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Research Article

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Posted Date: October 20th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-11400599/v1>

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Additional Declarations: The authors declare no competing interests.

Cultural attenuation of a universal aesthetic preference:

Symmetry and beauty in ikebana

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Abstract

Symmetry is a leading candidate as a universal determinant of beauty; however, ikebana, the Japanese art of flower arrangement, has cultivated a codified norm of asymmetry for centuries. In a preregistered study, 976 participants in Japan, Germany, the United Kingdom, and the United States rated 150 photographs of ikebana arrangements (24,367 trials) on perceived symmetry, beauty, liking, arousal, and positive and negative emotion. Perceived symmetry predicted beauty strongly in the three Western countries but barely in Japan (one-tenth of the Western slope); liking and positive emotion kept a weak positive link in Japan. Computational symmetry measures acted largely through perceived symmetry, and the perception-to-evaluation pathway weakened only in Japan. Japanese participants also reported the highest mixed emotion, which penalized beauty at one-quarter the Western rate. Thus, the universal pull of symmetry survives a codified counter-norm in weakened form: culture tunes its weight, entering into evaluation rather than perception.

Keywords: ikebana, symmetry, cross-cultural, empirical aesthetics, mixed emotion

Introduction

Symmetry is one of the most robust predictors of aesthetic judgment. In beauty judgments of abstract patterns, symmetry has emerged as the single most important stimulus property (e.g., Jacobsen et al., 2006), and the preference for symmetry has been documented consistently across stimulus classes and cultures (Che et al., 2018; Leder et al., 2024; Palmer et al., 2013; Rhodes, 2006; Westphal-Fitch et al., 2012). Three independent theoretical traditions converge in predicting that this preference is universal. In Berlyne's (1971) psychobiological theory, symmetry is a collative property that increases redundancy and reduces uncertainty, linking it to pleasure through its arousal potential (Silvia, 2005). Processing fluency theory holds that symmetric stimuli are processed fluently and that this fluency is itself experienced as pleasure (Reber et al., 2004). Evolutionary accounts root the preference deep in the perceptual system (Enquist & Arak, 1994; Møller, 1992); indeed, symmetry is processed by specialized regions of extrastriate visual cortex in both humans and macaques (Sasaki et al., 2005). Under any of these accounts, the preference for symmetry should be a shared human determinant of beauty.

Simultaneously, aesthetic preferences are demonstrably shaped by cultural learning. East Asian and North American observers differ systematically in visual attention and compositional preferences (Masuda et al., 2008; Nisbett & Masuda, 2003), while their evaluations of art reflect both their own-cultural preferences and their interplay with expertise (Darda & Cross, 2022). Indeed, expertise can invert the very preference at issue (Leder et al., 2019), and a norm absorbed through a lifetime of cultural participation should be at least as consequential as a few years of training. However, empirical aesthetics continue to rely heavily on WEIRD samples (Darda et al., 2026; Henrich et al., 2010). What is missing is a test in a culture that holds an

explicit, codified, and institutionally transmitted norm that could serve as a ‘counter-norm’ to the very dimension claimed to be universal: symmetry itself.

Ikebana, the traditional Japanese art of flower arrangement (Sato, 2008), is one such example. In the classic formulation of Zen aesthetics, Hisamatsu (1971) placed *fukinsei* (asymmetry) first among the seven characteristics of Japanese beauty: not mere lateral asymmetry, but a broader aesthetic norm against completeness, regularity, and perfection, and one from a family of untranslatable aesthetic concepts that have crystallized in the Japanese language (Lomas, 2023). While Western flower arrangements are built on symmetry, ikebana considers asymmetry as its formal norm (Moriyama & Moriyama, 1999). The norm was codified in medieval manuals (the right-long, left-short rule of the *Sendensho*; Inoue, 2021) and taught explicitly across generations through ikebana schools (Sato, 2008). Ikebana is thus a maximum-dose condition of cultural learning: a codified counter-norm aimed at the very dimension of the universality claim, equipped with an institutional transmission mechanism. Importantly, Japanese participants also evaluated symmetry in abstract patterns as beautiful both explicitly and implicitly (Leder et al., 2024). Any influence of culture should therefore appear not at the level of perceiving abstract form but in the art form in which the norm of asymmetry has been taught and practiced: ikebana itself. However, quantitative evidence is limited to a single Japanese-sample study in which perceived symmetry predicted beauty positively (Hitsuwari & Jacobsen, 2026); without a comparison group, it cannot tell whether the strength of that link is culturally tuned. The open question is this: under a codified counter-norm, is the preference for symmetry preserved at Western levels, attenuated, or abolished?

Testing this question requires going beyond single beauty ratings. First, aesthetic emotions are multidimensional (Menninghaus et al., 2019), and arousal has been a core

dimension of aesthetic experience since Berlyne. The emotions that are preferentially elicited may depend on culture. East Asian participants report experiencing positive and negative emotions concurrently, even in pleasant situations (Miyamoto et al., 2010), and ikebana, an art that thematizes life and transience, is well suited to detecting cultural differences in mixed emotion (Larsen et al., 2001). Second, we measured both computational image properties (Redies et al., 2025) and perceived symmetry to test the mediational pathway from objective symmetry through perceived symmetry to beauty. Third, we measured individual differences that may modulate the weight given to symmetry: ikebana experience (as cognitive mastery; Leder et al., 2004), visual aesthetic sensitivity, desire for aesthetic experiences, and attitude toward ambiguity (Lauriola et al., 2016). Because ambiguity and its resolvability are central to aesthetic appreciation (Muth et al., 2015) and symmetry reduces uncertainty, individuals who find ambiguity discomforting and those with a strong absolutist mindset that seeks clarity should place more weight on symmetry.

