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A cross-cultural comparison for preference for symmetry: comparing British and Egyptians non-experts

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The aesthetic appeal of symmetry has been noted and discussed by artists, historians and scientists. To what extent this appeal is universal is a difficult question to answer. From a theoretical perspective, cross-cultural comparisons are important, because similarities would support the universality of the response to symmetry. Some pioneering work has focussed on comparisons between Britain and Egypt (Soueif & Eysenck, 1971, 1972), including both experts and naive subjects. These studies confirmed some degree of universal agreement in preferences for simple abstract symmetry. We revisited this comparison after almost half a century. We compared preferences of naïve students in Egypt (n = 200) and Britain (n= 200) for 6 different classes of symmetry in novel, abstract stimuli. We used three different measurements of complexity: Gif ratio, Edge length and the average cell size (average blob size, ABS). The results support Soueif & Eysenck's findings regarding preferences for reflectional and rotational symmetry, however they also throw new light on a greater preference for simplicity in Egyptian participants already noted by Soueif & Eysenck (1971).

Keywords: symmetry, aesthetic preference, beauty, complexity, cross-cultural preferences

Highlights:

- Cross-cultural comparison of symmetry preferences for novel, abstract stimuli of naïve Egyptian and British students.
- Three different measurements of complexity: Gif ratio, Edge length and the average cell size (average blob size, ABS).
- Results support Soueif & Eysenck's (1971: 1972) findings regarding preferences for reflectional and rotational symmetry, and a greater preference for simplicity in Egyptian participants.

Symmetry has long been associated with universal ideals of orderliness, harmony and proportion, and as a concept that is closely related to beauty (Bertamini, Makin, & Rampone, 2013; Pollio, 1960; Zaidel & Hessamian,

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2010). The relationship between visual symmetry and beauty is a subject of interest for artists, scientists and mathematicians (McManus, 2005; Washburn & Crowe, 1988; Weyl, 1952) and symmetry has been proposed as a fundamental principle of aesthetics (Ramachandran & Hirstein, 1999). However, empirical analysis of symmetry preference and also of preference for order and simplicity is a challenge. Many factors have been suggested to explain preference for symmetry in terms of biological signals of mate quality (Møller, 1992), the anatomy of the human brain (Eisenman, 1967; Herbert & Humphrey, 1996), a need to recognize objects (Enquist & Arak, 1994), and prior experience (Schwarz, 1998). Some authors, like Kubovy (2000), argue that individual differences render futile any attempt at analysis of the factors that may embody beauty.

Not all types of symmetry have equal salience to the viewer, in particular reflectional symmetry is more easily detected than others, and a vertical axis of reflection is more salient than a horizontal axis (Corballis & Roldan, 1975; Mach, 1959). Detection times for symmetry are also fastest for vertical symmetry compared to horizontal (Julesz, 1971; Palmer & Hemenway, 1978).

The sensitivity of the human visual system to symmetry, and reflectional symmetry in particular, has been confirmed by neurophysiological work (Bertamini & Makin, 2014; Makin, Rampone, & Bertamini, 2015; Sasaki, Vanduffel, Knutsen, Tyler, & Tootell, 2005). This evidence about a tuning of the visual system to symmetry suggests a very fundamental role of symmetry within the visual system. With respect to preference, however, cultural factors may also influence what people prefer. Darwin (1871) noted that whilst many people attempt to enhance physical traits through permanent and temporary ornamental embellishments, and bodily modifications, preferences for these (beauty) traits differ across cultures. Washburn (1999) for instance, has suggested that the salience of symmetry has been used in art as a metaphor for describing important cultural principles and relationships. With respect to cross-cultural comparisons, Masuda, Gonzalez, Kwan, and Nisbett (2008) examined cultural variations among East Asians and Americans in visual art. Their analysis of traditional East Asian and Western art found that traditional Western art tends to be object-focused (attention is focused on discrete objects seen from a single viewpoint) whereas traditional East Asian art is principally context-inclusive (attention is focused on the relationships between multiple objects from multiple viewpoints). In the special case of preference for symmetrical faces, Pisanski and Feinberg (2013) recently reviewed the literature and interpreted the cultural differences in terms of evolutionary adaptations. For example, facial symmetry may be less important in countries where parental input in offspring is most valued, and more important in regions where disease resistance of offspring is stronger.

In the context of aesthetic judgements of beauty in visual images, complexity (along with order) is a key characteristic influencing preference for an image (Nadal, Munar, Marty, & Cela-Conde, 2010). Complexity is commonly defined as the amount of detail the image contains (Snodgrass & Vanderwart, 1980). However, definitions of complexity may differ from study to study (Gauvrit, Soler-Toscano, & Guida, 2017; Palumbo, Ogden, Makin, & Bertamini, 2014). Lack of agreement in terms of the methods and measures used to examine complexity and aesthetic preference has led to varied and sometimes contradictory results, particularly when based on subjective human judgments

Some authors have tried to formalise indices of order and of complexity to explain human preference of symmetrical patterns in relation to beauty. Birkhoff (1932) proposed a measure of aesthetic pleasure where attraction to an object (M) depends on the ratio of order (O) and complexity (C) perceived by the observer. He created examples of polygons that could be used as stimuli (Birkhoff, 1932). Critiques of Birkhoff's formula have focused on low or negative correlations for preference of polygons, its failure to address the issue of individual differences when making aesthetic judgments, and on the nature of the polygons used, some of which may have semantic associations (see Eysenck, 1942). Eysenck (1941) developed his own formula: $M=O*C$ utilising Birkhoff's polygons, but avoiding those with strong semantic associations such as the swastika and Star of David. Overall, Eysenck demonstrated that his formula provided good correlations for order and complexity in preference for polygons, and predicted that the formula could be used to assess aesthetic preference in stimuli other than polygons.

