

Preference for Curved Contours Across Cultures

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We postulate that humans' preference for curvature is an expression of a natural propensity for aesthetics, understood as a set of perceptual, cognitive, and affective abilities and biases that orient humans toward the sort of sensory features that are used to convey culturally relevant meanings. Here we investigate whether preference for curved contours, observed previously in Western large-scale societies, is also present in 2 small-scale societies relatively uninfluenced by Western culture. We asked participants from Oaxaca (Mexico) and Bawku (Ghana), and also from Mallorca (Spain), to perform a 2-alternative, forced-choice task consisting in choosing between photographs of curved and sharp-angled versions of the same real objects presented for 80 milliseconds. The task required minimal instructions, aiming to avoid confounds arising from translations. Our results show that participants in each of the 3 countries chose the curved-contour alternative significantly more often than the sharp-angled one (Spain: .59; Mexico: .55; Ghana: .58) and that these proportions did not differ significantly. We conclude that preference for curved-contour objects is common across cultures and conjecture that it is a constituent of a natural propensity for aesthetics.

Keywords: aesthetics, preference, curvature, sharpness, cross-cultural

The classic debate about the role of nature and nurture in human cognition dissipated with the realization that human nature and culture are inextricably intertwined. Our nature is cultural and our culture, natural (Kim & Sasaki, 2014; Laland, Odling-Smee, & Myles, 2010; Richerson & Boyd, 2005). Cognition is both biologically and culturally grounded. For instance, humans have a natural propensity to acquire and develop language, which is expressed culturally in myriad languages, dialects, jargons, and idiolects. This propensity is constituted by a set of perceptual and cognitive biases and abilities that orient human newborns and young infants toward certain physical and statistical properties of speech, facilitating language acquisition (Bijeljac-Babic, Bertoncini, & Mehler, 1993; Eimas, Siqueland, Jusczyk, & Vigorito, 1971; Mehler et al.,

1988; Saffran, Aslin, & Newport, 1996). Thus, we are born perceptually and cognitively equipped to acquire language as we develop in a language-rich environment.

Like language, it is conceivable that our species is endowed with a natural propensity for aesthetics, which is expressed culturally and individually in the form of diverse traditions, canons, schools, and tastes. Unlike language, however, very little research has aimed to identify and characterize the constituents of humans' natural propensity for aesthetics. In fact, it is even unclear what to search for. In what terms should a natural propensity for aesthetics be understood? In a broad sense, we believe it makes sense to conceive it as a disposition to develop various forms of aesthetic experience, including those of aesthetic enjoyment, preference, judgment, production, and so on.

In this paper we focus on the propensity for aesthetic preference, conceived as a set of sensory-motor, perceptual, cognitive, and affective abilities and biases that orient humans toward the sort of sensory features—and arrangements thereof—that convey culturally relevant meaning. Color, symmetry, form, texture, speed, direction, angle, rhythm, tone, and many other sensory features convey meaningful information about natural phenomena, resources, and threats. Moreover, these features, combined with affectively engaging media, are intentionally and skillfully exploited in large- and small-scale societies to imbue objects, movements, sounds, smells, people, places, times, occasions, and so on with culturally relevant meaning (Anderson, 1989). These constitute the aesthetically enriched environments within which the putative propensity for aesthetics develops into fully fledged aesthetic preferences.

Preference for curvature exhibits the sort of qualities expected from the product of a natural propensity for aesthetic preference, as defined above. Several converging lines of evidence support this

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remark. First, contour curvature is preferred in a broad range of visual stimuli: people prefer objects (Bar & Neta, 2006, 2007), rooms (Vartanian et al., 2013), designs (Westerman et al., 2012), and geometric figures (Bertamini, Palumbo, Gheorghes, & Galatsidas, 2016; Palumbo & Bertamini, 2016; Palumbo, Ruta, & Bertamini, 2015; Silvia & Barona, 2009) with curved contours to those with sharp-angled contours. Second, evidence for this preference has been obtained reliably using several different experimental paradigms (Gómez-Puerto, Munar, & Nadal, 2016; Palumbo & Bertamini, 2016). Third, people prefer curved contours even when stimuli are shown very briefly (Bar & Neta, 2006, 2007). Fourth, young infants (Jadva, Hines, & Golombok, 2010) and even newborns (Fantz & Miranda, 1975) prefer curved contours to sharp ones. Fifth, curves and angles convey distinct meanings: whereas curved lines are commonly regarded as gentle, quiet, sad, or lazy, sharp lines are consistently regarded as agitating, hard, or furious (Hevner, 1935; Lundholm, 1921; Poffenberger & Barrows, 1924). Finally, chimpanzees and gorillas also prefer curved contours to sharp-angled ones (Munar, Gómez-Puerto, Call, & Nadal, 2015), and, like humans, they tend to fixate on them first (Gómez-Puerto, Munar, Kano, & Call, 2015). The evidence thus suggests the existence of evolutionary ancient sensory-motor, perceptual, cognitive, and/or affective mechanisms driving humans' preference for curved contours in many objects and under varying presentation conditions, even from early infancy, which are often associated with meanings, moods, and feelings.