This study was preregistered and conducted in Japan, Germany, the United Kingdom, and the United States ($N = 976$). Using 150 stimuli, photographs of 75 arrangements created by a professional ikebana artist and their mirror images, each participant rated 25 works on six dimensions: perceived symmetry, beauty, liking, arousal, positive emotion, and negative emotion. The hypotheses are categorized into three groups: (a) cross-national differences in aesthetic evaluation and emotional profile; (b) effects of subjective and objective symmetry and their shape (linear or curvilinear); and (c) main effects of individual differences (desire for aesthetic experiences and aesthetic sensitivity) and moderation of the symmetry effect (by culture, ikebana experience, and attitudes toward ambiguity). The central prediction was that

perceived symmetry would predict beauty positively in all four countries, with the weakest association in Japan.

Research Transparency Statement

General disclosures

Conflicts of interest: The authors declare no conflicts of interest. Funding: This research was supported by the Japan Society for the Promotion of Science (JSPS) through an Overseas Research Fellowship and a Grant-in-Aid for JSPS Fellows (Grant Number JP26KJ0364) awarded to J.H., by Sawakami Mirai Lab, through crowdfunding via academist, and through intramural funding from Helmut Schmidt University/University of the Federal Armed Forces, Hamburg. Artificial intelligence: Large language models (primarily Claude Fable 5; Anthropic) were used to assist in writing the analysis code, drafting the manuscript, and English language editing, all of which were verified and approved by the authors. The manuscript has been additionally edited by a professional language editing service (Editage). Ethics: This study was approved by the Ethics Committee of Psychology at the Faculty of Humanities and Social Sciences, Helmut Schmidt University, and was conducted in accordance with the tenets of the Declaration of Helsinki. All participants provided informed consent.

Study-specific disclosures

Preregistration: The design, hypotheses, and analysis plan were preregistered in the Open Science Framework (https://osf.io/hfgw8/?view_only=1f344cf1a4e347bdaf10234165d025bc; anonymized view-only link for review; the public registration will be linked upon acceptance). Deviations from the preregistration are reported in the Methods section and summarized in Supplementary Table S10. Materials: Stimulus lists and the de-identified questionnaire exports are deposited on Zenodo (<https://doi.org/10.5281/zenodo.23413072>; the record will be made

public upon acceptance). Data: All trial- and participant-level data are deposited on Zenodo (same DOI). Analysis scripts: All R scripts for preprocessing, analyses, and figures, with a README describing how to reproduce the reported results, are deposited on Zenodo (same DOI).

Method

Ethical Considerations and Open Science

This study was approved by the Ethics Committee of Psychology at the Faculty of Humanities and Social Sciences, Helmut Schmidt University and was conducted in accordance with the tenets of the Declaration of Helsinki. In line with Open Science practices, the study design, hypotheses, and analysis plan were registered with the Open Science Framework (OSF; https://osf.io/hfgw8/?view_only=1f344cf1a4e347bdaf10234165d025bc). The raw data, materials, and analysis scripts are deposited on Zenodo (<https://doi.org/10.5281/zenodo.23413072>).

Participants

A total of $N = 976$ adults from four countries participated in the study: Japan (JP, $n = 251$), Germany (DE, $n = 248$), the United Kingdom (UK, $n = 240$), and the United States (US, $n = 237$). Japanese participants were recruited through CrowdWorks (<https://crowdworks.jp>), a Japanese crowdsourcing platform, and participants from the other three countries were recruited through Prolific (<https://www.prolific.com>). Ikebana experience was low in all four samples ($M = 2.00, 1.82, 1.73$, and 2.15 on a 5-point scale for JP, DE, UK, and US; item-level means in

Supplementary Table S12), and the German sample was younger ($M = 33.3$ years, $SD = 11.9$) and more male-dominated (188 of 248) than the other samples. The full demographic characteristics by country are shown in Supplementary Table S1.

The target sample size was determined a priori through power simulations with the *simr* package (Green & MacLeod, 2016), based on the preregistered multilevel design (planned $N = 1,000$; 250 per country; 25 trials each; 200 simulations; $\alpha = .05$). The simulations indicated power $\geq .90$ for all primary effects, including the linear and quadratic effects of subjective symmetry, the cultural main effect, and the Culture $\times$ symmetry interaction. After the exclusion, the final sample ($N = 976$) closely approximated the target.

Data collection was completed in January 2026. Participants were excluded prior to analysis if they did not complete the survey, failed an embedded attention-check item, completed the task in less than 10 min or more than 90 min, or left more than 20% of the rating items unanswered. Respondents who did not report a gender ("no answer," $n = 25$) were also excluded. Beyond these criteria, no dedicated screening for automated or AI-generated responses was applied; the attention check and completion-time bounds served as the screen for inattentive or automated responding. The final sample comprised 24,367 trial-level observations.

Stimuli

The stimulus set comprised 75 photographs of ikebana created by the professional ikebana artist Akiko Kaneko (Figure 1), the same work used by Hitsuwari and Jacobsen (2026). Each image was presented in its original orientation and as a horizontally mirrored version, yielding 150 stimuli; the experimental factor was whether an image appeared in its original or mirrored orientation (stimulus orientation). The 150 stimuli were divided into six

counterbalanced sets of 25 images each. Every participant viewed a single set so that no participant saw both the original and the mirrored version of the same arrangement.

Fig. 1.

Examples of the ikebana stimuli.

Low CNN symmetry	 .206	 .213
High CNN symmetry	 .519	 .536

Note. The values beneath each photograph are CNN-based left–right symmetry scores; the upper two arrangements are low and the lower two are high in objective symmetry.