Eysenck and Castle (1970) asked groups of British male and female artists and non-artists to rate the aesthetic pleasantness of Birkhoff's polygons on a 7 point scale (7= most pleasing, 1– least pleasing). They speculated that though Birkhoff's formula predicted higher correlations between his aesthetic formula and artists, it was also possible that there would be no difference between artists and non-artists in making aesthetic judgments. Whilst Birkhoff's formula correlated with the artists' preference scores better than the non-artists' scores, most of the factors across the two groups were similar. The pattern of preferences showed that artists preferred simple polygons, and the non-artists preferred complex ones. For this different set of polygons, artists' preferences correlated with Eysenck's (1968) simplicity factor suggesting a preference for simple polygons. Soueif and Eysenck (1971) compared cross-cultural preferences for polygonal figures (Birkhoff, 1932) in British and Egyptian groups of artists and non-artists. They found some differences in preferences for simplicity and complexity. British artists preferred simpler polygons compared to British non-artists who preferred more complex polygons. For Egyptians there was a less marked trend in the opposite direction, specifically, the Egyptian artists preferred complex polygons and the Egyptian non-artists tended to prefer simple polygons. However, differences were small, and Eysenck and Soueif concluded that the results supported the view of universal preferences more than the expectations of large cultural differences in aesthetic preference. A second study (Soueif & Eysenck, 1972) analysed preference for Birkhoff's polygons (1932) in Egyptian artists and non-artists in comparison with British artists and non-artists. They also found that age was related to preference on certain polygons, suggesting that there may be differences in preferences for specific polygons within different age groups and greater variability with age.

There were some cultural differences between the two groups in preference for certain polygonal figures. For example, the British demonstrated a stronger preference for cruciform shapes than the Egyptians. They speculated that these would have more subjective meaning in a largely Christian culture than an Islamic culture.

It should be noted that the Islamic culture has a long tradition of abstract, geometric based art (Abas & Salman, 1992). Indeed historically, representational art has not been practiced in the Islamic world, especially in relation to the depiction of humans and animals. This is one reason that makes the cross-cultural comparison interesting. There is strong evidence to suggest that exposure to and familiarity with visual stimuli may increase our preference for those stimuli (*mere exposure*, Zajonc, 1968). However, over exposure or massive familiarisation may affect subsequent preferences in complexity. People who were familiarised with simple patterns subsequently tended to prefer complex stimuli, and those familiarised with complex patterns showed a tendency to prefer simple patterns (see Tinio & Leder, 2009).

Recent studies have examined complexity and aesthetic preference using quantitative measures of complexity: GIF compression rates, density, the number of elements and edge length. In the case of the GIF, the idea is that the application of a compression algorithm will achieve greater reduction in size for pattern that a lower in algorithmic complexity.

Observers showed a preference for polygons with greater complexity in contour length and in the number of concavities (Friedenberg & Bertamini, 2015); a correlation between GIF ratio and edge length suggesting a preference for intermediate density over the number of elements in binary chequerboard patterns (Friedenberg & Liby, 2016); and image compression of the contours in nonsense shapes correlated with subjective human judgments for the same shapes whilst avoiding familiarity biases (Forsythe, Mulhern, & Sawey, 2008). Gauvrit et al. (2017) reanalysed the data from the study carried out by Friedenberg & Liby (2016) using entropy (in this context, entropy refers to the density of black and white cells in a pattern) and algorithmic complexity (GIF ratio and Block Decomposition Method) and Edge length (the complexity of the edge created by the cells, thus related to the 'crookedness' of the pattern) as additional measures of complexity. They found that people showed an overall preference for high entropy, and low algorithmic complexity, when controlling for entropy. They also found that aesthetic judgments positively correlated with total Edge length, supporting the findings by Forsythe et al. (2008). In other words, people prefer some, but not all, types of complexity depending on the balance of the number of elements, 'crookedness' and density.

A study of symmetry preference in two cultures

Soueif and Eysenck (1971, 1972) studied preference for shapes, using stimuli that varied both in complexity and familiarity in ways that were not controlled. The nature of their stimulus set makes interpretation difficult. In our study we compared British and Egyptian participants but, unlike Soueif and Eysenck, we focus on preference for symmetry. We created a controlled set of patterns made up of a square matrix with black and white cells (10 x 10). There were six classes: asymmetric, 90^{o} rotation, 180^{o} rotation, horizontal, vertical, and horizontal-vertical. In general a preference for regularity is well documented, with a particularly strong preference for reflection and rotation (Makin, Pecchinenda, & Bertamini, 2012).

As mentioned earlier, Birkhoff's polygons have been criticised because of possible associations with known objects and symbols. Abstract, non-figurative images are likely to contain fewer confounds than figurative images (Friedenberg & Liby, 2016; Forsythe et al., 2008).

It should also be noted that in the forty years since Soueif and Eysenck carried out their experiments, both British and Egyptian cultures have undergone major technological changes in terms of communication and media that have increased access to each other's cultures and visual media. We were interested to see whether our study (using untrained participants) would confirm the preferences Soueif and Eysenck found in Egyptian and British groups, further supporting their idea of a universal preference for symmetry.

None of the participants were artists, the majority being undergraduates of social science courses. As Eysenck and Castle (1970) noted, artists are trained to appreciate order and symmetry in the visual world. Therefore, we chose not to use art students in our study in order to avoid any confound related to art school training. The groups were tested in their respective countries, and they were native speakers in either English (Britain) or Arabic (Egypt).