Lacking in this catalog, however, is critical evidence for cross-cultural agreement in preference for curved contours. In general terms, if humans are, by their nature, endowed with a set of abilities and biases that orient them toward the aforementioned kind of sensory features, there should be evidence for such orientation and preference in cultures around the world. This has been successfully demonstrated for music. Several features of music structure and function are common across cultures, including the influence of processing constraints on music perception and memory (Stevens & Byron, 2009), the recognition of emotions carried by music (Fritz et al., 2009), and several features related to musical structure, such as pitch and rhythm, and function, such as performance style and social context (Savage, Brown, Sakai, & Currie, 2015). Thus, despite the wondrous variety of music around the world, a core of common features and functions are determined by our species' nature—by the features and limitations of our cognition and biology.

In sharp contrast, there is no evidence that people outside Western industrialized countries prefer—or do not prefer, for that

matter—curved contours to sharp-angled ones. The reason is that research on preference for curvature is remarkably culture blind (Heine & Norenzayan, 2006): Findings from Western samples—often college students—are uncritically assumed to generalize to all humans. Moreover, cross-cultural research on the psychological mechanisms involved in the aesthetic appreciation of visual features of any sort has been, at best, sporadic and unsystematic. The first wave of studies were mainly concerned with ascertaining whether there was agreement across cultures on the aesthetic value of specific geometric patterns or particular works (Lawlor, 1955; Lowie, 1921; McElroy, 1952). Later work shifted the emphasis to agreement among experts from different cultures on the artistic value of paintings and other visual materials (Anwar & Child, 1972; Child & Siroto, 1965; Ford, Prothro, & Child, 1966; Iwao & Child, 1966; Iwao, Child, & García, 1969). The most recent trend attempted to determine whether certain visual features—mainly visual complexity and symmetry—drive aesthetic preference in different cultures (Berlyne, 1975, 1976; Berlyne, Robbins, & Thompson, 1974; Eysenck & Iwawaki, 1971, 1975; Farley & Ahn, 1973; Soueif & Eysenck, 1971, 1972).

Even when taken together, it is uncertain what these studies reveal about the commonalities and differences in aesthetic preference among cultures. In fact, from Child's search for agreement on artistic merit among experts from different cultures to Berlyne's search for common dimensions across cultures underlying preference for complexity, the aforementioned studies addressed different issues. The differences are subtle but important. There can be agreement across cultures on the features that are relevant to aesthetics, but differences in the preferred values of those features, or in the meanings attributed to those features or values: "In the visual arts [. . .] certain formal categories are universally attended to. These include, at the very least, symmetry, proportion and balance, surface finish, and where pertinent, structural soundness. Cultures may differ widely in terms of what exactly is valued in these categories, but the categories themselves are attended to by artist and audience alike." (Silver, 1979, p. 290). Thus, the examination of cross-cultural commonalities in aesthetic preference requires a precise specification of what it is that is common. Extending Silver's (1979) account, at least four sorts of commonalities could be expected in relation to aesthetic preference in the visual domain (see Table 1): (a) The formal categories or dimensions that are taken into account; (b) the preferred level of those categories or dimensions; (c) the values/meanings attributed to such categories and levels; and (d) the semantic or symbolic content of aesthetic expressions.

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Table 1
Levels of Possible Cross-Cultural Commonalities in Aesthetic Preference

Sort of cross-cultural commonality	Examples
Formal categories that are attended to	The simplicity-complexity is relevant to aesthetic preference (Berlyne, Robbins, & Thompson, 1974; Berlyne, 1975)
Preferred level of formal category	Organized patterns are preferred to unorganized patterns (Berlyne, Robbins, & Thompson, 1974; Berlyne, 1975)
Values/meanings attributed to formal category	Tall, thin, vertical rectangles are regarded as active, unstable, elegant, and tense (McManus & Wu, 2013)
Content of aesthetic manifestations	Eye spots, bulging eyes, direct gaze in masks, paintings, etc. elicit defense reaction (Aiken, 1998)

In some cases, cultures exhibit several of these levels of commonalities simultaneously. McManus and Wu (2013) provide evidence for cross-cultural agreement for proportion on three of these levels. They showed that rectangle proportion (height vs. width) influenced British and Chinese participants' preference for the figures, that both groups had a bimodal preference distribution favoring squares and rectangles close to the golden section, and that both groups agreed on the meanings conveyed by rectangles of certain proportions. Thus, across cultures, (a) people take proportion into consideration when asked to express their aesthetic preference for geometric figures, (b) certain proportions are preferred to others, and (c) certain proportions convey specific meanings. In other cases, however, cultures might show only one of these sorts of commonalities. Uduehi (1995), for instance, reported that although regularity influenced American and Nigerian participants' aesthetic judgments, Americans preferred regular forms and Nigerians tended to prefer irregular forms. Thus, Americans and Nigerians seemed to take the same formal category regularity into consideration, but they differed regarding the pole they preferred most.

With regard to these distinctions, we postulate that humans' propensity for aesthetic preference predisposes people to orient toward the dimension of curvature and to develop a preference for objects with curved contours rather than for those with sharp-angled contours. Accordingly, the study reported here aimed to answer two questions: (a) Are the visual preferences of people in small- and large-scale societies influenced by curvature and (b) do people in small- and large-scale societies prefer curved contours to sharp-angled ones? Positive answers to both of these questions would constitute cross-cultural evidence of a common orientation toward the formal dimension curvature and of a common preference for one of the dimension's poles: curved contours.

