異なる絵画スタイルにおける絵画作品の典型度と嗜好度との関係
Relationships Between Prototypicality and Preference in Different Painting Styles

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Abstract

This study aims to clarify whether the relationship between prototypicality and preference of paintings differs across painting styles. Two psychological experiments, one with style learning (Experiment 1) and one without style learning (Experiment 2), are conducted to remove the effects of confounding factors. Vincent van Gogh's and Paul Gauguin's paintings are used as experimental stimuli. Data analyses of Experiment 1 show that the affective evaluation of the paintings has three psychological dimensions "Nervosity", "Individuality" and "Preference". Correlation analyses reveal that, regarding the acquired Gogh-style paintings, nervosity positively correlates with prototypicality and negatively correlates with preference, which implies that nervosity may bridge a spurious negative relationship between prototypicality and preference. On the other hand, regarding the acquired Gauguin-style paintings, no correlation was found between nervosity and prototypicality or between prototypicality and preference. The results suggest that, in different painting styles, different prototypicality-preference correlations will be detected due to different psychological mechanisms (including mediating effects of confounding factors) that underlie the correlations.

Keywords : prototypicality, preference, painting, style, semantic differential

1. Introduction

The relationship between prototypicality and aesthetic preference was first studied by Martindale and Moore (1988)[1], in which they found that American people preferred colors that were typical for basic color categories in the English language to less typical colors. Prototypicality-preference relationship of colors was also studied in Japan by Fang and Matsui (2018)[2], who found that Japanese people generally liked colors of low prototypicality because they felt low-prototypicality colors as being graceful. There are multitudes of categories also in the realm of paintings, which are usually called "styles". Paintings in every painting style differ in their prototypicality, namely, the extent to which they are considered to be typical examples of the style. Hekket and Wieringen (1990)[3] reported that, regarding a portion of cubist paintings, people tended to prefer paintings that were typical for the style to less typical paintings. Farkas (2002)[4] found a similar prototypicality effect with regard to surrealist paintings.

In this study, we aim to clarify whether the relationship between prototypicality and preference differs across painting styles, and probe into the relationships between prototypicality and psychological dimensions of the affective evaluation of paintings other than aesthetic preference, depending on the results of the factor analysis of the affective evaluation of paintings.

The clarification of prototypicality-preference relationship cannot be achieved by simply plotting the prototypicality and preference data, because confounding variables may exist that can bring about a spurious relationship between prototypicality and preference by mediating between the two. Specifically, as shown in Figure 1, if a psychological variable exits that occasionally has a significant relationship both with prototypicality and with preference, this variable will bridge a relationship between prototypicality and preference, and, if this bridged relationship is strong, it may distort or even cover the direct rela-

tionship between prototypicality and preference.

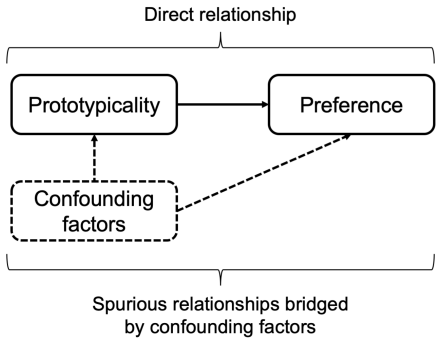

Figure 1 Sketch of the direct relationship between prototypicality and preference and the spurious prototypicality-preference relationships bridged by confounding factors.

To solve the problem, in this study, we conducted two psychological experiments. In the first experiment, e.g., Experiment 1, participants are asked to acquire how to distinguish two painting styles, that is, how to classify paintings into two styles and how typical each painting is in terms of the style that it belongs to, before performing affective evaluation of paintings. The plotting of the prototypicality data and the preference data obtained in Experiment 1 will show a mixture of the direct relationship between prototypicality and preference and the spurious relationships between the two if aforementioned confounding factors exist. In the second experiment, e.g., Experiment 2, participants carry out affective evaluation of paintings without style learning. This means that the participants have no idea of prototypicality of paintings and therefore do not know the direct relationship between prototypicality and preference. Thus, the plotting of the prototypicality data and the preference data obtained in Experiment 2 will show only the spurious relationships between prototypicality and preference mediated by confounding factors. Through comparing the results of the two experiments in a subtractive manner as shown in Figure 2, the direct prototypicality-preference relationship, if it exists, will be discovered.

