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TITLE

Preference for illusory contours: Beyond object symmetry, familiarity & nameability.

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KEY WORDS

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Preference

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ABSTRACT

It has previously been reported that individuals prefer figures from which they can extract shapes via illusory contours (Kanisza figures) over figures in which this is not possible. However, based on the past research in this area, it is not possible to distinguish the influence of illusory contour perception from other factors such as the symmetry, familiarity, prototypicality and nameability of the perceived shape. Here, we investigate the influence of illusory contours in the absence of these confounding variables by measuring participants' aesthetic/liking ratings for symmetric Kanisza figures and for unfamiliar and asymmetric Kanisza figures. Results show that illusory contours do indeed influence preference above and beyond any effects of these other factors.

INTRODUCTION

Perceptual fluency can influence aesthetic judgments of apparently neutral stimuli. For example, in a series of studies Reber, Winkielman, & Schwarz (1998) showed that liking ratings of stimuli rise if visual processing fluency is facilitated by increasing image contrast or by increasing viewing time. Similarly, more fluent motor processes directed to a stimulus increase preference, an effect that holds even when participants are merely observing the fluent actions of another person (e.g., Hayes, Paul, Beuger, & Tipper (2008).

Recently, Erle, Reber, & Topolinski (2017) suggested that other processes, which are not directly based on manipulations of perceptual/motor fluency, can also influence preference judgments. That is, they argue it is not just how fluently a process takes place, but also whether a particular perceptual process is undertaken. Erle et al. (2017), examined whether achieving the computations that enable the perception of shape via illusory contours (a Kanisza figure) is reinforcing. If so, aesthetic/preference ratings of Kanisza figures would be greater than those for control figures made of identical components but arranged to lack illusory contours (see Figure 1*A* for examples). They found that briefly presented Kanisza figures were indeed preferred over similarly presented control figures. However, it is noteworthy that the figures they examined (squares and triangles) possessed salient properties that are themselves associated with increased liking such as high object symmetry (e.g. Evans et al., 2012; Makin, Wilton, Pecchinenda, & Bertamini, 2012; Rhodes, Sumich, & Byatt, 1999), prototypicality (how representative an item is of the category to which it belongs, Halberstadt, 2006), averageness (e.g. Halberstadt & Rhodes, 2000), nameability (e.g., “square”) and familiarity (e.g. Halberstadt, Rhodes, & Catty, 2003). Because of this, it is not clear whether it really is the completion of the illusory contour perception process that elicits the positive affect, or rather one (or some combination) of these other factors.

Therefore in this study we investigated whether the preference for Kanisza figures exists even when stimulus properties of symmetry, familiarity prototypicality and nameability are absent. To this end we presented classic Kanisza and control targets, and novel Kanisza and control targets (see Figure 1*A*) that were asymmetric, unfamiliar and un-nameable.

METHODS

Forty-six participants (age mean±SD = 18.8±0.8, 9 males) completed the experiment and none were excluded from analysis. Protocols were approved by the University of York's Psychology Departmental Ethics Committee and were in accord with the tenets of the Declaration of Helsinki. Participants sat at a table in a dimmed room facing a 27" touch screen monitor (Iiyama ProLite T2735MSC-B2, 1920×1080 pixels) at approximately 60 cm distance. A keyboard was positioned on the table between the participant and the screen. A PC (Dell XPS, Intel (R) Core (TM) i5-4430, 3 GHz CPU, 12 GB RAM, 64 bit Windows 7) presented stimuli (60 Hz mean refresh rate) using custom scripts and Psychtoolbox (version 3.0.11, Brainard, 1997; Kleiner, Brainard, & Pelli, 2007; Pelli, 1997) operating within Matlab (R2015a The MathWorks Inc., Massachusetts, USA). Data, code and assets are available at https://osf.io/4v7un/

Our protocol replicated 'Experiment 1' in Erle et al. (2017). Once seated, participants were shown each target in the upcoming experiment (Figure 1*A*) once for 2s for familiarisation. They were then instructed that in each subsequent trial one of those targets would "…appear and then be covered up very quickly…" and that they would then rate how much they liked that pattern. Each trial was structured thus: a fixation cross was presented for 500 ms followed by 500ms of blank screen, the target for either 32, 64 or 128ms, then a mask for 500 ms, and finally 1000 ms of blank screen before rating of the target (Figure 1*B*). At the rating stage the following text appeared in the centre of the screen "*How much did you like the pattern?*" and participants entered ratings from "*0 (I did not like it at all) to 10 (I like it a lot)*" using the keyboard's number pad. Each target appeared three times at each presentation period (32, 64 and 128ms) giving 36 trials per participant. These were presented in a random order between participants. Presentation periods differed from Erle et al.'s (2017) which were 25, 50 and 100 ms because of hardware limitations. Our symmetric Kanisza targets (Figure 1*A*) were modelled on the square Kanisza figure of Erle et al. (2017) and our mask was copied directly from the supplementary material of that report. Support ratios (the ratio of real to illusory contours) were .66 for the symmetric Kanisza target and .65 for the asymmetric Kanisza target.

