The Role Of Stimuli Complexity And Handedness
On Visual Symmetry And Asymmetry Preference

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Abstract.
Previous study results indicate visual information processing asymmetry of visual verbal stimuli. However, other studies that investigate nonverbal stimuli processing show inconsistent effect of laterality. Although differences between left and right handers can be found in task that involves letters, spatial attention stimuli and visuomotor control performance, the differences between the two groups almost vanish in several directional preference tasks, suggesting that direction preference is influenced mainly by writing and reading habits. Perceiving visual art involves visual attention, that is driven by the bottom-up aspects of the visual stimuli, therefore perception of nonverbal images, that contain geometrical forms, might be influenced by handedness. To assess the possible differences in visual symmetry-asymmetry preference, university students have been gathered (N = 65), and were distributed into two separate groups by handedness status, as a measurement we used stimuli based on Jacobsen and Höfel (2001). Our main result shows a significant effect of stimuli complexity on symmetry-asymmetry preference. The interaction effect between handedness and symmetry-asymmetry type was not significant. After conducting a pairwise comparison our results show that right handers evaluate simple and complex symmetrical forms as more preferable than simple and complex asymmetrical forms. We also found that there is a preference for symmetry over asymmetry in both groups, however this differences are significant only in the right handers group. We conclude that preference for geometrical symmetrical forms is not influenced by handedness, however preference for complexity is affected by right handedness. To extend these results, further investigations are needed.

Keywords: handedness, symmetry-asymmetry preference, geometrical forms

1. Introduction

Aesthetical judging is the process where one evaluates certain visual stimulus considering several aesthetic standards while aesthetic preference is a result of the liking of the certain visual stimulus (van Hounten et al., 1981). The former process is assumed as more objective, while the latter is influenced by more subjective factors. Considering the differences between the two processes in this study we are concentrating on the aesthetical preference aspect of geometrical forms.
Aesthetical preference is influenced by several physical and psychological factors of the to-be-preferred stimulus and by the person that is making the decision. Therefore, physical characteristics of the stimulus, colour, composition, symmetry, visual complexity and contrast play a major role in the process, while personal attributes like age, education, knowledge and context have an impact on aesthetical preference (Braun et al. 2019; Kahler et al., 2020). However, there is some inconsistency in the literature regarding the personal factors of the aesthetical sensitivity, results indicate that neither intelligence, personal traits nor domain specific knowledge, such experience in art do not influence aesthetical sensitivity (Corradi et al., 2019).

Studies, that investigate biological factors that influence aesthetical preferences of symmetrical and asymmetrical visual stimuli, are reporting that hemispheric asymmetry (Nachson et al., 1999), age (de Agostini et al., 2010) and sex (De Agostini, et al., 2010; Bode et al., 2017) affect visual symmetry and asymmetry preference. The link between left- or right handedness and aesthetical preference has been investigated earlier, previous study results indicate that the relationship between them is not direct (Nachson et al., 1999), however results also show that performance of left handers in visual symmetry tasks, were less consistent regarding asymmetry (Bryden, 1973).

Visual perception is influenced by different cerebral processes. It has been proven that the two hemispheric functions differ during visual perception in the majority of people (Petit et al., 2015; Nachson, 1985; Bryden, 1973). Left handers tend to have a right hemispheric dominance, the right hemisphere is responsible for the processing of verbal stimuli, while left hemisphere is considered to process the visuo-spatial aspect of the visual field by visual attention (Petit et al., 2015).

Hemispheric asymmetry studies report that while stimulus processing is influenced by the aspect of the stimulus. Verbal stimulus processing shows a left hemispheric dominance, while visual stimuli processing is right hemisphere dependent (Nachson, 1985). Interestingly, results of one particular study indicates no differences between left and right handers regarding non-verbal stimulus processing (Bryden, 1973). However, left handers tend to use more often their non-dominant hands during object manipulation, compared to right handers (Gonzalez et al., 2007), left handers also tend to react slower to haptic stimuli (Stoycheva & Tiippana, 2018). This can explain the specific spatial attention processing of the right hemispheric dominance, which is mere a manipulation aspect, rather than perceptual or motoric processing difference (Bryden, 1973).