In European cultures, people read from left to right, and in Arabic countries people read from right to left. Acquired skills, such as reading and writing, may affect perception of visual stimuli and thus, aesthetic judgments (see Nachson, 1981; Nachson, Argamon, & Luria 1999). Therefore reading direction is also an important difference between the groups.

It is important to note that though the entire Egyptian group reported learning English (mean age 9.97 years), and inevitably exposure to British culture is greater in Egypt than vice versa, the key point is that the two cultures remain different in many ways.

Methods

Participants

Two hundred British students from the University of Liverpool, UK (mean age: 24.83 years; n = 51 males and n = 149 females) and two hundred Egyptian students (mean age: 19.83 years; n = 117 males and n = 83 females) from the University of Menoufia, Egypt took part in the study. All data used in the study were analyzed anonymously. The research was conducted in accordance with the ethical standards of the University of Liverpool (https://www.liverpool.ac.uk/research-integrity/policies-guidance/) and with the University of Menoufia. Participants read and signed a consent form that explained the task and asked them for permission to use their data.

Participants were restricted to native British speakers and native Egyptian speakers. Both groups of participants were asked whether they had studied a second language. The Egyptian students were also asked if, and from what age, they had studied English (100 % answered yes: mean age: 9.97 years). Additional questions included handedness, age, sex and subject studied. Some of the students were rewarded with course credits to take part, and all were naïve regarding the experimental hypothesis.

Stimuli

The stimuli were based on a black and white matrix (ten by ten elements). Ten patterns were randomly generated from each of the following classes of symmetry: asymmetric, 90^{o} rotation, 180^{o} rotation, horizontal, vertical, and horizontal-vertical (see Figure 1). We coded these six classes of symmetry as: a, cc, c, h, v, and hv respectively. The patterns (10 * 6 = 60) were arranged on an A4 sheet of white paper in landscape format (Set A). Each pattern had a small box placed underneath in order for the participant to record a preference score. A second sheet of patterns was produced (Set B) using the same patterns, but presented in a different random order. The original sheets forming Set A and Set B were then mirror reversed in order to produce two further sets of patterns (Set AA and Set BB).

Procedure

Each participant was asked to look at the sheet of paper and then rate each pattern. They used a scale ranging from 0 – ‘extremely ugly’ to 10 – ‘extremely beautiful’ and entered the number in the box below the pattern. Each participant was presented with only one version of the patterns, and they could rate the patterns in any order they wished. They were allowed to take as much time as they needed, and to change a response before submitting the response sheet.

Results

Figure 2 provides a visual summary of the responses for each of the six classes. The ten patterns are ranked in terms of preference and the images are shown above each graph. In general one can see many similarities between the two groups, with ratings towards the low end of the scale for asymmetrical patterns, and high ratings instead for the patterns with reflectional symmetry.