Measures

Trial-level Aesthetic Ratings

For each image, participants rated perceived symmetry, beauty, liking, arousal, positive emotion, and negative emotion on 5-point scales. The response-scale order was counterbalanced across participants; ratings from the half who received the reversed-order version were recoded

(6 – x) to a common direction before analysis, independent of the image-mirroring manipulation. We derived a mixed-emotion index from the positive and negative emotion ratings. Mixed emotion was preregistered as the minimum of the two ratings (MIN rule; Larsen et al., 2001), but we departed from this plan: under the predominantly positively valenced stimuli the minimum showed a severe floor effect and was largely redundant with negative emotion (distributions in Supplementary Figure S1). We therefore adopted the Griffin ambivalence index (Thompson et al., 1995) as the primary measure ($\text{mixed} = [\text{positive} + \text{negative}] / 2 - |\text{positive} - \text{negative}|$), which is maximized when positive and negative emotion are simultaneously high and similar in magnitude; the Griffin and minimum-based indices correlated .76–.88 within country, and the preregistered minimum-based index is reported only in Supplementary Table S2.

Individual Differences

Participants completed four trait measures, each scored as the mean of its items:

Visual Aesthetic Sensitivity Test–Revised (VAST-R; Myszkowski & Storme, 2017; see also Götz et al., 1979 for original version). 25 forced-choice items were scored as the proportion correct (0–1).

Desire for Aesthetics Scale (DFAS; Lundy et al., 2010; Japanese version: Hitsuwari et al., 2025; German version, Tetzlaff et al., 2024). Trait motivation to seek aesthetic experience across four content domains (visual arts, music, individual, and habitat); an example item is "My mood is affected by the attractiveness of my surroundings." The standard 36-item form was administered in JP, UK, and US, and the validated 37-item DFAS-G was administered in DE. Because the DFAS factor structure differed across language versions, only the total score was used.

Multidimensional Attitude toward Ambiguity Scale (MAAS; Lauriola et al., 2016; Japanese version: Hitsuwari & Nomura, 2021; German version: Meyer, 2022). Three seven-item subscales — Discomfort with Ambiguity (DA; unease in the presence of ambiguous situations), Absolutism (AB; dichotomous, black-or-white thinking; example item: "There are two kinds of people in the world: the weak and the strong."), and Need for Complexity and Novelty (NC; attraction to complex and novel stimuli). The three subscales were analyzed separately.

Ikebana experience. A 5-item composite (creating, interest, observing, historical knowledge, and structural knowledge) was adapted from the measure used by Hitsuwari and Jacobsen (2026).

Image-level Predictors

Objective symmetry was indexed using five measures derived from the Aesthetics Toolbox (Redies et al., 2025): pixel-level mirror symmetry, CNN-based symmetry (LRUD), visual balance, and horizontal and vertical deviations of the center of mass (DCM_x, DCM_y). To control for low-level confounders, 29 additional quantitative image properties (QIPs) spanning color, complexity, and structural statistics, also computed using the Aesthetics Toolbox, were subjected to principal component analysis (PCA). Nine components, together explaining 82% of the variance, were retained and entered as covariates (QIP_PC1–PC9). The eigenvalues, variance explained, and component loadings are reported in Supplementary Table S3. Symmetry-related QIPs were excluded from the PCA to avoid redundancy with objective symmetry indices.

Demographics

Age and years of education were continuously recorded. Gender was recoded as a binary variable (male vs. female, with nonbinary cases combined into the female category for analysis).

Analysis

All analyses were conducted in R (Version 4.4.2; R Core Team, 2024). Models were estimated with lme4 (Bates et al., 2015) and lmerTest (Kuznetsova et al., 2017); simple slopes were obtained with emmeans/emtrends (Lenth, 2024) and predicted values withggeffects (Lüdtke, 2018); marginal and conditional R^2 were computed with MuMIn (Bartoń, 2024) following Nakagawa and Schielzeth (2013); variance inflation factors were obtained with car (Fox & Weisberg, 2019); and mediation analyses used the mediation package (Tingley et al., 2014). All continuous predictors were z-standardized prior to modeling, and reliability coefficients were computed using psych (Revelle, 2025).

For each of the six dependent variables (beauty, liking, arousal, positive emotion, negative emotion, and mixed emotion), we fitted a linear mixed-effects model with fixed effects for country, stimulus orientation, linear and quadratic terms of perceived symmetry, five objective symmetry indices, nine QIP principal components, six individual-difference measures, and three demographic covariates (age, gender, and education). The model also included the interactions of perceived symmetry with country and each individual-difference moderator (ikebana experience, DA, AB, and NC) and random intercepts for participants, images, and stimulus sets. Random slopes for perceived symmetry were preregistered but omitted, as the models did not converge with them. The quadratic term for perceived symmetry was included to test the preregistered hypothesis of an inverted-U relationship. The reference categories were Japan (country), original (stimulus orientation), and male (gender). The full model specifications

are listed in Supplementary Table S4. Variance inflation factors were at most 2.55 for predictors not entering an interaction; perceived symmetry, which enters five interaction terms, had a value of 4.11, as is expected when a lower-order term is retained alongside its interactions and thus represents a conditional effect.

We used a two-tailed criterion of $p < .05$; in line with the preregistration, p -values across the six dependent variables were adjusted using Holm's sequential procedure. Simple slopes for the symmetry effect were estimated separately by country and at ± 1 SD of the continuous moderators (ikebana experience, AB). The mediation of objective symmetry (CNN_LR) on beauty via perceived symmetry was tested at the image level ($N = 150$), controlling for QIP_PC1–PC9 using nonparametric bootstrapping with 5,000 resamples. Hypotheses are referred to below by the groups (a)–(c) defined in the Introduction; Supplementary Table S9 lists each preregistered prediction with its outcome.