Method

Participants

Twenty Spanish adults (18 females, age $M = 20.75$, $SD = 4.60$), 23 Mexican adults (11 females, age $M = 46.17$, $SD = 13.15$), and 13 Ghanaian adults (six females, ages unknown) participated in the experiment. This research was approved by the Ethical Committee of the Comunitat Autònoma de les Illes Balears (Spain), and all participants were treated in accordance with the Declaration of Helsinki (2008). The Spanish sample was constituted by psychology students from the University of the Balearic Islands, thus pertaining to a large-scale industrialized European society and similar to the samples used in previous studies on preference for curvature.

The Mexican and Ghanaian samples, in contrast, represent small-scale nonindustrialized American and African societies (Anderson, 1989). The Mexican sample was conformed by indigenous Chontal, living in several small towns (approximately 135–3,600 inhabitants) in the Tehuantepec district, located in the Isthmus region of Oaxaca, one of the Mexican federal states. Most people's livelihood in this region depends on small-scale subsistence farming and agriculture, growing corn, sugar cane, rice, and fruits and live in small nuclear families of parents and children. Despite growing homogenization among Mexican cultures, these indige-

nous people maintain their distinct identity, customs, clothing, and dialects (Acedo-Carmona & Gomila, 2015).

The Ghanaian sample included participants from the town of Bawku (approximately 69,500 inhabitants), an urban nucleus located in the Bawku Municipal District in the impoverished Northern region of Ghana. People in this region, dominated by Savannah grasslands, are reliant on subsistence slash-and-burn agriculture and livestock. Ghanaian participants' ethnic origins were diverse (Kussasi, Sissala, Frafra, Ashanti, Bissa, Waala, and Mossi). Since the country's independence in 1957, these groups have reaffirmed their own cultural identity, with their own languages, customs, and beliefs. Large extended monogamous or polygamous families are the most frequent form of cohabitation, and they are closely related to properties, identity, and status (Acedo-Carmona & Gomila, 2015).

Materials

One hundred forty-four gray-scale photographs of diverse real objects, lacking any inherent positive or negative valence, were chosen from a set used in previous studies (Bar & Neta, 2006, 2007; Munar, Gómez-Puerto, Call, & Nadal, 2015) and are available on the Web (<https://faculty.biu.ac.il/~barlab/stimuli.html>). The stimuli were improved in resolution and combined to create two sets of 36 pairs: a contour set, in which both images in a pair depicted the same object and differed mainly in the curvature of its contour, such that one of the alternatives was curved and the other sharp angled (see Figure 1), and a content set, in which images in a pair depicted different objects with the same sort of contour (curved or sharp angled), thus differing in their semantic meaning (see Figure 2). Content pairs were designed and included only as filler trials to make the aims and main aesthetic dimension (contour curvature) of the study less apparent to participants. An additional 16 nonrelated images taken from the same set that combined distinct curved and sharp features were paired to create a set of eight practice trials.

Each individual image was scaled to a resolution of 340×340 px. Because of the limitations derived from fieldwork, the size of the screens used varied across locations, thus resulting in varying presentation sizes (Spain: 19 inches at 1440×900 px; Ghana: 10.1 inches at 1024×600 px; Mexico: 13.3 inches at 1366×768 px). Nevertheless, there is no indication that these differences might have affected the results obtained.

Procedure

We designed a two-alternative forced choice task that minimized verbal content so that it would not be dependent on cognitive or linguistic skills or cultural differences in the understanding of verbal instructions. As discussed elsewhere (Munar, Gómez-Puerto, & Gomila, 2015), this was achieved based on an approach-avoidance framework, in which the forced choice was followed by displaying the selected image as being closer to the participant. In this way the task was made self-evident, requiring minimal verbal instructions and allowing its use in very different cultural environments and even with other primate species (Munar, Gómez-Puerto, Call, & Nadal, 2015).

In each trial of the task, participants were presented with a pair of images varying in their contour or semantic content and in-