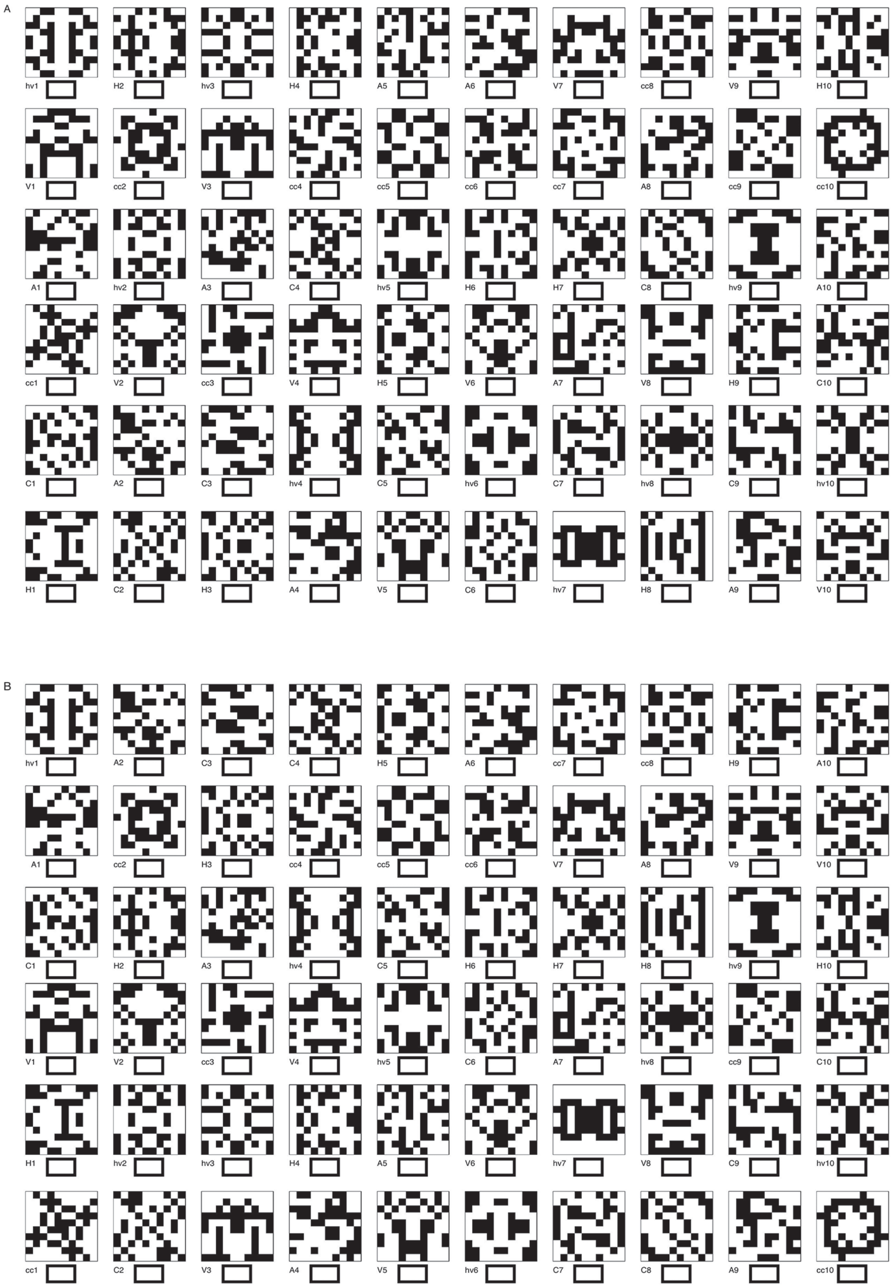

Figure 1. The 60 patterns used in the experiment: Versions A (top) and B (bottom) are the two randomisations. The codes in the bottom left corner were not present on the sheets used in the experiment. Two more versions (AA and BB) were used which were the mirror reversal (around the vertical axis) of these patterns.

We carried out a mixed ANOVA. We tested a within-subjects Symmetry factor with 6 levels (asymmetry, 90° rotation, 180° rotation, horizontal, horizontal-vertical, and vertical), and three between-subjects factors; Country (English speakers and Arabic speakers), Orientation (Original or Mirror reversed) and Sex (male and female), and Age as a covariate. We also tested the different classes of Symmetry using a series of contrasts in which the reference group was always the asymmetrical category of patterns (the 'a' class).

We confirmed that there was a difference between the levels of Symmetry [F (5, 1955) = 52.76, MSE = 74.24, p <.001, n_p^2 = .119], and a significant effect of Country [F (1, 391) = 4.26, MSE= 5.30, p = .040, n_p^2 = .011]. There were no effects of Orientation, Age or Sex. Overall preference ratings were higher by Egyptians. The largest difference was for the horizontal-vertical class in which the average rating by the British was 5.79, and 7.27 for Egyptians. In terms of interactions, there were significant interactions between Symmetry and Country [F (5, 1955) = 27.56, MSE = 38.77, p <.001, n_p^2= .066] and Symmetry and Sex [F (5, 1955) = 3.27, MSE = 4.60, p = .006, n_p^2 = .008]. There were significant three way interactions between Symmetry, Orientation and Country [F (5, 1955) = 2.22, MSE = 3.12, p = .050, n_p^2 = .006] and Symmetry, Country and Sex [F (5, 1955) = 2.34, MSE = 3.30, p = .039, n_p^2 = .006] . These potentially interesting interactions are shown in Figure 3. This graph also shows the higher values for the Egyptian group in general, although for the asymmetrical patterns the Egyptian average was lower than the British average, showing a tendency for the Egyptians to provide a greater range of responses (i.e. use of the full extent of the scale).

In terms of linear contrasts, when any of the six symmetry classes were tested against the asymmetrical class all these comparisons were significant (all ps <.001). This is not particularly interesting as it only shows that all participants systematically rated the asymmetrical patterns as the least beautiful. The next step of the analysis is very important. We were particularly interested to see if the way that British and Egyptian participants responded to symmetry was different for each class of symmetry using the asymmetrical class as reference. In other words whether the specific advantage of, say, vertical symmetry over asymmetry was similar or different in the two countries. We found that of the nine contrasts only four were significant. There were interactions for Country and the contrast between asymmetry and vertical symmetry [F (1, 391) = 23.55, MSE = 87.24, p <.001, n_p^2 = .057], for Country and the contrast between asymmetry and horizontal-vertical symmetry [F (1, 391) = 68.00, MSE = 260.71, p <.001, n_p^2 = .148], for Country and the contrast between asymmetry and 180° rotational symmetry [F (1, 391) = 5.49, MSE = 19.99, p = .020, n_p^2 = .014], and for Country and the contrast between asymmetry and 90° rotational symmetry [F (1, 391) = 5.01, MSE = 87.24, p = .026, n_p^2 = .013]. There was an interaction for Sex between asymmetry and the contrast for 180° rotational symmetry [F (1, 391) = 9.16, MSE = 17.38, p = .003, n_p^2 = .023]. In the three way contrast between Symmetry, Country and Sex there were interactions between asymmetry and 90°

rotational symmetry [*F* (1, 391) = 4.38, *MSE* = 17.48, *p* = .037, n_p^2 = .011], and asymmetry and horizontal symmetry [*F* (1, 391) = 4.90, *MSE* = 6.43, *p* = .028, n_p^2 = .012].

The results for the vertical and horizontal-vertical symmetry confirm that the most salient reflection symmetries were the ones containing vertical symmetry (see Fig.2), and that these were rated differently between the two groups of participants.