Visual aesthetic preference is influenced on an individual level (Corradi et al., 2019) by psychological factors such as culture (Bode et al., 2017), domain specific knowledge such as visual art expertise (Koide et al., 2015). However aesthetic judgement is influenced by hemispheric dominance (van Hounten et al., 1981), the purpose of the current study is to investigate aesthetical preference mediated by handedness.

However, as mentioned earlier, symmetry defines aesthetical preference besides several psychological factors. Together with the symmetrical aspects, results indicate that curved shapes are preferred over sharp forms, balanced over unbalanced and complex over simple forms (Corradi et al., 2019).
Considering the above-mentioned fact, the aim of the current study is to investigate specific aspect of handedness on symmetry-asymmetry preference of geometrical simple and complex forms.

1.1 Materials and Methods

Participants

65 participants from Babes-Bolyai University, Cluj-Napoca, Romania have been gathered. Participants have been distributed into two separate groups by their hand dominance, group with right handers (N = 35), group with left handers (N = 30), status for handedness was reported by each participant. Mean age was 21.02, it ranged from 18 to 30 years.

| Table 1: Sociodemographic Data of the Participants |
|--------------------------------------------------|
| N | Min. | Max. | M.  | SD | % |
|---|------|------|-----|----|---|
| Age | 65   | 18   | 30  | 21.02 | 2.36 |
| Gender | Male | 15   | 23.1 |
|        | Female | 50  | 76.9 |
| Handedness | Right handers | 35 | 53.8 |
|          | Left handers | 30 | 46.2 |

Material

In the present study we investigated a symmetry-asymmetry preference of complex and simple geometrical forms. We used the stimuli created by Jacobsen & Höfel (2001). Two hundred fifty-two stimuli have been constructed. Half of the stimuli (126) were symmetrical, while the other half of the stimuli were non-symmetrical. Stimulus complexity has been manipulated by changing the number of elements of the pattern.

Procedure

Participants were presented with the stimuli; they were requested to evaluate aesthetically the presented patterns. They were instructed to evaluate the patterns as beautiful, not beautiful, or indifferent, however at least 75 of the shown stimuli have to been categorized as beautiful and 75 of the patterns have to been categorized as not beautiful (Jacobsen & Höfel, 2002).

Data Analysis

A statistical power analysis, G*Power (Faul, Erdfelder, Lang, Buchner, 2007; Faul, Buchner, Lang, 2009), have been used to compute sample size. In order to detect an effect of $\eta^2_p = .04$ with 80% power in two-way analysis of variance ANOVA (two groups, alpha = .05), G*Power suggests we would need 32 participants in each group (N = 64).
1.2 Results

A Shapiro-Wilk test of normality did not show a significant departure from normality for the mean scores: of Simple symmetrical forms $W(65) = .963$, $p = .52$; Complex symmetrical forms $W(65) = .972$, $p = .151$; Simple asymmetrical forms $W(65) = .984$, $p = .58$; Complex asymmetrical forms $W(65) = .982$, $p = .482$.

Two-way between-groups analysis of variance was conducted to explore the impact of artistic experience on the dependent variable, measured by visual stimuli originally produced by Jacobsen and Höfel (2001). Participants were divided into two groups according to their hand dominance.

*Table 2: Means and Standard Deviations for Hand dominance and Symmetry-asymmetry preference for complex and simple geometrical forms*

| Group          | Symmetrical simple | Symmetrical complex | Asymmetrical simple | Asymmetrical complex |
|----------------|--------------------|---------------------|---------------------|----------------------|
| Right handers  | 1.57               | 1.67                | 1.76                | 1.87                 |
|                | 0.34               | 0.34                | 0.27                | 0.23                 |
| Left handers   | 1.62               | 1.63                | 1.76                | 1.76                 |
|                | 0.62               | 0.37                | 0.33                | 0.26                 |

The interaction effect between handedness and symmetry-asymmetry type was not significant $F(3, 252) = 0.75$, $p = 0.53$. The main effect for handedness $F(1, 252) = 0.28$, $p = 0.59$, was statistically not significant. There was a statistically significant main effect for symmetry-asymmetry type $F(3, 252) = 6.3$, $p = 0.00$, the effect size was medium (partial eta squared = .07).