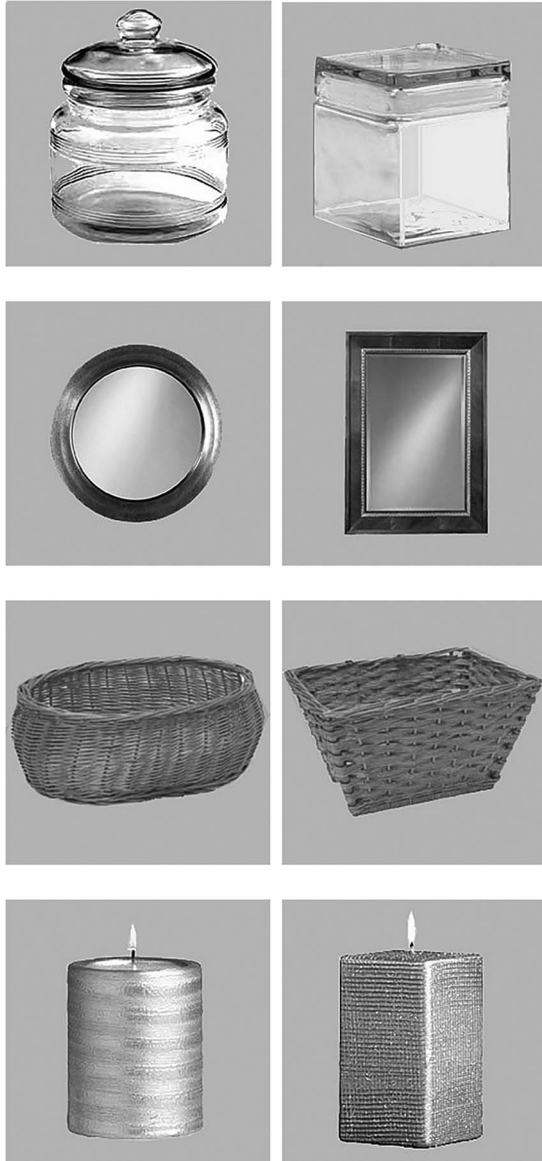


Figure 1. Four examples of *contour pairs*: The objects in each pair share a common semantic content but differ in contour. Here the objects on the left have curved contours; the ones on the right, sharp-angled contours. From Bar & Neta (2006), used with their permission.

structed to select one of the images in the presented pair by pressing a keyboard arrow (left or right). Instructions were simple, and specifically avoided the use of terms such as *wanting*, *liking*, or *preferring*. The action of choosing was made meaningful in a nonsemantically dependent way by implementing the effect of approaching the chosen image upon selection. This was achieved by immediately displaying the chosen image on its own, centered and enlarged. A trial consisted of a fixation cross shown for 500 milliseconds, followed by the paired stimuli displayed for 80 milliseconds. These images were then immediately replaced by a pair of light gray squares, which prompted the participant to make a choice, and reduced possible aftereffects. As soon as one of the

images was selected, it was shown again for 1 second, centered, and at twice its original size.

To avoid undesired familiarity effects, participants were tested in a single session. Each session consisted of two equivalent blocks of 72 trials performed in succession without interruption. Both blocks were identical, except each element of a pair appeared on different sides of the screen on each occasion. For simplicity, the stimuli pairs were assigned to two subblocks of 36, and all the pairs in each subblock switched together from the first to the second block.

The order of both blocks was randomized, as was the order of the 72 trials within each block. This design enabled measuring



Figure 2. Four examples of *content pairs*: The objects in each pair share the same kind of contour but differ in semantic meaning. Objects in the two top pairs have curved contours; those in the two bottom pairs, sharp-angled contours. From Bar & Neta (2006), used with their permission.

lateralization effects and identifying other possible sources for preference while at the same time increasing the number of trials. Eight additional training trials, comprising stimuli that combined both curved and sharp-angled features, were added at the beginning of the session so participants could become familiar with the procedure before the actual test began.

The presentation and recording of the data were performed using the DirectRT software version 2006 and version 2014 (Empirisoft Corporation, New York, NY) in a controlled environment. In Spain, participants undertook the experiment in isolation, inside a soundproof laboratory with constant light. An effort was made so that conditions in Mexico and Ghana replicated this setting; but because of the lack of resources and cultural differences, full isolation was not possible. Still, participants in those countries were able to participate in an adequately lit environment devoid of distractions.

Data Preparation

Given the cultural differences between participants from different countries and the lack of familiarity of a good part of them with computer-based tasks, data examination and data deputation were required prior to analysis. Only data from the contour trials were analyzed.

Because both very short and very long response times can seriously affect choice processes, thus biasing the results and interpretation, the responses were first examined, in a trial-by-trial basis, with reference to the corresponding response times. This way, we conducted a preliminary exploratory analysis to detect outliers showing both very fast and very slow responses. Response times under 300 ms were considered fast responses, and those falling above the $Q3 + 1.5$ interquartile range (IQR) for each country were regarded as slow outliers (Ghana: 2013 ms; Mexico: 3474 ms; Spain: 1384 ms). These fast and slow trials were excluded from the analyses (9.51% of all responses). For six participants these data deputation implied that more than a half of their trials were excluded, so we decided to remove those individuals from subsequent analyses (increasing the number of excluded responses to 13.26%).

Finally, to further ensure the integrity of the data, we removed all the trials from two additional participants whose response patterns were aberrant, suggesting either they performed choices in a careless way and/or they misunderstood the task: One participant always pressed the same key; the other systematically alternated, trial by trial, between the two options. By countries, the final percentages of excluded responses were 27.71% (Ghana), 19.43% (Mexico), and 6.73% (Spain). We then proceeded to restructure the remaining data (83.17%, 48 participants), setting the proportion of curved choices for the contour pairs as the dependent variable. From this point, results are based on this data array.

Results

Data were analyzed with SPSS 20.0.0 (SPSS Inc., Chicago, IL). An alpha level of .05 was used for all analyses. The dependent variable was checked both for normality and homogeneity of variances. The Shapiro-Wilks test indicated normality could be assumed for each of the three samples, $W(10) = 0.966, p = .848$ (Ghana); $W(19) = 0.962, p = .606$ (Mexico); $W(19) = 0.914, p =$

.089 (Spain). However, Levene's test was significant, $F(2, 45) = 10.626, p < .001$, indicating that, for the country factor, the variances were statistically different, an outcome we must take into account in further analyses.

To contrast the hypothesis regarding general visual preferences for curved contours, we first conducted a one-sample t test (two-tailed) for the overall mean (all samples taken together) of curved choices proportions ($M = 0.57, SD = 0.08$), which was above the chance level of 0.5, showing a statistically significant mean difference of 0.07, 95% confidence interval (CI) [0.048, 0.094], $t(47) = 6.275, p < .001, d = 0.905$.