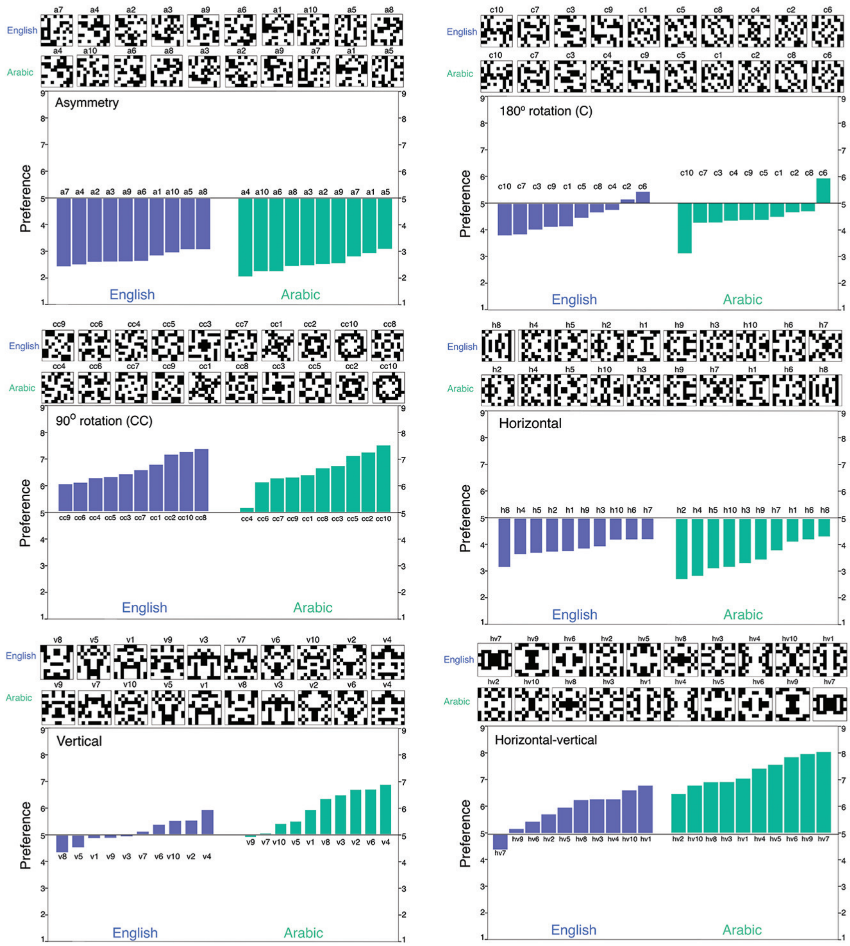

Figure 2. Preference scores for asymmetric, 90º rotation, 180º rotation, horizontal, horizontal-vertical and vertical patterns by country (English speakers and Arabic speakers). Data from all four experimental pattern sheets (A, B, AA and BB) were combined. The images of the stimuli are shown above the graph and they allow a direct comparison between the groups in terms of the ranking.

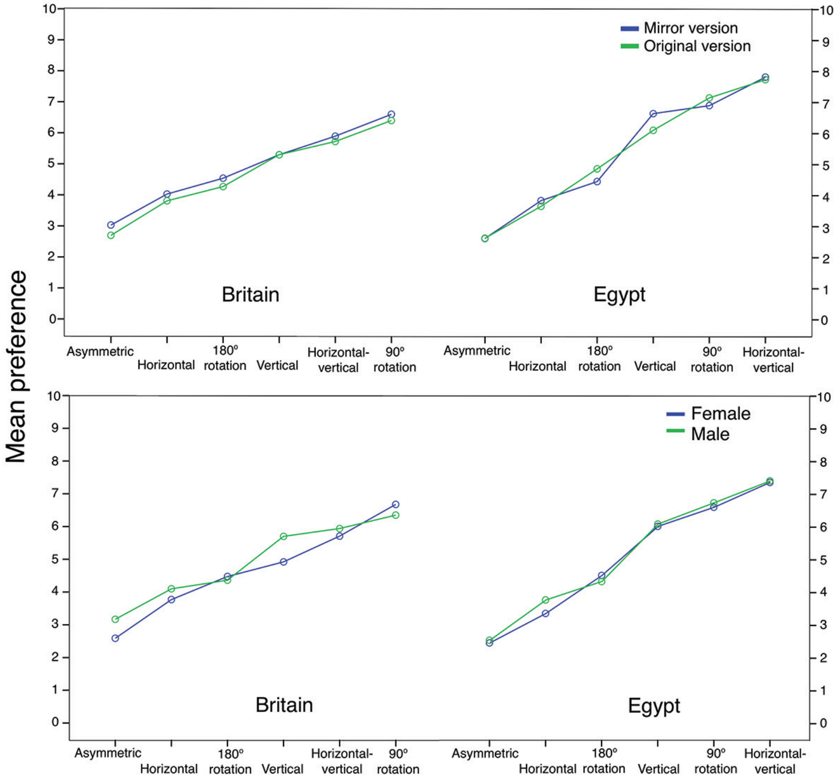

Figure 3. Top: Estimated marginal means comparing male and female preferences for the experimental stimuli patterns in British and Egyptians. Bottom: Estimated marginal means comparing for the original versions (A and B) and mirror reversed versions (AA and BB) of the experimental stimuli patterns.

Visual Complexity

In this next analysis we examined whether the pattern preferences of the British and Egyptian groups correlated with measures of visual complexity. We analyse three measures of complexity. The first is the Gif ratio defined as the ratio between the size of the original image and the size of the compressed image. This measure has been shown to correlate with human judgments of complexity (Forsythe et al., 2008; Forsythe, Nadal, Sheehy, Cela-Conde, & Sawey, 2011; Palumbo et al., 2014). Because this is a measure of how much compression a computer can obtain, it can be seen as a proxy for Kolmogorov complexity, which is defined as the length of the shortest computer program that produces the pattern as output. Importantly, given the definition, as the pattern gets simpler the GIF ratio gets bigger.