Results

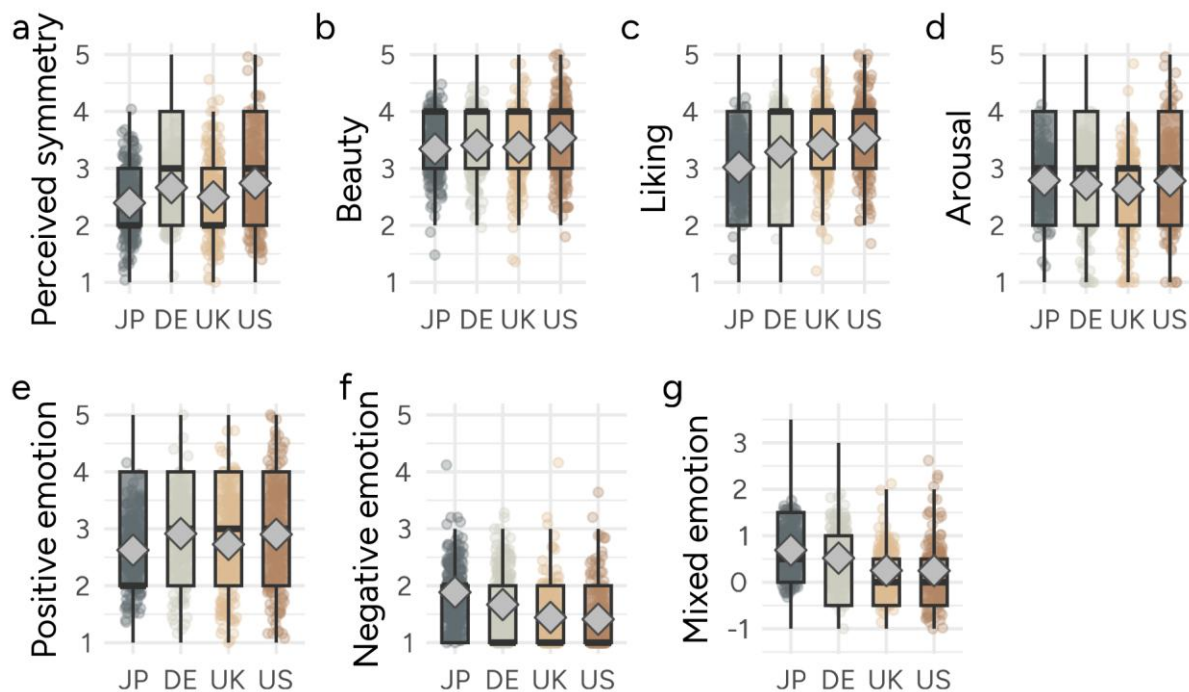
Descriptive statistics and reliability

Descriptive statistics for the six dependent variables and the perceived symmetry rating are reported in Table 1, and the distributions of all dependent variables by country are displayed in Figure 2. Internal consistency was acceptable to good across countries for the DFAS ($\alpha = .88$ –.91), MAAS subscales ($\alpha = .76$ –.90), and ikebana experience ($\alpha = .72$ –.83); reliability for the VAST-R was modest, as expected for a heterogeneous forced-choice test ($KR-20 = .57$ –.65). The full reliability statistics by country are provided in Supplementary Table S5.

The first notable pattern emerged in the country means. Contrary to the hypothesis that Japanese participants would give the highest aesthetic ratings, the raw means of the Japanese sample were lower on beauty, liking, and positive emotion, and higher on negative and mixed emotion, than those of the Western samples.

Fig. 2.

Distribution of the dependent variables by country (participant-level means overlaid on trial-level boxplots): (a) perceived symmetry, (b) beauty, (c) liking, (d) arousal, (e) positive emotion, (f) negative emotion, and (g) mixed emotion (Griffin index).



2 **Table 1.**

3 *Dependent variables by country (participant-level means)*

DV	JP	DE	UK	US
Beauty	3.34 [3.29, 3.40]	3.41 [3.35, 3.46]	3.37 [3.31, 3.44]	3.54 [3.46, 3.61]
Liking	3.02 [2.96, 3.08]	3.29 [3.23, 3.35]	3.43 [3.36, 3.49]	3.53 [3.45, 3.60]
Arousal	2.79 [2.74, 2.84]	2.72 [2.65, 2.79]	2.63 [2.55, 2.71]	2.78 [2.70, 2.86]
Positive emotion	2.63 [2.56, 2.69]	2.91 [2.84, 2.99]	2.73 [2.64, 2.82]	2.90 [2.80, 3.01]
Negative emotion	1.89 [1.82, 1.95]	1.67 [1.60, 1.74]	1.44 [1.39, 1.50]	1.41 [1.35, 1.47]
Mixed emotion (Griffin)	0.69 [0.63, 0.75]	0.52 [0.46, 0.58]	0.25 [0.20, 0.31]	0.25 [0.18, 0.32]
Perceived symmetry	2.39 [2.33, 2.46]	2.66 [2.61, 2.72]	2.50 [2.42, 2.58]	2.74 [2.65, 2.83]

4 *Note. Values are participant-level M [95% CI] on 5-point scales. Mixed emotion is the Griffin*
 5 *ambivalence index, whose range differs from the rating scales. SDs are reported in*
 6 *Supplementary Table S11.*

7 **Image-level correlations**

At the image level ($N = 150$), CNN-based left–right symmetry was the only objective index that correlated appreciably with both perceived symmetry ($r = .56$) and beauty ($r = .37$). Pixel-level mirror symmetry, balance, and the center-of-mass measures showed near-zero correlations with perceived symmetry ($|r| \leq .11$; Supplementary Figure S2) and with beauty. Beauty and liking were nearly collinear ($r = .97$).

Model fit

Marginal R^2 (fixed effects) ranged from .060 (arousal) to .137 (positive emotion), and conditional R^2 (including random effects) ranged from .168 to .278, indicating substantial between-participant and between-image variance captured by the random-effects structure.

Main effects across dependent variables

We report fixed effects surviving Holm correction across the six dependent variables (corrected $p < .05$); the p-values reported below are Holm-corrected unless noted otherwise. The complete coefficient tables for all six models are provided in Supplementary Table S6.