To test the hypothesis that the visual preference for curved contours occurs in every country, three additional one-sample t tests were conducted to determine whether a statistically significant difference existed between the mean proportion of curved choices for each country and the chance level. Results indicated that the proportion of curved choices from Ghana ($M = 0.58, SD = 0.07$), from Mexico ($M = 0.55, SD = 0.05$), and from Spain ($M = 0.59, SD = 0.1$) were all greater than 0.5. The statistically significant mean differences were, for Ghana $m = 0.082, 95\% CI [0.034, 0.129], t(9) = 3.898, p = .004, d = 1.23$, for Mexico $m = 0.047, 95\% CI [0.026, 0.069], t(18) = 4.537, p < .001, d = 1.04$, and for Spain $m = 0.089, 95\% CI [0.039, 0.14], t(18) = 3.742, p = .001, d = 0.858$.

An additional analysis was conducted to compare the preference for curved contours between the three groups. Thus, we ran a one-way, between-subjects analysis of variance to test whether there were any statistically significant differences between the three countries regarding the proportion of curved choices. Because heteroscedasticity is commonly regarded to be a problem, especially when sample sizes are unequal in different levels of a factor, we decided to use the Welch's adjusted F ratio (1.94). The test did not reveal any significant effect of the country on the preference for curved contours, $Welch's F(2, 21.682) = 1.94, p = .167, est. \omega^2 = .038$ (see Figure 3).

F3

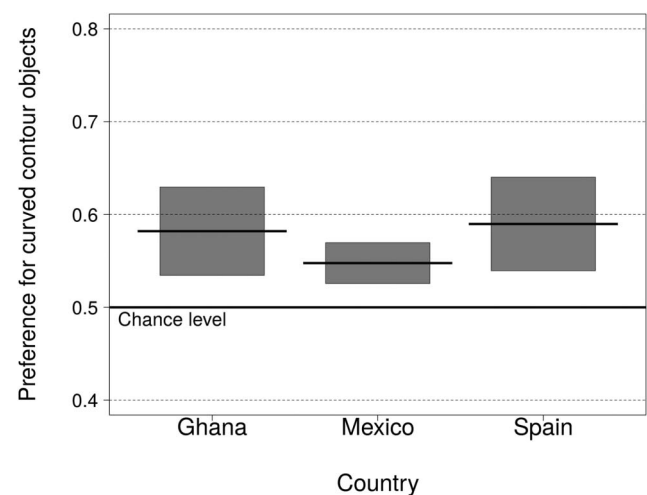


Figure 3. Preference for curved contours for each of the participant groups. Values over .5 reflect preference for curved contours; values below .5 reflect preference for sharp-angled contours. Lines indicate mean values; gray shading indicates 95% confidence intervals.

Therefore, because there were statistically significant differences between the mean of each country and the chance level, the results support the conclusion that people from Bawku (Ghana), from Oaxaca (Mexico), and from Mallorca (Spain) prefer curved contours to sharp-angled ones. Moreover, there were no significant differences among cultures in the extent of such preference, as indicated by the outcome of the Welch analysis of variance.

We conducted additional by-stimulus and by-participant analyses to offer another angle on our results. First, we checked for object pairs that elicited extreme preference responses—either for the curved or the sharp-angled options—using the 1.5 IQR method for detecting extreme responses. This analysis revealed that there were no object pairs with extremely low (below $Q1 - 1.5$ IQR) or extremely high (above $Q3 + 1.5$ IQR) proportions of curved preference choices. This was the case when considering the three samples together, and when conducting this analysis separately for each of them. Second, we wanted to determine the proportion of participants in each country who chose curved items most often (i.e., in more than 50% of trials). The results showed that 90% of Ghanaian, 85.22% of Mexican, and 79.85% of Spanish participants (83.34% overall) chose the curved alternative more often than not.

Discussion

In this study we aimed to determine whether preference for curved contours is common across cultures from three different continents. Specifically, we wanted to ascertain whether contour curvature-sharpness constitutes a relevant dimension for visual preferences of people in small- and large-scale societies and whether curved contours are preferred to sharp-angled ones in small- and large-scale societies. Our results show that indeed this is the case. First, contour influenced the choices of participants in the Mexican, Ghanaian, and Spanish samples: They were significantly different from the chance level in all groups, meaning that participants' choices were not indifferent to this dimension. Second, participants in the three samples preferred objects with curved contours significantly more than their sharp-angled equivalents. Moreover, we found no evidence of between-groups differences in the extent to which they preferred curved contours (there were no significant differences between preference levels). Taken together, these results suggest that orientation toward, and preference for, curvature are common across small- and large-scale societies sampled from different continents.

These results thus suggest that *curvature* is one of the aesthetic categories or dimensions that drive visual preference of people from different cultures around the world, together with *color hue*, *saturation* and *lightness*, *symmetry*, *complexity*, *regularity*, and *proportion* (Berlyne, 1976; Eysenck & Iwawaki, 1971; McManus & Wu, 2013; Palmer, Schloss, & Sammartino, 2013; Silver, 1979). Moreover, curved constitutes the preferred value (at least to sharp angled) across cultures for the *curvature* dimension, just as there seems to be cross-cultural agreement on preference for certain values along other dimensions: square and near-golden section are the preferred proportions in rectangles (McManus & Wu, 2013).