We also used a second measure much more specific to the nature of our stimuli comprising the number of black and white cells in each matrix. Each individual pattern was made up of a total of 100 cells. There were always 60 white cells and 40 black cells. For each pattern we counted the size of all the black regions in terms of the number of black cells that were connected. Two cells were defined as connected if they shared one side. We then averaged the size of all the black regions for each pattern separately. This provides a number for each pattern that can be as low as 1, if the black and white cells tend to alternate, and therefore there is no region larger than 1, or as high as 40 if all black cells are connected and form a single, solid region. We call this measure *average blob size* (ABS).

The third measure of complexity is *edge length*. We counted the number of edges of each black cell adjacent to the white space within each pattern. Two individuals did the counts independently. Edge length can be described as a measure of the "crookedness" in a pattern (see Gauvrit et al., 2016). For example, patterns with few convex regions will have a small number of edges, while complex irregular patterns with many regions or concave regions will have a large number of edges (see Fig. 4).

We tested the correlation between the average number of squares (ABS), the GIF Ratio, and the average edge length for each pattern. We also tested the average preference scores for each pattern in the Egyptian and British groups, and British males (n= 51) and females (n = 149) and Egyptian males (n = 83) and females (n = 117). For all correlations the measures are based on the total number of patterns (60).

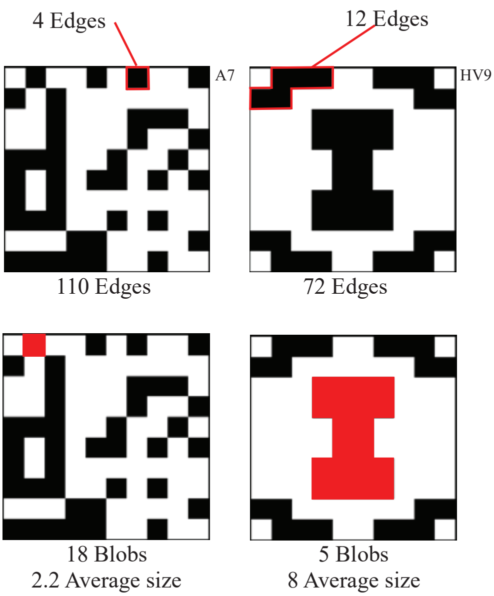

Figure 4. Examples of different patterns showing Edge length and Average Blob Size (ABS). Top: a random, asymmetric pattern, and a horizontal-vertical pattern and the corresponding edge length of the black portions of the pattern perimeter. Bottom: the same patterns with the corresponding number of elements or ABS. The highlighted areas define a single element.

The means and standard deviations (N = 60) for the correlations are shown in Table 1. The first interesting correlation is between GIF ratio and ABS. As they both increase with simplicity we expect a positive correlation. The Pearson correlation was r = .413 (N = 60, p <.001). It may also be worth noting that overall British and Egyptian responses were highly correlated, (r = .868, N = 60, p <0.001).

With respect to the comparison between British and Egyptian ratings, for the British group there were no significant correlations between preference and complexity, and not even any trend in that direction. For the Egyptian group there was a positive correlation between GIF ratio and preference (r = .260, N = 60, p = 0.045), and a positive correlation between ABS and preference (r = .303, N = 60, p = .018). There was a significant positive correlation between GIF ratio and preference in Egyptian females (r = .266, N = 60, p = .040) but none for Egyptian males, or British males and females. There were significant correlations between ABS and preference in Egyptian males (r = .292, N = 60, p = .024), and ABS and preference in Egyptian females (r = .309, N = 60, p = .016), but none for either British males or females.

There were significant negative correlations between Edge length and ABS: (r= –.648, N = 60, p <.001), and for Edge length and GIF ratio: (r = – .714, N = 60, p <.001). Interestingly, there was a negative correlation between Edge length and preference for complexity in the Egyptian group (r = – .363, N = 60, p = .004), but no significant correlation between Edge length and preference in the British group. There were negative correlations between Edge length and preference in Egyptian males (r = – .350, N = 60, p = .006), and also in Egyptian females (r = – .369, N = 60, p = .004), but no correlation for either British males and British females. In terms of preference of complexity, these results show a consistent pattern of correlations between complexity and preference for both males and females.

The correlations are shown in Tables 2 and 3, and the pattern is shown in the scatter graphs of Figure 3. There are two analyses because we noted an outlier in the case of ABS: the value for pattern HV7 reached the maximum (40). We therefore report the correlations with and without this item. The results were very similar with and without pattern HV7. These results show a preference for simpler patterns in the Egyptian group but not in the British group.

Table 1
Means and standard deviations for the correlations for complexity measures, Egyptian and British groups preferences, and male and female preferences for both countries.

	Mean	*Standard Deviation*
Egypt preferences	5.06	1.81
Britain preferences	4.74	1.36
ABS	4.02	4.98
GIF Ratio	31.72	2.70
Edge length	101.33	12.59
Arabic female	5.02	1.85
Arabic male	5.10	1.78
British female	4.68	1.43
British male	4.92	1.24

N = 60

Table 2 & 3

*Correlations between Preference for the 60 patterns in the two groups (Egypt and Britain), and three indices of complexity: number of edge lengths, average blob size (ABS) and GIF ratio. Correlations for British males (N = 51) and females (N = 149), and Egyptian males (N = 83) and females (N =117) are in grey. The table is repeated a second time with the exclusion of an outlier (N =59). **. Correlation is significant at the .01 level (2-tailed). *. Correlation is significant at the .05 level (2-tailed).*