*Table 3: Summary of the Two-way Analysis of Variance for Groups and Symmetry-asymmetry preference*

| Source                 | df | SS   | MS   | F     |
|------------------------|----|------|------|-------|
| Group                  | 1  | .029 | .029 | .28   |
| Symmetry-asymmetry     | 3  | 1.92 | .64  | 6.34* |
| Group x Symmetry-      | 3  | .224 | .075 | .737  |
| asymmetry              |    |      |      |       |
| Within cells           | 252| 25.52|      |       |
To entirely understand group differences, we conducted Pair-wise tests of the differences between right- and left handers group over symmetrical simple-, symmetrical complex-, asymmetrical symple and asymmetrical complex preference.

*Figure 1:* Preference for Symmetrical- asymmetrical simple and complex geometrical forms of the two groups.

Note: higher the score the less preferable the stimuli been judged.

Pair-wise comparision indicated that the mean score for right handed group of simple symmetrical forms ($M = 1.57, SE = .054$), was significantly different from simple ($M = 1.76, SE = .054$) and complex asymmetrical forms ($M = 1.87, SE = .054$), however the mean score of simple symmetrical forms was not significantly different from complex symmetrical forms ($M = 1.67, SE = .054$). The differences between simple ($M = 1.76, SE = .054$) and complex asymmetrical forms ($M = 1.87, SE = .054$) were not significant statistically, in the right- handed group.

The mean score for left handed group of simple symmetrical forms ($M = 1.63, SE = .058$), was not significantly different from simple ($M = 1.76, SE = .058$) and complex asymmetrical forms ($M = 1.76, SE = .058$). The mean score of simple symmetrical forms was not significantly different from complex symmetrical forms ($M = 1.63, SE = .058$). The differences between simple ($M = 1.76, SE = .058$) and complex asymmetrical forms ($M = 1.76, SE = .058$) were not significant statistically, in the left- handed group.
Discussion and Conclusion

In the present study a two-way analysis of variance was conducted to explore the impact of handedness on symmetry-asymmetry type, measured by the stimuli originally produced by Jacobsen & Höfel (2001). Participants were divided into two groups according to their hand dominance. The interaction effect between handedness and symmetry-asymmetry type was not significant. There was a statistically significant main effect for symmetrical and asymmetrical geometrical form complexity, the effect size was medium. Our results also show that symmetrical simple- and complex forms are preferred over asymmetrical simple- and complex forms regardless of groups. After conducting a pairwise comparison test, our result indicates a significant difference within groups, regarding of complexity of symmetrical-asymmetrical forms. Right handers tend to prefer symmetrical simple- and complex forms more than asymmetrical simple- and complex forms, however these differences in preference for complexity of symmetrical- and asymmetrical forms are not significant in the left handers group. We found no significant differences between the two groups, regarding preference of symmetrical simple-, complex- and asymmetrical complex forms.

The results of the current paper indicate that symmetrical forms are preferred over asymmetrical ones. These results are in line with previous study results (Jacobsen & Höfel, 2001; Leder et al., 2004; Corradi et al., 2019). Our results also indicate that hemispheric dominance did not influence aesthetic preference, nor does directional habits (Nachson et al., 1999).

Interestingly, statistically significant differences in preference complexity have been shown only in the group of right handers, differences in preference between simple- and complex forms did not differ statistically in the left handers group. These results might suggest that hand dominance plays a role on visual field preference and are also by some means in line with previous study results, where aesthetic preference of left-handed adult female participants did not show significant differences (De Agostini et al., 2010).

As another possible explanation our result, the significant differences in complexity preference within right handers and the lack of the same difference within left handers, was originated by the nature of the study materials. Geometrical abstract forms have been presented, regardless of their non-verbal aspect, it is possible that the processing of them required some verbalizations, as claimed earlier by Bryden et al. (1973), that non-verbal task performance results specific activity, that might inhibit to observe the laterality effect.

As a further direction and a current limitation of this study, we suggest that testing for hand dominance is needed, to extend our results. Participants have been distributed into two separate groups by their hand dominance, hand dominance was self-reported, therefore participants with not reported ambidexterity miscategorized.

As a summary we can conclude that preference for geometrical symmetrical forms is not influenced by handedness, however preference for complexity is affected by right handedness, further examinations are needed, to investigate other possible biological and psychological factors, that determine preference for symmetrical simple and complex forms.
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