To argue for a general preference for curved contour objects, however, is not to claim that everyone prefers curves over angles all the time. In this study almost 17% of participants chose the sharp-angled items most of the times. And other recent research

shows that openness to experience and training in art history or architecture can attenuate—an even invert—preference for curved contour objects, shapes, and rooms (Belman et al., 2016; Cotter, Silvia, Bertamini, Palumbo, & Vartanian, submitted; Vartanian et al., submitted). Thus, everyday life experience and formal training, among other factors, contribute to shaping the outcome of the hypothesized propensity to develop preferences in relation to curvature: Although general among people, preference for curvature is not uniform across people.

The full significance of the results presented in this paper is apparent when woven together with other strands of evidence. Curved contours are preferred to sharp-angled ones in many sorts of images (Bar & Neta, 2006, 2007; Bertamini et al., 2016; Palumbo & Bertamini, 2016; Palumbo et al., 2015; Silvia & Barona, 2009; Vartanian et al., 2013; Westerman et al., 2012), even when different methods are used (Palumbo & Bertamini, 2016) and under very short presentation times (Bar & Neta, 2006, 2007). This preference arises early in infancy (Fantz & Miranda, 1975; Jadva et al., 2010), and it is common across large- and small-scale societies from different continents and is present, even in great apes (Munar, Gómez-Puerto, Call, & Nadal, 2015; Gómez-Puerto, Munar, Kano, & Call, 2015). We believe that, together, these strands of evidence support the following conjectures:

1. Humans are endowed with a natural propensity to acquire aesthetic preferences as we develop in an aesthetically rich environment, that functions to orient us fast and efficiently toward sensory features that, alone or in combination, carry culturally relevant meanings.
2. This propensity is constituted by a set of sensory-motor, perceptual, affective, and/or cognitive capacities and biases. Although characterizing these psychological processes is the object of current research, their precise nature remains still largely unknown.
3. The evidence to date, however, indicates that we share, at least in a large part, the psychological mechanisms underlying the human propensity for aesthetics with African great apes. This suggests that humans, gorillas, and chimpanzees inherited such mechanisms from their common ancestor, which lived some 9 million to 10 million years ago. It also suggests that although in humans these psychological mechanisms play a crucial role in aesthetic preference, they are best regarded as components of a primate—maybe even mammal—general valuation system.
4. This propensity is culturally and individually expressed in the form of historically and geographically distinct traditions, canons, schools, and tastes and can be modulated by training and experience in general.

Although these conjectures are in agreement with this study's results and those of the studies reviewed in the introduction, much more evidence is required to support them. Indeed, the research presented in this paper corresponds to stage 1 of Heine and Norenzayan's (2006) research program for a culture-sensitive cog-

nitive psychology: the documentation of similarities and differences in psychological processes across cultures. In the case of the present study's research line, stage 2—the explanation of these similarities and differences—will require additional experiments to determine the psychological processes underlying preference for curvature (Gómez-Puerto Munar, Kano, & Call, 2015), the developmental processes involved in the expression of such putative propensity into full-fledged preferences, the differences and similarities in the cultural expression of aesthetic preference, and the differences and similarities in preference for aesthetic features across species.