Experiment 1 has finished, and Experiment 2 is still ongoing. This paper describes the designs and settings of the two experiments as well as the preliminary results of the analyses of the data obtained in Experiment 1.

2. Experiment 1

2.1 Participants

Twenty-two participants (genders and ages described in **Section 4.1**), who were either undergraduate or graduate students at Waseda University, took part in the experiment. They all passed the Ishihara Color Vision Test (38 plates, the International Edition), and none reported having deficiencies in color vision. All of them were native Japanese speakers, and received no professional training in art history, painting or relevant fields. Informed consents of participation were obtained from all the participants.

2.2 Experiment Platform and Stimuli

The experiment was run using a PsychoPy (version 1.90.2) program on a MacBook Air PC (15 inch, 2017). The PC display was calibrated using an i1 Display Pro calibrator and the software DisplayCAL (version 3.7.1.3). The experiment was conducted using the Japanese language.

The experimental stimuli were digital photos of 23 landscape paintings by Vincent van Gogh (called "Gogh paintings" for short) and 23 landscape paintings by Paul Gauguin (called "Gauguin paintings" for short) collected from museum websites. The paintings were divided into a training set which consisted of eight Gogh paintings and eight Gauguin paintings and a validation set which consisted of 15 Gogh paintings and 15 Gauguin paintings. All the paintings in the training set were the most typical Gogh and Gauguin paintings, while the paintings in the validation set ranged from the least typical Gogh and Gauguin paintings to the most typical Gogh and Gauguin paintings. How typical each painting was was determined by 13 experts in Western painting through an interview prior to the experiment. We removed the painters' signings in the painting images using Adobe Photoshop, and set the longer edges of the images to be 650 pixels.

With regard to the names of the painters, to prevent the participants from using knowledge about Gogh and/or Gauguin in finishing the tasks in the experiment, we did not tell the participants that the paintings were painted by Gogh and Gauguin. Gogh was

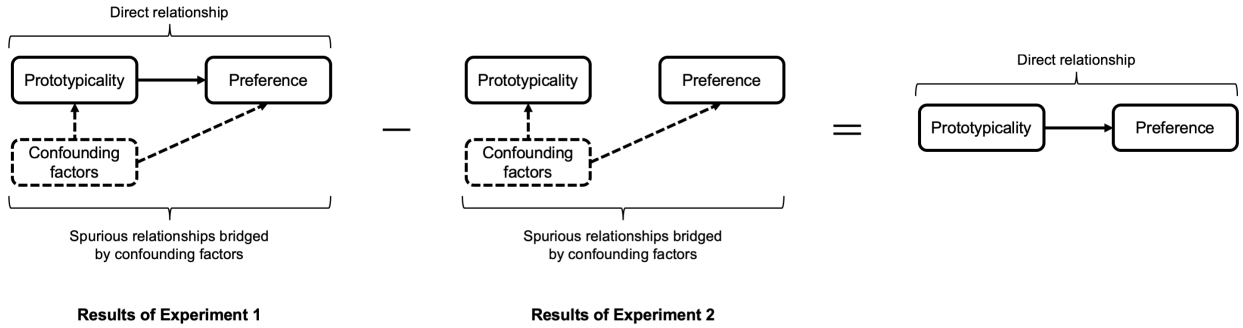

Figure 2 Logic of comparing the results of Experiment 1 and Experiment 2 in a subtractive manner to obtain the direct relationship between prototypicality and preference.

referred as "Painter A" and Gauguin was referred as "Painter B" throughout the experiment.

2.3 Procedure

The experiment had two sessions. Figure 3 shows the procedure of the experiment.

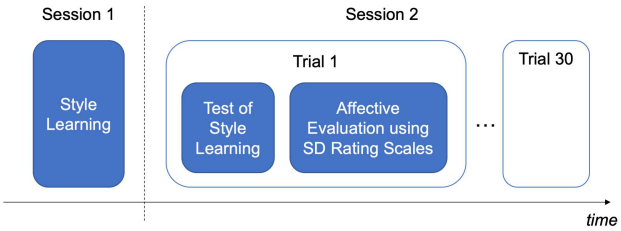

Figure 3 Procedure of Experiment 1.