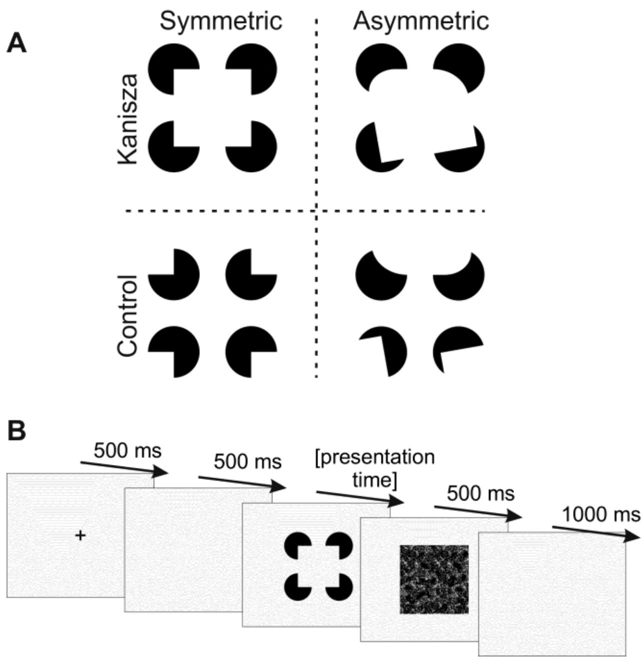

Figure 1. (*A*) Experiment targets: symmetric Kanisza target, and its control; asymmetric Kanisza target and its control. Components in control targets are 180° rotations of components in Kanisza targets. (*B*) Schematic of trial chronology: fixation cross; blank screen; target stimulus; mask; and blank screen (rating of stimuli followed this). Note that the experimental background was white during but is rendered as grey here for illustration.

RESULTS

Repeated measures ANOVAs were conducted with α of .05. Shape (symmetrical/asymmetrical), contour (illusory/control), and presentation period were within participant factors. Where sphericity is violated we report Greenhouse-Geisser corrections (GG). Data are plotted in Figure 2.

All targets. An ANOVA indicated main effects of shape ($F(1, 45) = 62.982$, $p < .001$, $\eta_p^2 = .583$), contour ($F(1, 45) = 62.387$, $p < .001$, $\eta_p^2 = .581$) and presentation time (GG, $F(1.615, 72.697) = 7.846$, $p = .002$, $\eta_p^2 = .148$). The ANOVA also indicated interaction effects between shape × period (GG, $F(1.486, 66.848) = 40.775$, $p < .001$, $\eta_p^2 = .475$), contour × period ($F(2, 90) = 3.654$, $p = .03$, $\eta_p^2 = .75$), and shape × contour × period (GG, $F(1.522, 68.504) = 3.587$, $p = .032$, $\eta_p^2 = .074$) but not between shape × contour interaction ($p = .172$). We conducted separate repeated measures ANOVAs for the symmetrical and asymmetrical targets to better interpret these interactions.

Symmetric targets. There was a main effect of contour ($F(1, 45) = 45.8$, $p < .001$, $\eta_p^2 = .504$) where illusory contours were preferred ($\Delta = 1.268$, $p < .001$) replicating the findings of Erle et al. (2017). There was also a main effect presentation period (GG, $F(1.605, 72.209) = 34.163$, $p < .001$, $\eta_p^2 = .432$) where ratings increased with longer periods ($p <= .002$) as was reported by Reber et al. (1998). The interaction between contour and presentation period was also significant ($F(2, 90) = 7.462$, $p < .001$, $\eta_p^2 = .142$), where increasing preference with increased viewing time is more prominent when viewing illusory figures than control figures. We note that this interaction was not reported by Erle et al. (2017) but a similar data pattern is observed in the right panel of their 'Figure 2' which represents the square stimuli conditions that we replicated. Furthermore, we performed a supplementary ANOVA on the 'square target' data from Erle et al.'s (2017) open access data. This revealed the same pattern of main effects but most importantly our interaction (between contour and period) is observed in their data ($F(2, 28) = 3.694$, $p = .038$, $\eta_p^2 = .209$).