Country. Relative to Japan, all Western samples rated the arrangements higher on liking (DE $\beta = +0.145$, UK $\beta = +0.373$, US $\beta = +0.356$) and positive emotion (DE $\beta = +0.186$, UK $\beta = +0.081$, US $\beta = +0.087$) and lower on negative emotion (DE $\beta = -0.132$, UK $\beta = -0.378$, US $\beta = -0.441$; all $p < .001$). Beauty showed no consistent Western advantage: the US sample rated the arrangements slightly higher ($\beta = +0.057$, $p = .002$), the UK sample did not differ ($\beta = +0.009$, $p = .61$), and the German sample rated them slightly lower ($\beta = -0.049$, $p = .017$). Contrary to the prediction that Japanese participants would provide the highest aesthetic ratings (group a), the Japanese sample was distinguished by lower hedonic ratings and higher negative affect. On

arousal, Japan was rated higher than all three Western samples (DE $\beta = -0.075$, $p = .002$; UK $\beta = -0.175$, $p < .001$; US $\beta = -0.110$, $p < .001$); the prediction that Japanese viewers would report lower arousal (group a) was therefore not supported.

Perceived symmetry. The linear term, which represents the slope in the reference country (Japan), was positive for liking ($\beta = +0.045$, $p = .009$) and positive emotion ($\beta = +0.083$, $p < .001$) but not for beauty ($\beta = +0.025$, $p = .16$); the predicted linear effect (group b) was thus supported for liking and positive emotion, whereas for beauty it emerged only outside Japan (see Country $\times$ perceived symmetry below). The quadratic term was positive and significant for these DVs as well as for arousal and negative emotion (e.g., beauty $\beta = +0.026$, $p < .001$), indicating a U-shaped rather than the hypothesized inverted-U relationship (group b): aesthetic ratings were highest at both low and high levels of perceived symmetry, with a trough at intermediate symmetry. We report this as a direct test of the inverted-U prediction and do not interpret it further here; the inverted-U pattern was observed only for mixed emotion (see below).

Objective symmetry. None of the five objective symmetry indices reached significance once perceived symmetry was included in the model, contrary to the predicted direct effect (group b). When subjective and objective symmetry were entered simultaneously, only subjective symmetry contributed independently; the objective indices were non-significant, indicating that their bivariate association with beauty was mediated by perceived symmetry (group b; see Mediation below).

Stimulus orientation. Mirrored images were rated lower on beauty ($\beta = -0.104$), liking, arousal, and positive emotion, and higher on negative emotion, indicating a small but consistent preference for the original orientation (all corrected $p < .05$).

Individual differences. DFAS was a consistent positive predictor of beauty, liking, and positive emotion, and a negative predictor of negative emotion (all $p < .001$), as predicted (group c). Ikebana experience positively predicted the five rated dependent variables (e.g., beauty $\beta = +0.073$, $p < .001$) but was unrelated to mixed emotion. Absolutism (AB) negatively predicted beauty and liking. VAST-R positively predicted liking and arousal but did not significantly predict beauty or positive emotion after correction, providing only partial support for the predicted effect of aesthetic sensitivity (group c).