	ABS	GIF ratio	Edge length	Egypt preference	Britain preference	Arabic female	Arabic male	British female	British male
ABS									
Pearson's r	1								
Sig (2-tailed)									
N = 59									
GIF ratio									
Pearson's r	.413**	1							
Sig (2-tailed)	.001								
N = 59									
Edge length									
Pearson's r	-.648**	-.714**	1						
Sig (2-tailed)	.000	.000							
N = 59									
Egypt preference									
Pearson's r	.303*	.260*	-.363**	1					
Sig (2-tailed)	.018	.045	.004						
N = 59									
Britain preference									
Pearson's r	.015	-.001	-.073	.868**	1				
Sig (2-tailed)	.907	.993	.577	.000					
N = 59									
Egyptian female									
Pearson's r	.309*	.266*	-.369**	.997**	.856**	1			
Sig (2-tailed)	.016	.040	.004	.000	.000				
N = 60 Sample = 117									
Egyptian male									
Pearson's r	.292*	.248	-.350**	.994**	..879**	.984**	1		
Sig (2-tailed)	.024	.056	.006	.000	.000	.000			
N = 60 Sample = 83									
British female									
Pearson's r	-.007	-.037	-.038	.848**	.996**	.834**	.860**	1	
Sig (2-tailed)	.958	.777	.773	.000	.000	.000	.000		
N = 60 Sample = 149									
British male									
Pearson's r	.089	.121	-.189	.880**	.950**	.872**	.884**	.918**	1
Sig (2-tailed)	.497	.356	.147	.000	.000	.000	.000	.000	
N = 60 Sample = 51									

	ABS	GIF ratio	Edge length	Egypt preference	Britain preference	Arabic female	Arabic male	British female	British male
ABS									
Pearson's r	1								
Sig (2-tailed)									
N = 59									
GIF ratio									
Pearson's r	.555**	1							
Sig (2-tailed)	.001								
N = 59									
Edge length									
Pearson's r	-.835**	-.693**	1						
Sig (2-tailed)	.000	.000							
N = 59									
Egypt preference									
Pearson's r	.325*	.218	-.308*	1					
Sig (2-tailed)	.012	.098	.018						
N = 59									
Britain preference									
Pearson's r	.122	.005	-.093	.894**	1				
Sig (2-tailed)	.357	.968	.483	.000					
N = 59									
Egyptian female									
Pearson's r	.329*	.223	-.312*	.997**	-.883**	1			
Sig (2-tailed)	.011	.089	.016	.000	.000				
N = 60 Sample = 117									
Egyptian male									
Pearson's r	.314*	.207	-.297*	.994**	.903**	.984**	1		
Sig (2-tailed)	.015	.115	.022	.000	.000	.000			
N = 60 Sample = 83									
British female									
Pearson's r	.088	-.029	-.060	.877**	.996**	.864**	.887**	1	
Sig (2-tailed)	.506	.828	.653	.000	.000	.000	.000		
N = 60 Sample = 149									
British male									
Pearson's r	.230	.121	-.202	.898**	.951**	.890**	.900**	.919**	1
Sig (2-tailed)	.080	.362	.125	.000	.000	.000	.000	.000	
N = 60 Sample = 51									

Discussion

In our study we compared preferences for abstract symmetry in two groups of individuals, one in Egypt (native language Arabic) and one in Britain (native language English). In this context, our study is closely related to a study conducted in 1971 by Soueif and Eysenck (1971). Unlike the Soueif and Eysenck studies we wanted to test non-artists in order to assess whether people without special training differed in preferences for symmetry. Because our stimuli were different it was more likely they would avoid problems of semantic associations, and they also compared different types of regularities. Abstract stimuli, such as the binary black and white chequerboard patterns we employed are provide a more objective, robust method of measuring complexity, and are easier to interpret (see Bertamini, Makin, & Pecchinenda, 2013; Corballis & Roldan, 1975; Gauvrit et al., 2016; Royer, 1981). Abstract images may also be less vulnerable to a familiarity bias (Forsythe et al., 2008). However, previous studies involving aesthetic judgments of visual art have shown that whilst people prefer representational art to unfamiliar, abstract images, they will also give higher ratings to those abstract images to which they can attribute some figurative, 'real world' quality in an attempt to make sense of the image (Forsythe et al., 2011; McWhinnie, 1987).

A typical feature in Islamic art is that it incorporates abstract, geometrical designs (Abas & Salman, 1992; Gonzales, 2001). These designs and patterns are used widely across Islamic cultures. An example is shown in Figure 5. Everyday exposure to, and thus familiarity with such geometric patterns may explain the higher ratings by the Egyptian group, in the sense that abstract patterns found in Arabic art are similar to the matrices we used, and are less novel to the Egyptian group than the British group. We found an overall pattern of preference for symmetry, and a dislike for asymmetry that was similar across the two cultures. Overall the Egyptian group rated the symmetrical patterns higher and there were bigger differences between the scores for asymmetry and symmetry (that is they used the scale of scores to a fuller extent in comparison to the British group). In the Egyptian group the most salient symmetry (around the vertical axis) was given particularly high scores. We speculate that the lower preference ratings across all symmetries from the British group, and the higher ratings from the Egyptian group may be due in part, to a dislike of the unfamiliar, abstract patterns amongst the British group. The interaction between symmetry, preference and orientation is potentially very interesting (see Fig. 3, top). First of all, as the figure for the interaction between symmetry, preference and orientation shows, the effects are significant but mostly subtle. The British gave 90º rotational symmetry the highest scores, with horizontal-vertical symmetry as the next highest scoring symmetry. Interestingly, the British show a slightly higher preference for asymmetry, horizontal, 90º and 180º rotational symmetries in the mirror-reversed orientation. The British ratings for vertical symmetry are similarly rated in both orientations. The reverse was true for the Egyptians, who gave horizontal symmetry the highest scores, with 90º rotational symmetry next. More interestingly, there is a relatively high score from the Egyptian group for vertical symmetry in the mirror reversed (right to left) version relative to the original (left to right) version. We tentatively suggest that overall Egyptian preference for patterns with vertical axes in the mirror reversed orientation, may be further enhanced by the numerous factors including familiarity, (Tinio & Leder, 2009), ease of interpretation (McWhinnie, 1987) and reading direction (Chokron & De Agostini, 2000; Nachson et al., 1999). The same factors, though replacing novelty for familiarity, may explain the British lower ratings overall, preference for multiple symmetries, and a slight preference for patterns in the mirror reversed orientation.

