received significantly higher ratings than distracters (m = 0.09; 95% CI [-0.18, 0.36]) [β = 0.23; t = 2.05; p = 0.043]. In addition, there was a main effect of *exposure*, such that during the first phase (m = 0.29; 95% CI [0.06, 0.52]) artworks received higher ratings than in the second phase (m = 0.11; 95% CI [-0.12, 0.35]), [β = -0.18; t = 2.39; p = 0.021]. No significant interaction was found between *exposure* and *image category* [β = 0.09; t = 1.01; p = 0.312] (*Figure 3*).

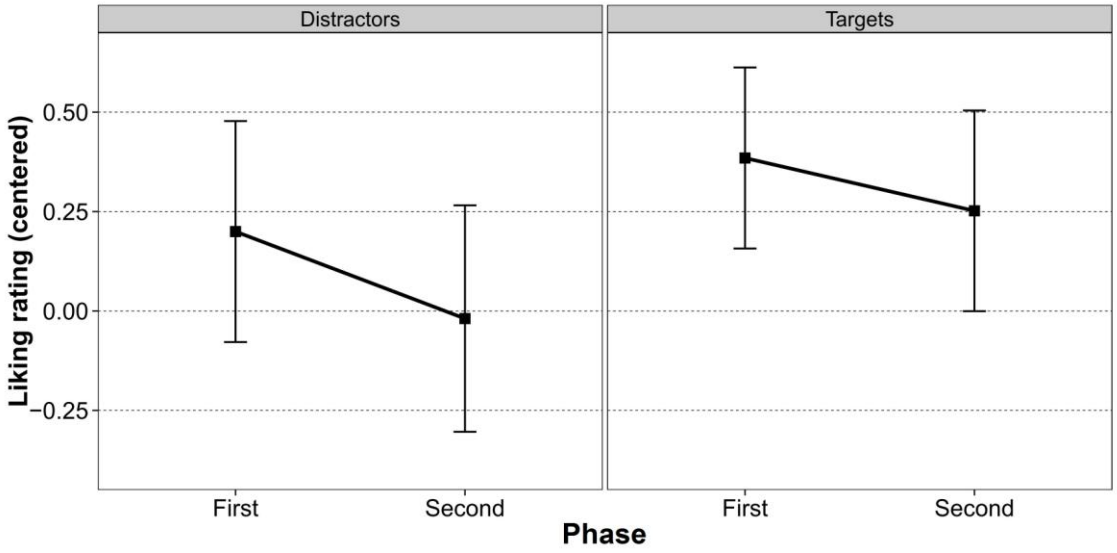

Figure 3. Interaction between image category and exposure.

There was no significant effect of *gender* [β = -0.15; t = 0.65; p = 0.52], *age* [β = -0.04; t = 1.78; p = 0.082] and *ambiguity rating* [β = -0.18; t = 2.39; p = 0.021] on participants' *response*, although *age* showed a trend towards significance: the older participants were, the lower their scores. The interaction between exposure and ambiguity rating was also non-significant [β = 0.03; t = 1.46; p = 0.144]. The analysis of random effects in the model show only very small variations owing to differences among participants and among stimuli. Specifically, of the variation in responses not accounted for by the fixed effects, only 13.60% can be attributed to differences among participants, and only 5.44% to differences among the stimuli.

The linear mixed effects model of the participants' *response times* revealed no significant effect of any of the independent variables. Participants' *response times* (m = 911.6; SD = 427.87) was centered for every participant (m = 0; SD = 301.74) in order to improve the interpretation and the convergence of the model. Because in this case the dependent variable was centered, the overall average was set 0 [β = 0.23; t = 0.04; p =

0.971]. There was no significant effect of *exposure* [β = -0.09; t = 0.01;p = 0.991], *image category* [β = -13.37; t = 0.88; p = 0.381] or *their interaction* [β = -3.12; t = 0.17; p = 0.862], nor of *ambiguity rating* [β = 1.64; t = 0.79; p = 0.43], *age* [β = 0.05; t = 0.05; p = 0.964], *gender* [β = -0.41; t = 0.04; p = 0.967] or the interaction between *exposure* and *ambiguity rating* [β = -4.29; t = 1.05; p = 0.293]. Again, the analysis of the random effects revealed only negligible variation in response times attributable to differences among participants (<0.01%) or among stimuli (1.27%).