Interaction effects

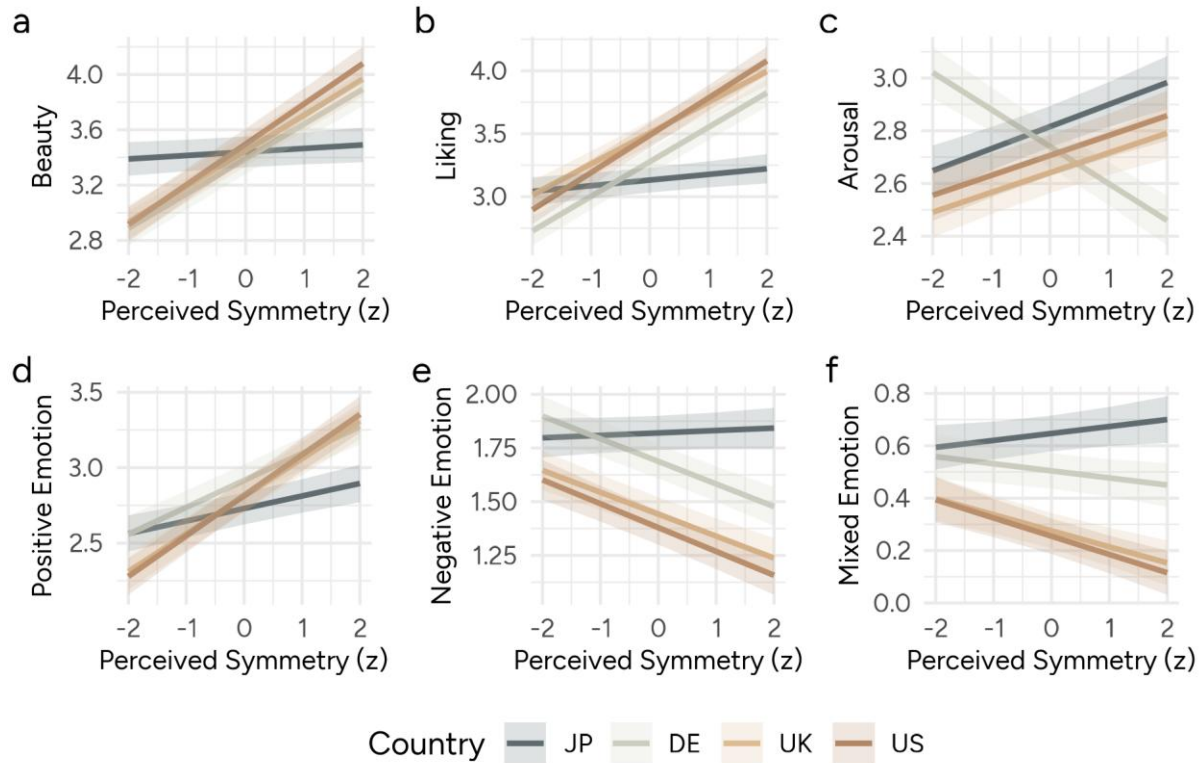
Country $\times$ perceived symmetry

The central interaction concerned how the symmetry–aesthetics relationship varied across cultures (Figure 3; full simple slopes for all six DVs in Supplementary Table S7). Perceived symmetry was strongly associated with beauty in the three Western samples ($\beta = 0.252\text{--}0.291$) but not in Japan ($\beta = 0.025$, 95% CI $[-0.001, 0.052]$); for liking, the Japanese slope was positive but again much shallower ($\beta = 0.045$, 95% CI $[0.016, 0.074]$) than the Western slopes ($\beta = 0.245\text{--}0.296$). All pairwise contrasts between Japan and the other countries were significant ($p < .001$), supporting the hypothesis that Japanese aesthetic traditions attenuate the preference for symmetry (group c).

Arousal showed a qualitatively different and country-specific pattern: the symmetry–arousal slope was positive in Japan ($\beta = 0.084$), the UK ($\beta = 0.075$), and the US ($\beta = 0.076$) but negative in Germany ($\beta = -0.140$, $p < .001$), where more symmetric arrangements were experienced as calmer.

2 **Fig. 3.**

3 *Country × perceived symmetry interaction for all six dependent variables: (a) beauty, (b) liking,*
 4 *(c) arousal, (d) positive emotion, (e) negative emotion, and (f) mixed emotion (Griffin index).*



5
 6 *Note.* Lines show model-predicted values with 95% confidence bands across perceived
 7 symmetry (z-standardized).

8 *Ikebana experience × perceived symmetry*

9 The symmetry–beauty slope was steeper for participants with less ikebana experience
 10 (low, -1 SD: $\beta = 0.224$) than for those with more experience (high, $+1$ SD: $\beta = 0.190$; interaction
 11 $\beta = -0.017$, $p = .035$), *as predicted (group c): familiarity with an asymmetric aesthetic tradition*
 12 *weakens reliance on symmetry.*

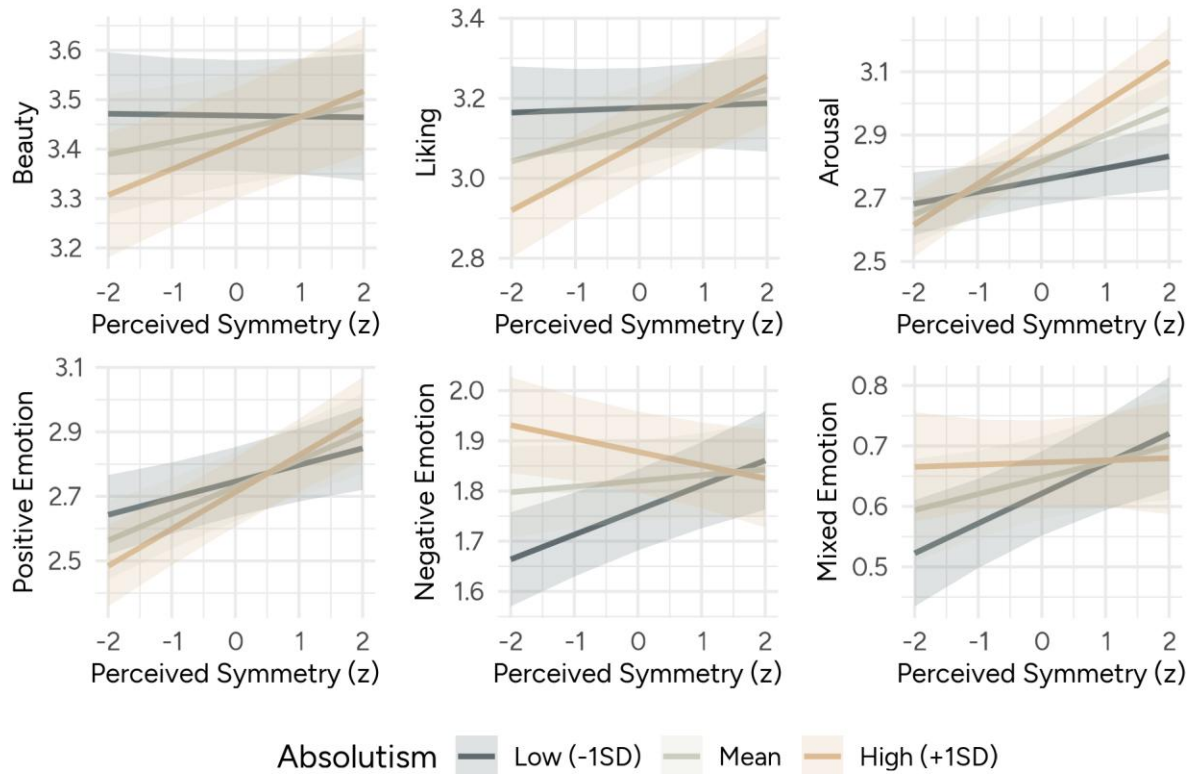
2 *Attitudes toward ambiguity × perceived symmetry*

3 The three MAAS subscales, Absolutism (AB), Discomfort with Ambiguity (DA), and
 4 Need for Complexity (NC), differed sharply in how they moderated the symmetry–aesthetic
 5 relationship. Absolutism showed the most consistent effect: higher absolutism was associated
 6 with a steeper symmetry–beauty slope (low, $-1\ SD: \beta = 0.179$; high, $+1\ SD: \beta = 0.233$;
 7 interaction $\beta = +0.027, p < .001$), and the $AB \times$ symmetry interaction was significant for all six
 8 dependent variables (Figure 4), as predicted (group c). Discomfort with Ambiguity moderated
 9 only mixed emotion (interaction $\beta = +0.021, p = .002$): the negative linear symmetry–mixed-
 10 emotion slope was attenuated as DA increased (low, $-1\ SD: \beta = -0.054, 95\% CI [-0.072,$
 11 $-0.036]$; high, $+1\ SD: \beta = -0.011, 95\% CI [-0.030, 0.007]$), providing only partial support for
 12 the predicted moderation by Discomfort with Ambiguity (group c). The Need for Complexity $\times$
 13 symmetry interaction was non-significant for every dependent variable, contrary to prediction
 14 (group c).