Asymmetric targets. As with symmetrical stimuli, there was a main effect of contour ($F(1, 45) = 51.322$, $p < .001$, $\eta_p^2 = .533$) where illusory contours were preferred ($\Delta = 1.531$, $p < .001$) and a main effect of presentation period (GG, $F(1.488.\ 66.974) = 10.834$, $p < .001$, $\eta_p^2 = .194$). Regarding the latter finding, stimuli presented for 64 ms were rated more highly than those presented for 32 or 128 ms ($\Delta <= .877$, $p <= .017$). There was no interaction effect (GG, $p = .721$). These data confirm the findings of Erle et al. (2017), and extend the preferences for the processing of illusory contours to a range of different conditions beyond symmetry, familiarity and nameability.

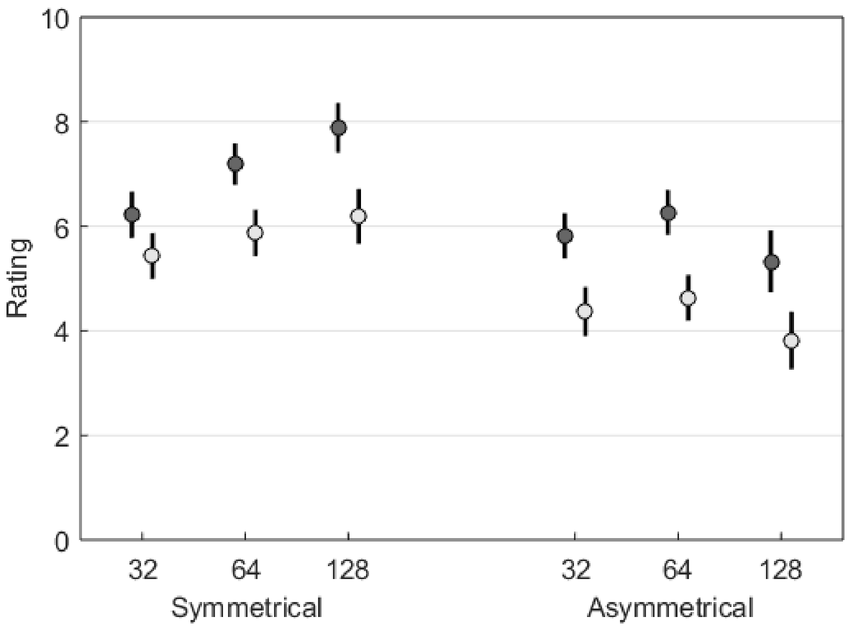

Figure 2. Means ± 95% confidence intervals for all conditions: symmetrical (left) and asymmetrical (right) targets in the Kanisza (dark grey) and control (pale grey) configurations at each presentation time (32, 64 or 128 ms).

DISCUSSION & CONCLUSION

This study demonstrates a number of new findings. First and foremost, it confirms that the preference for a stimulus that emerges during processing of illusory contour objects is not determined solely by the factors of object symmetry, familiarity, prototypicality and/or nameability. We observed a clear preference for asymmetric Kanisza targets over its control. Hence we confirm the findings of Erle et al. (2017) that simply extracting an image's illusory contours is reinforcing. We also replicated their finding of preference for the symmetrical Kanisza target over it's control.

However, we also confirm the importance of symmetry in preference judgments as our participants preferred symmetrical over asymmetrical targets. Furthermore, the ratings for symmetrical Kanisza targets rise as stimulus display time increases (see also Reber et al. (1998)). This appears not to be the case for asymmetrical targets. Though an ANOVA indicated an effect of presentation period for asymmetric targets, it appears that peak preference is observed at 64ms, thereafter declining. To our knowledge, this interaction between presentation period and whether an object possesses symmetry has not been reported previously.

An anonymous reviewer provided us with possible mechanisms that might explain this unexpected data pattern. They suggested that extraction of contourless figures might be a relatively rapid process, being achieved by around the 64 ms presentation time. A subsequent process is the computation of symmetry that is achieved by 128 ms. For the symmetrical stimuli this further processing results in an increase in liking due to the combination of illusory contour and symmetry processing. However, for the asymmetrical stimuli the further processing of asymmetry results in a decline in liking. Further study of this temporal processing account would be worthwhile.

Understanding the perceptual processes that mediate the subtle emotional responses influencing preference has important real-world implications. Interventions focused on behaviour change, ranging from biasing consumer product preferences to improving health and well being by encouraging healthy choices, rely on changes in emotional response and liking of stimuli. Understanding subtle perceptual processes such as those discussed here, embedded in advertisements or games, may provide a further route to changing such behaviours.

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