Session 1 aimed at style learning. In this session, each painting in the training set was displayed three times, each time for 5 seconds. The display order of the paintings was randomly determined for each participant. During the display of a painting, the name of the painter, e.g., Painter A or Painter B, was shown below the painting image. The background color of the screen was set to be medium grey ($L^* = 50$). The participants were asked to view the paintings carefully to learn how to differentiate between Gogh and Gauguin paintings. The participants did not need to provide any feedback. Between displays of two paintings, a small white cross was displayed in the middle of the screen for two seconds, and the participants were asked to view the cross sign to remove the afterimage of the painting just displayed. This style learning method was adapted from the passive label-only training method developed by Rush (1974)[5].

Session 2 aimed at testing the participants' performance of the style learning and obtaining the participants' affective evaluation data. In this session, the paintings in the validation set were displayed one after another. In other words, the session had 30 trials. In each trial, the participants were first asked to judge whether the painting being displayed was painted by Painter A or Painter B by clicking on one of the two buttons below the painting image on which the name labels of the two painters were shown. Then, the participants were asked to report to which extent he/she thought the painting was painted by Painter A by rating the extent on a continuous scale ranging from 1 to 100. The participants then reported the extent to which they thought the painting was painted by Painter B using the same method. Next, the participants were required to rate the familiarity and complexity of the painting using two seven-point adjective pair scales "familiar- unfamiliar" and "simple-complex". Familiarity and complexity were rated because they were reported to be able to influence preference[6, 7, 8, 9, 10, 11] and therefore were potential confounding factors in this study. Then, the participants were required to evaluate the affective impressions of the painting using a list of 21 seven-point semantic differential (SD) scales. Cho and Haraguchi (2013, 2014)[12, 13] developed this list through an extensive literature review and experimental studies on Japanese people's affective evaluation of Western painting using SD scales. The scales are shown in Table 1. The presentation order of the scales was randomized for each participant. Like in Session 1, a small white cross appeared in the middle of the screen between displays of two paintings to remove

the after-images. The display order of the paintings was randomly determined for each participant.

Before Session 2 started, there was a training trial which told the participants how to use the platform to fulfill the tasks in the session. For half the participants, the training trial used a Gogh painting which was not used in the formal trials. To the other half of the participants, the training trial used a Gauguin painting which was not used in the formal trials.

3. Experiment 2

3.1 Participants, Platform and Stimuli

We plan to recruit at least 20 participants. Like in Experiment 1, all the participants should be native Japanese speakers, have normal color vision and have received no professional training in art history, painting or relating fields.

The experiment will be performed using the same platform and PC as in Experiment 1. The experimental stimuli are the validation-set paintings used in Experiment 1. The experiment is conducted using the Japanese language.

3.2 Procedure

In this experiment, the participants conduct affective evaluation without style learning. In other words, this experiment directly performs the familiarity, complexity and affective evaluation part in Session 2 of Experiment 1. Figure 4 shows the procedure of this experiment.

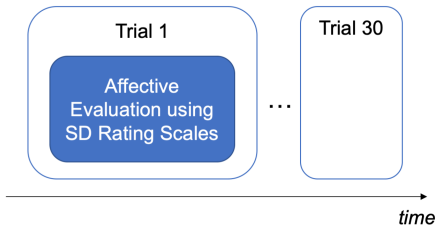

Figure 4 Procedure of Experiment 2.

4. Data Analyses of Experiment 1

4.1 Screening of Participants

We screened the participants by examining their learning performance of the Gogh style and the Gauguin style respectively. The learning performance of each participant regarding the Gogh paintings was computed as the accuracy of the participant's answers to the two-choice (Painter A or Painter B) question about the Gogh paintings in Session 2 of Experiment 1. The five least typical Gogh paintings were not used in the performance evaluation. The learning performance regarding the Gauguin paintings was calculated using the same method.

In terms of the Gogh paintings, all participants showed high accuracies. In terms of the Gauguin paintings, however, two participants correctly recognized only three paintings. The data obtained from the two participants were thus excluded from later data analyses. The rest 20 participants were 13 males and nine females of ages $M = 23.62$ and $SD = 7.51$.

4.2 Effects of Familiarity

The familiarity score of each painting was computed as the mean of the rating scores of the painting on the scale "familiar-unfamiliar" which were obtained in Session 2 of the experiment. The results show that all the paintings have a familiarity score smaller than 1.0, which implies that all the paintings were unfamiliar to the participants. Hence, no painting should be excluded from later data analyses, or in other words, familiarity is unable to exert confounding effects in this study.