15

Fig. 4.

Absolutism × perceived symmetry interaction for all six dependent variables: (a) beauty, (b) liking, (c) arousal, (d) positive emotion, (e) negative emotion, and (f) mixed emotion (Griffin index).



Note. Lines show model-predicted values with 95% confidence bands across perceived symmetry (z-standardized).

Mixed emotion

Because the preregistered minimum-based index showed a pronounced floor effect and was largely redundant with negative emotion (Supplementary Figure S1), the analyses below use the Griffin index. With the Griffin index as the dependent variable, Japanese participants showed the highest mixed emotion (Table 1), and all Western samples were significantly lower ($DE \beta = -0.143$, UK $\beta = -0.371$, US $\beta = -0.392$, all $p < .001$), as predicted (group a). The quadratic effect of perceived symmetry was negative ($\beta = -0.078$, $p < .001$), an inverted-U whereby mixed emotion peaked at intermediate symmetry. The country $\times$ symmetry simple slopes again set

Japan apart: the slope was flat in Japan ($\beta = +0.027$, ns) but negative in the Western samples (DE -0.027 , UK -0.061 , US -0.070), and all three contrasts with Japan were significant (Tukey-corrected; JP–DE $p = .019$, JP–UK and JP–US $p < .001$).

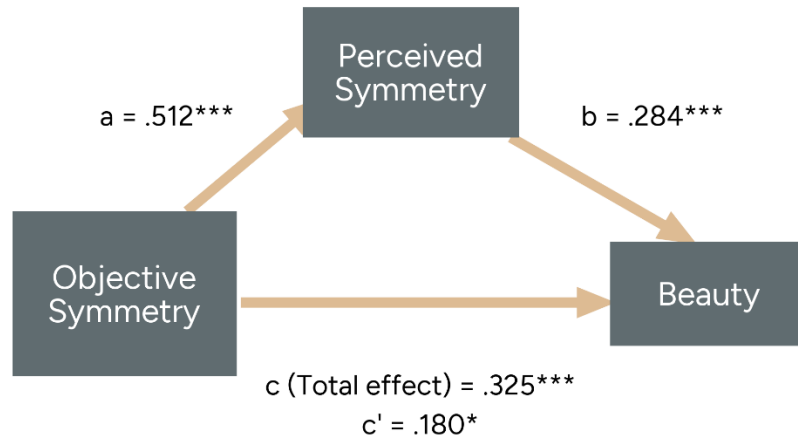
Allowing the Griffin–beauty slope to vary by country showed that mixed emotion predicted *lower* beauty in every sample, but the negative slope was strongly attenuated in Japan ($\beta = -0.082$) relative to the Western samples (DE -0.317 , UK -0.356 , US -0.328); all JP-vs-Western contrasts were significant ($p < .0001$), with no differences among the Western samples. Thus, arrangements eliciting mixed emotion were penalized approximately four times less in Japan than in the West. In an exploratory model controlling for the intensities of positive and negative emotion, the Griffin index predicted beauty positively ($\beta = +0.036$, $p < .001$, uncorrected), reversing the sign of the unadjusted association ($\beta = -0.257$).

Mediation of objective symmetry on beauty via perceived symmetry

At the image level, after controlling for QIP_PC1–PC9, the indirect effect of CNN-based symmetry on beauty through perceived symmetry was significant overall (ACME = 0.145, 95% CI [0.061, 0.238], $p < .001$), with a total effect of 0.325 partially mediated (44.8%; direct effect ADE = 0.180, $p = .043$; Figure 5). The mediation pattern differed by country; it was complete in Germany and the US, partial in the UK, and absent in Japan, where neither the indirect nor direct path was significant (full by-country estimates in Supplementary Table S8 and Figure S3). This convergence with the country $\times$ symmetry interaction indicates that the weaker symmetry–beauty link in Japan reflects a genuinely weaker perceptual-to-evaluative pathway rather than differences in symmetry perception per se.

2 **Fig. 5.**

3 *Image-level mediation path model linking objective symmetry, perceived symmetry, and beauty.*



4

5 *Note. Objective symmetry is the CNN-based left–right symmetry index; coefficients are*
 6 *standardized, controlling for QIP PC1–PC9. * $p < .05$. *** $p < .001$.*

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Discussion

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Perceived symmetry predicted aesthetic evaluation in all four countries; however, the strength of this association was culturally tuned. Summarizing the three groups of hypotheses: (a) cross-national differences ran counter to our predictions, with Japanese participants reporting the lowest liking and positive emotion and the highest negative emotion, mixed emotion, and arousal; (b) perceived symmetry predicted liking and positive emotion in every country and beauty in the Western countries, the effects of five objective symmetry measures were largely mediated by perceived symmetry, and the quadratic relation was U-shaped (the preregistered inverted U emerged only for mixed emotion); (c) absolutist thinking amplified the effect of

symmetry, whereas ikebana experience attenuated it. Centrally, the symmetry–beauty slope in Japan ($\beta = 0.025$, not reliably above zero) was one tenth of the Western value ($\beta = 0.252\text{--}0.291$).