Overall, like Soueif and Eysenck (1971, 1972) and Eysenck and Castle (1970) we found no large differences in preference for the patterns between females and males in either the British or Egyptian groups. However, the interaction (see Fig 3, bottom) between symmetry, preference and sex is interesting. British males liked asymmetry better than females (m= males: 3.12; females: 2.56). British males also gave higher ratings than British females to all symmetries, particularly to vertical symmetry (m = males: 5.68; females: 4.91), except 90° rotational symmetry, which British females rated higher (m = males: 6.32; females: 6.66) than males. On average Egyptian males (m =3.70) rated horizontal symmetry slightly higher than Egyptian females (m = 3.36) but other than this, both male and female Egyptians gave similar ratings for the different classes of symmetry.

It is possible that there are sex differences in preference for specific symmetries in relation to human judgments of visual art and abstract patterns (see Bernard, 1972; Humphrey, 1997; Johnson & Knapp, 1963). It is also possible that male and female aesthetic judgments for symmetry are based on a difference in perceived complexity. Previous research suggests the number of elements a pattern contains determines its complexity, and the structural organization (i.e. whether the pattern has a single axis or multiple axes of symmetry) of the image may reduce or increase this perception (Chipman, 1977; Ichikawa, 1985). However, for us the most important difference is the relative position of the different types of symmetry with horizontal-vertical being the preferred symmetry for Egyptians and 90° rotation for the British, a pattern of preferences similar to those described by Soueif and Eysenck (1971, 1972). A 3-way interaction with a factor that has six levels is difficult to interpret and it suffers from possible risk of multiple comparisons. Finally, in our study both group of participants contained more females than males. A more detailed analysis of sex as a factor will therefore remain as a topic for further research.

Soueif and Eysenck (1972) found some differences in preference for polygons when they analysed the preferences of younger and older participants. They speculated that greater variance in the age range of a group may elicit greater differences in preference for polygons within that group. Although there was a somewhat greater variance in the ages of the British group (18 to 63 years) compared to the Egyptian group (18 to 26 years) we found no such effects or interactions of age on preference for abstract patterns.

The analysis of the specific images in our dataset of 60 images for preferences of complexity also revealed a relationship between preference and simplicity in the Egyptian group. This correlation was absent in the British group. We used three different measures of complexity: GIF ratio, ABS, and Edge length, all of which correlate with different aspects of complexity. These measures are also unaffected by familiarity biases, such as those commonly found in subjective judgments of complexity (see Forsythe et al., 2008). There were negative correlations between all three measures. This may not be so surprising if we consider the processes involved. ABS measures the scale or volume of elements, GIF ratio measures the algorithmic complexity of an image, and Edge length measures the dispersion of elements within an image. Thus, in real terms, we have two measures of simplicity (ABS and GIF ratio) and one measure of complexity (Edge length). The differences between these measures are demonstrated not only by the negative correlations between the British group and preference, but also by that of the three measures, only Edge length appears to correlate strongly with preferences of the Egyptians (both as a combined group, and also when separated into male and female groups) and simpler, less complex patterns. This is also supported by the positive correlations between ABS and the Egyptians (again as a combined group and separate male and female groups). The positive correlation between the Egyptian females and GIF ratio disappeared with the removal of an outlier (HV7). However, the pattern remained the same: the correlations showed a consistent pattern of preference for simpler patterns in Egyptians than the British. Additionally, in terms of preference of complexity, these results show a very consistent pattern of correlations between complexity and preference for males and females in both groups. One interesting explanation for the higher ratings for simple stimuli by the Egyptians is that over familiarisation with one group of stimuli may not only subsequently affect preference ratings for those stimuli, but also later result in higher ratings for stimuli that are the structural opposite (Tinio & Leder, 2009). The Egyptian group may be very familiar with everyday objects and images that are decorated with complex, geometric art, and therefore over familiarisation with this type of art could result in a preference for novelty (Biederman & Vessel, 2006). The more complex rotational patterns used in the study may have elicited the opposing preferential responses in the Egyptians, and indeed, those of the British.

We cannot statistically argue that Edge length is superior to GIF ratio or ABS as a measure of complexity. It simply measures a different aspect of complexity (i.e. dispersion) and this may explain the negative correlation with the British group. The preferences of British group appear to be consistent with a preference for intermediate density stimuli (Friedenberg & Liby, 2016), and the notion that people prefer patterns with high entropy and low algorithmic complexity (Gauvrit et al., 2017). We can only speculate given the lack of comparative data for our findings, but this notion may be reversed for the Egyptian group for certain patterns. We cautiously suggest that the differences in ratings for asymmetry and symmetry indicate this as a possibility. What is interesting is that all three measures provide a compelling story: that Egyptians appear more sensitive to these particular patterns than the British group, and this merits further investigation.

Figure 5. Ceramic tile (8-9th century) with geometric pattern from the Transoxiana region. Now in the Louvre museum (catalogue number LOU 098).

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