Discussion

The aim of the present study was to further investigate the preference for curvature and its possible presence in the appreciation of visual artworks. Following previous results, we took advantage of the negative mere exposure effect found previously with Robert Pepperell's paintings (2011) in order to formulate our hypothesis: if participants perceived both images of a target pair as different no mere exposure effect should be present and thus the difference between both versions of a target pair would be caused by the curved/sharp edges.

Our results show a negative effect of mere exposure, both in the targets and in the distracters. Although targets were liked more than distracters, no interaction was found between exposure and image type. This means that exposure affected both types of stimuli in the same way and to the same extent. Since no other variable of our model had a significant impact on participants' responses, individual differences among participants and differences across artworks seem not to have had an important or influencing variation on the data. Regarding response times, we observed no effect of any of our independent variables. This means that response times remained relatively

constant for each participant, despite being exposed to one stimulus or another, to a target or a distracter and during the first or the second presentation. The fact that variation was small among participants and stimuli for responses and response times, suggests that our results are generalizable to other similar participants and artistic stimuli.

Thus, our results contradict our initial hypothesis: an effect of mere exposure in the target pairs suggested that both versions, the alternative (curved) and the original (sharp), were regarded as the same image. This could be attributed to the fact that both images were almost identical, with only 6 modified edges in the center of the image. Nevertheless, the image type effect shown in the results could be explained because although participants seem to have perceived them as the same image, target pairs could be introducing more variety and thus, less monotony than distracter pairs. In any case, what seems clear is that the expected negative exposure effect superseded the image type effect: Independently of the nature of the image (target or distracter) participants consistently gave lower ratings the second time they saw any given artwork.

One of the main explanations for our results could be the nature of the artworks used in this study. Regarding the alternative versions of the target pairs, maybe 6 modified edges in the center of the image were not enough for the participants to perceive a different image. In addition, the absence of color, being all black and white images, could be negatively affecting the participants' engaging with the rating task. The overall complexity of the images could also be hindering the perception of the centered edges of the image, thus concealing any preference and producing a negative exposure effect. The images being indeterminate (Pepperell, 2011) and not abstract, could also be directing the participants attention to trying to recognize objects instead of just viewing and appreciating the image and its features, including its contours.

Another main reason that could throw some light on the findings of this study is related to the presentation time used in this experiment. The stimuli were presented for 83 ms in order to ensure low level processing (Leder et al., 2004). However, in hindsight, it seems not to be an optimal decision, given the nature and the complexity of the stimuli. Indeterminate artworks seem to lead the participants to try to recognize objects or elements (Ishai, Fairhall & Pepperell, 2007). This tendency is especially evident in artistically naïve participants (Cattaneo et al., 2014), such as the ones in this study, because naïve people view art as an extension of everyday perception (Cupchik & Gebotys, 1988). Thus, they tend to look for object schemes and search for recognizable elements in order to produce pleasant associations. With a presentation time of 83 ms almost any attempt to recognize an object or a figure is clearly prevented and that could negatively affect the participants' experience and, hence, their rating.

In sum, our results showed a negative effect of mere exposure indicating that participants did not regard both images of a target pair as different. This prevented further analyses and conclusions regarding preference for curvature. Although the results did not allow for a positive conclusion about preference for curvature in art, it is not possible to draw a negative conclusion with the data of this experiment alone. Elements of the experiments' framework like the chosen stimuli and the presentation time should be revised in future studies because presenting simpler artworks with more evident differences in the curvature of their edges and contours, and giving more time to the participants to view them, could expand the knowledge about art appreciation and could help by the unveiling of the nature of the preference for curvature effect.

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