The central finding is constrained universality. Under the maximal pressure a culture can bring to bear on the preference for symmetry, a codified counter-norm with an institutional transmission mechanism, the link between symmetry and evaluation was attenuated but not reversed: it shrank to near zero for beauty and remained positive for liking and positive emotion. That it was weakened rather than inverted is consistent with the view that preferences are deeply rooted in the perceptual system (Enquist & Arak, 1994; Sasaki et al., 2005). Simultaneously, the link demonstrably bends, and the mediation analysis locates where. The path from objective symmetry to perceived symmetry was as intact in Japan as elsewhere, and the path from perception to evaluation was weaker. Japanese participants do not fail to perceive symmetry; rather, they assign less weight to observed symmetry when judging beauty. This also suggests that culturally loaded stimuli, such as art forms saturated with cultural meaning, can reveal cultural differences that decontextualized abstract patterns do not (cf. Leder et al., 2024). As most participants do not practice ikebana, a plausible route for this tuning is incidental exposure to a visual environment shaped by a broader norm of asymmetry, ranging from gardens and architecture to tea ceramics. Consistent with this route, Japanese participants saw ikebana more often than Western participants but reported no more interest or knowledge (Supplementary Table S12). Japanese and Western everyday scenes differ measurably and afford distinct modes of perception (Miyamoto et al., 2006), although asymmetry itself has not been quantified in such comparisons. The additional attenuation among experienced participants suggests that implicit immersion and explicit training push in the same direction, although our design cannot separate these two routes. Two broad implications follow. First, whereas classic work argued that culture

alters visual perception itself (Segall et al., 1963), our results identify the stage of processing at which culture enters: perception is shared, whereas culture enters at the evaluation stage. Second, they suggest a qualification to processing fluency theory (Reber et al., 2004): the link between fluent processing and pleasure is preserved, but the extent to which fluency translates to pleasure appears culturally tuned. As fluency was inferred rather than measured, this extension awaits direct testing, such as through response-time measures.

The emotional profile indicates that Japanese participants engaged with ikebana in a different mode (cf. Brinkmann et al., 2023). Japan recorded the highest levels of negative and mixed emotion, extending research on dialectical emotions, the concurrent experience of positive and negative affect (Miyamoto et al., 2010), into the aesthetic domain. More importantly, the consequences varied: mixed emotion predicted lower beauty everywhere, but the penalty imposed in Japan was approximately one-quarter of that observed in the West. Once the intensities of positive and negative emotion were held constant, co-activation itself increased beauty slightly. Thus, culture influences both the extent to which mixed emotion is experienced and its consequences for aesthetic judgment, shifting cultural research on emotion from comparing frequencies to comparing consequences. One candidate cultural schema supporting this mode is *mujo*, the awareness of impermanence (cf. Fernández-Campos et al., 2021); in ikebana, flowers have long been associated with the transience of human life (Inoue, 2021; Sato, 2008).

Individual differences within cultures mirrored the differences observed between cultures. Participants high in absolutist thinking, who seek clarity and dichotomy, placed greater weight on symmetry, and this moderating effect was significant across all six dependent variables. Given that symmetry reduces uncertainty (Berlyne, 1971; Muth et al., 2015), this

suggests that epistemic motives drive the weighting of aesthetic evidence, connecting aesthetics to the broader literature on motivated cognition (Kruglanski & Webster, 1996). In contrast, ikebana experience reduced the weight of symmetry even when country and country $\times$ symmetry interactions were controlled, aligning with the view that cognitive mastery lowers reliance on formal cues (Leder et al., 2004). Among art experts the preference can even reverse (Leder et al., 2019). No expert spontaneously mentioned asymmetry when describing ikebana's beauty (Hitsuwari et al., 2026), suggesting that the norm operates implicitly rather than as a stated rule. Discomfort with Ambiguity only moderated the impact of symmetry on mixed emotion.

Two alternative accounts deserve consideration. The first is the within-culture stereotype of ikebana as formal and old-fashioned. The second is the criticism that generic evaluative terms, such as beauty, are an imported Western framework (Darda et al., 2026). Both bear on mean differences, but not on slopes.

Several limitations point to next steps. First, the stimuli were professional artworks only. Therefore, the variation in symmetry remained within an asymmetric range. Replications with stimuli manipulated parametrically from full symmetry to asymmetry are required; for example, crossed pairs of symmetric and asymmetric arrangements made from identical materials, or ikebana-like stimuli generated by AI. Second, the design was correlational, and the causal role of cultural exposure could not be identified. Testing whether short-term exposure or learning shifts the weight of symmetry would address whether cultural internalization can be induced on a laboratory timescale. Third, online convenience samples do not represent national cultures, and a nation is not a culture. Measuring within-culture variations and refining the measurement of ikebana experience remain future tasks.

Symmetry pulls on aesthetic evaluation everywhere, and culture determines how hard it pulls. Under the maximal pressure of a codified counter-norm, the universal tendency was not reversed but reliably bent, for beauty almost to zero. For empirical aesthetics, this shifts the question from whether a preference is universal or learned to where culture enters, and how much weight it sets. The question posed here, pitting a universal tendency against a codified counter-norm and measuring its attenuation, can be extended to any domain of preference in which claims of evolved universality intersect with cultural learning, ranging from morality to food to music. Art forms that carry dense cultural meaning can reveal where and to what extent universal preferences bend.

Acknowledgments

We thank Akiko Kaneko for creating and photographing the ikebana arrangements used as stimuli, and Editage for professional English language editing.

Author Contributions

J. Hitsuwari: Conceptualization, Methodology, Investigation, Formal analysis, Data curation, Visualization, Project administration, Funding acquisition, Writing – original draft, Writing – review & editing. **J.-F. Tameling:** Conceptualization, Methodology, Investigation, Writing – review & editing. **S. M. Weiler:** Conceptualization, Methodology, Investigation, Writing – review & editing. **T. Jacobsen:** Conceptualization, Methodology, Supervision, Funding acquisition, Writing – review & editing.

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