References

- Acedo-Carmona, C., & Gomila, A. (2015). Trust matters: A cross-cultural comparison of Northern Ghana and Oaxaca groups. *Frontiers in Psychology, 6*, 661. <http://dx.doi.org/10.3389/fpsyg.2015.00661>
- AQ: 3 Aiken, N. E. (1998). *The biological origins of art*. Westport, CT: Praeger.
- Anderson, R. L. (1989). *Art in small-scale societies* (2nd ed.). Englewood Cliffs, NJ: Prentice Hall.
- Anwar, M. P., & Child, I. L. (1972). Personality and esthetic sensitivity in an Islamic culture. *Journal of Social Psychology, 87*, 21–28. <http://dx.doi.org/10.1080/00224545.1972.9918643>
- Bar, M., & Neta, M. (2006). Humans prefer curved visual objects. *Psychological Science, 17*, 645–648. <http://dx.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*, 2191–2200. <http://dx.doi.org/10.1016/j.neuropsychologia.2007.03.008>
- Belman, M., Currò, T., Corradi, G., Nadal, M., Rosselló, J., Del Viva, M. M., & Munar, E. (2016). *Explaining individual differences in preference for curvature*. Poster presented at the 24th Conference of the International Association of Empirical Aesthetics, Vienna, Austria.
- Berlyne, D. E. (1975). Extension to Indian subjects of a study of exploratory and verbal responses to visual patterns. *Journal of Cross-Cultural Psychology, 6*, 316–330. <http://dx.doi.org/10.1177/002202217563004>
- Berlyne, D. E. (1976). Similarity and preference judgments of Indian and Canadian subjects exposed to Western paintings. *International Journal of Psychology, 11*, 43–55. <http://dx.doi.org/10.1080/00207597608247346>
- Berlyne, D. E., Robbins, M. C., & Thompson, R. (1974). A cross-cultural study of exploratory and verbal responses to visual patterns varying in complexity. In D. E. Berlyne (Ed.), *Studies in the new experimental aesthetics: Steps toward an objective psychology of aesthetic appreciation* (pp. 259–278). New York: Halstead Press.
- Bertamini, M., Palumbo, L., Gheorghes, T. N., & Galatsidas, M. (2016). Do observers like curvature or do they dislike angularity? *British Journal of Psychology, 107*, 154–178. <http://dx.doi.org/10.1111/bjop.12132>
- Bijeljac-Babic, R., Bertocini, J., & Mehler, J. (1993). How do four-day-old infants categorize multisyllabic utterances? *Developmental Psychology, 29*, 711–723. <http://dx.doi.org/10.1037/0012-1649.29.4.711>
- Child, I. L., & Siroto, L. (1965). BaKwele and American esthetic evaluations compared. *Ethnology, 4*, 349–360. <http://dx.doi.org/10.2307/3772785>
- Cotter, K. N., Silvia, P. J., Bertamini, M., Palumbo, L., & Vartanian, O. (submitted). Curve appeal: Exploring individual differences in preference for curved versus angular objects.
- Eimas, P. D., Siqueland, E. R., Jusczyk, P., & Vigorito, J. (1971). Speech perception in infants. *Science, 171*, 303–306. <http://dx.doi.org/10.1126/science.171.3968.303>
- Eysenck, H. J., & Iwawaki, S. (1971). Cultural relativity in aesthetic judgments: An empirical study. *Perceptual and Motor Skills, 32*, 817–818. <http://dx.doi.org/10.2466/pms.1971.32.3.817>
- Eysenck, H. J., & Iwawaki, S. (1975). The determination of aesthetic judgment by race and sex. *Journal of Social Psychology, 96*, 11–20. <http://dx.doi.org/10.1080/00224545.1975.9923256>
- Fantz, R. L., & Miranda, S. B. (1975). Newborn infant attention to form of contour. *Child Development, 46*, 224–228. <http://dx.doi.org/10.2307/1128853>
- Farley, F., & Ahn, S.-H. (1973). Experimental aesthetics: Visual aesthetic preference in five cultures. *Studies in Art Education, 15*, 44–48. <http://dx.doi.org/10.2307/1320057>
- Ford, C. S., Prothro, E. T., & Child, I. L. (1966). Some transcultural comparisons of esthetic judgment. *Journal of Social Psychology, 68*, 19–26. <http://dx.doi.org/10.1080/00224545.1966.9919661>
- Fritz, T., Jentschke, S., Gosselin, N., Sammler, D., Peretz, I., Turner, R., . . . Koelsch, S. (2009). Universal recognition of three basic emotions in music. *Current Biology, 19*, 573–576. <http://dx.doi.org/10.1016/j.cub.2009.02.058>
- Gómez-Puerto, G., Munar, E., Kano, F., & Call, J. (2015). Eye-tracking of primate's preference for curvature. *Perception, 44*(S1), 32.
- Gómez-Puerto, G., Munar, E., & Nadal, M. (2016). Preference for curvature: A historical and conceptual framework. *Frontiers in Human Neuroscience, 9*, 712. <http://dx.doi.org/10.3389/fnhum.2015.00712>
- Heine, S. J., & Norenzayan, A. (2006). Toward a psychological science for a cultural species. *Perspectives on Psychological Science, 1*, 251–269. <http://dx.doi.org/10.1111/j.1745-6916.2006.00015.x>
- Hevner, K. (1935). Experimental studies of the affective value of colors and lines. *Journal of Applied Psychology, 19*, 385–398. <http://dx.doi.org/10.1037/h0055538>
- Iwao, S., & Child, I. L. (1966). Comparison of esthetic judgments by American experts and by Japanese potters. *Journal of Social Psychology, 68*, 27–33. <http://dx.doi.org/10.1080/00224545.1966.9919662>
- Iwao, S., Child, I. L., & García, M. (1969). Further evidence of agreement between Japanese and American esthetic evaluations. *Journal of Social Psychology, 78*, 11–15. <http://dx.doi.org/10.1080/00224545.1969.9922334>
- Jadva, V., Hines, M., & Golombok, S. (2010). Infants' preferences for toys, colors, and shapes: Sex differences and similarities. *Archives of Sexual Behavior, 39*, 1261–1273. <http://dx.doi.org/10.1007/s10508-010-9618-z>
- Kim, H. S., & Sasaki, J. Y. (2014). Cultural neuroscience: Biology of the mind in cultural contexts. *Annual Review of Psychology, 65*, 487–514. <http://dx.doi.org/10.1146/annurev-psych-010213-115040>
- Laland, K. N., Odling-Smee, J., & Myles, S. (2010). How culture shaped the human genome: Bringing genetics and the human sciences together. *Nature Reviews Genetics, 11*, 137–148. <http://dx.doi.org/10.1038/nrg2734>
- Lawlor, M. (1955). Cultural influences on preference for designs. *Journal of Abnormal and Social Psychology, 51*, 690–692. <http://dx.doi.org/10.1037/h0047219>
- Lowie, R. H. (1921). A note on aesthetics. *American Anthropologist, 23*, 170–174. <http://dx.doi.org/10.1525/aa.1921.23.2.02a00040>
- Lundholm, H. (1921). The affective tone of lines: Experimental researches. *Psychological Review, 28*, 43–60. <http://dx.doi.org/10.1037/h0072647>
- McElroy, W. A. (1952). Aesthetic appreciation in aborigines of Arnhem Land: A comparative experimental study. *Oceania, 23*, 81–95. <http://dx.doi.org/10.1002/j.1834-4461.1952.tb00190.x>
- McManus, I. C., & Wu, W. (2013). “The square is . . . bulky, heavy, contented, plain, good-natured, stupid . . .”: A cross-cultural study of the aesthetics and meanings of rectangles. *Psychology of Aesthetics, Creativity, and the Arts, 7*, 130–139. <http://dx.doi.org/10.1037/a0030469>
- Mehler, J., Jusczyk, P., Lambertz, G., Halsted, N., Bertocini, J., & Amiel-Tison, C. (1988). A precursor of language acquisition in young infants. *Cognition, 29*, 143–178. [http://dx.doi.org/10.1016/0010-0277\(88\)90035-2](http://dx.doi.org/10.1016/0010-0277(88)90035-2)

- Munar, E., Gómez-Puerto, G., Call, J., & Nadal, M. (2015). Common visual preference for curved contours in humans and great apes. *PLoS One*, *10*, e0141106. <http://dx.doi.org/10.1371/journal.pone.0141106>
- Munar, E., Gómez-Puerto, G., & Gomila, A. (2015). The evolutionary roots of aesthetics: An approach-avoidance look at curvature preference. In A. Scarinzi (Ed.), *Embodied aesthetics: Proceedings of the 1st International Conference on Aesthetics and the Embodied Mind*. August 26–28, 2013 (pp. 3–17). Leiden: Brill Academic Publishers.
- Palmer, S. E., Schloss, K. B., & Sammartino, J. (2013). Visual aesthetics and human preference. *Annual Review of Psychology*, *64*, 77–107. <http://dx.doi.org/10.1146/annurev-psych-120710-100504>
- Palumbo, L., & Bertamini, M. (2016). The curvature effect: A comparison between preference tasks. *Empirical Studies of the Arts*, *34*, 35–52. <http://dx.doi.org/10.1177/0276237415621185>
- Palumbo, L., Ruta, N., & Bertamini, M. (2015). Comparing angular and curved shapes in terms of implicit associations and approach/avoidance responses. *PLoS One*, *10*, e0140043. <http://dx.doi.org/10.1371/journal.pone.0140043>
- Poffenberger, A. T., & Barrows, B. E. (1924). The feeling value of lines. *Journal of Applied Psychology*, *8*, 187–205. <http://dx.doi.org/10.1037/h0073513>
- Richerson, P. J., & Boyd, R. (2005). *Not by genes alone. How culture transformed human evolution*. Chicago: Chicago University Press.
- Saffran, J. R., Aslin, R. N., & Newport, E. L. (1996). Statistical learning by 8-month-old infants. *Science*, *274*, 1926–1928. <http://dx.doi.org/10.1126/science.274.5294.1926>
- Savage, P. E., Brown, S., Sakai, E., & Currie, T. E. (2015). Statistical universals reveal the structures and functions of human music. *Proceedings of the National Academy of Sciences, United States of America*, *112*, 8987–8992. <http://dx.doi.org/10.1073/pnas.1414495112>
- Silver, H. R. (1979). Ethnoart. *Annual Review of Anthropology*, *8*, 267–307. <http://dx.doi.org/10.1146/annurev.an.08.100179.001411>
- Silvia, P. J., & Barona, C. M. (2009). Do people prefer curved objects? Angularity, expertise, and aesthetic preference. *Empirical Studies of the Arts*, *27*, 25–42. <http://dx.doi.org/10.2190/EM.27.1.b>
- Soueif, M. I., & Eysenck, H. J. (1971). Cultural differences in aesthetic preferences. *International Journal of Psychology*, *6*, 293–298. <http://dx.doi.org/10.1080/00207597108246695>
- Soueif, M. I., & Eysenck, H. J. (1972). Factors in the determination of preference judgments for polygonal figures: A comparative study. *International Journal of Psychology*, *7*, 145–153. <http://dx.doi.org/10.1080/00207597208247048>
- Stevens, C., & Byron, T. (2009). Universals in music processing. In S. Hallam, I. Cross, & M. Thaut (Eds.), *The Oxford handbook of music psychology* (pp. 14–23). Oxford, New York: Oxford University Press.
- Uduehi, J. (1995). A cross-cultural assessment of the Maitland Graves Design Judgment Test using U.S. and Nigerian subjects. *Visual Arts Research*, *21*, 11–18.
- Vartanian, O., Navarrete, G., Chatterjee, A., Fich, L. B., Leder, H., Modroño, C., . . . Nadal, M. (submitted). Preference for curvilinear contour in interior architectural spaces: Evidence from experts and nonexperts.
- Vartanian, O., Navarrete, G., Chatterjee, A., Fich, L. B., Leder, H., Modroño, C., . . . Skov, M. (2013). Impact of contour on aesthetic judgments and approach-avoidance decisions in architecture. *Proceedings of the National Academy of Sciences, United States of America*, *110*(Suppl 2), 10446–10453. <http://dx.doi.org/10.1073/pnas.1301227110>
- Westerman, S. J., Gardner, P. H., Sutherland, E. J., White, T., Jordan, K., Watts, S., & Wells, S. (2012). Product design: Preference for rounded versus angular design elements. *Psychology and Marketing*, *29*, 595–605. <http://dx.doi.org/10.1002/mar.20546>

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