4.3 Psychological Dimensions of Affective Evaluation of Paintings

The rating scores of the paintings were averaged across the participants in terms of each SD scale. The Kaiser-Meyer-Olkin test for sampling adequacy of the averaged rating data shows that the overall measure of sampling adequacy (MSA) of the data is 0.77. The Bartlett's test for sphericity of the data reveals that significant correlations exist among the SD scales ($P < 0.001$). The results of the two analyses indicate that the data are suitable for the factor analysis.

Next, we processed the data using the factor analysis. Factors were extracted using the least square method, because Cho and Haraguchi (2014)[13] used this method. Main factors were defined as those with eigenvalues larger than 1.0. Then, the factors were

rotated using the promax method. As a result, three main factors "Nervosity", "Individuality" and "Preference" were extracted. Table 1 shows the factor loadings of each SD scale after the rotation. The factor Nervosity explained 36% of the overall variation, Individuality explaining 28%, and Preference explaining 26%, adding up to 91%. All the SD scales have a degree of communality greater than 0.74. These measures imply that the three factors are enough to explain the SD data.

All in all, the results of the factor analysis demonstrate that the affective evaluation of Gogh and Gauguin paintings are composed of three psychological dimensions Nervosity, Individuality and Preference. The nervosity score (NS), individuality score (IS) and preference score (PFS) of each painting were defined as its factor scores on each factor.

4.4 Categorization and Prototypicality Score Computation of Paintings

In Session 2 of the experiment, with regard to each painting, we asked the participants to rate the extent to which they think the painting was pained by Gogh. We averaged the rating scores of the painting across the participants and named the average score the "Gogh-like score" of the painting. The "Gauguin-like score" of the painting was defined in the same manner.

If the Gogh-like score is larger than the Gauguin-like score, we classified the painting into the category "acquired Gogh-style paintings" and defined the prototypicality score (PTS) of the painting as its Gogh-like score. On the other hand, if the Gogh-like score was smaller than the Gauguin-like score, we classified the painting into the category "acquired Gauguin-style paintings" and defined the PTS of the painting as its Gauguin-like score. The results of the categorization show that the two acquired categories contain nearly the same paintings as the real-world Gogh's and Gauguin's paintings do.

4.5 Style-Specific Prototypicality-Preference Relationships

With regard to the acquired Gogh-style paintings, there is a negative linear relationship between PTS and PFS (Pearson's correlation coefficient = -0.812, $P = 0.001$, plotted in Figure 5(A)). We also found a negative linear relationship between NS and PFS (Pearson's correlation coefficient = -0.717, $P = 0.009$, plotted in Figure 5(B)) and a positive linear relationship between PTS and NS (Pearson's correlation coefficient = 0.642, $P = 0.024$, plotted in Figure 5(C)). These results suggest the possibility that the detected negative relationship between PTS and PFS is a spurious one mediated by NS.

Regarding the acquired Gauguin-style paintings, there is no significant relationship between PTS and PFS (Pearson's correlation coefficient = 0.313, $P = 0.205$, plotted in Figure 6(A)). Also, no significant relationship exists between PTS and NS (Pearson's correlation coefficient = -0.383, $P = 0.117$, plotted in Figure 6(B)), although there is a negative linear relationship between NS and PFS (Pearson's correlation coefficient = -0.852, $P < 0.001$, plotted in Figure 6(C)). These results imply that, in the case of the acquired Gauguin-Style paintings, NS failed to bridge a significant relationship between PTS and PFS.

Concerning complexity, we computed the complexity score (CS) of each painting as the mean of the rating scores across the participants obtained in Session 2 of Experiment 1. We found no significant correlation between PTS and CS (Pearson's correlation coefficient = 0.035, $P = 0.913$), between CS and NS (Pearson's correlation coefficient = 0.269, $P = 0.398$), or between CS and PFS (Pearson's correlation coefficient = 0.128, $P = 0.692$) with regard to the acquired Gogh-style paintings. This implies that the detected PTS-NS-PFS relationships in terms of the acquired Gogh-style paintings could hardly be artefacts caused by CS.

5. Discussion

The data analyses of Experiment 1 show that, with regard to the acquired Gogh-style paintings, a negative linear relationship shows up between PTS and PFS. However, we also found that NS positively correlates with PTS and negatively correlates with PFS.

Table 1 Factor loadings of SD scales after factor rotation.

Factor identity	SD scale	Factor loading		
		Factor 1	Factor 2	Factor 3
Factor 1 (Nervosity)	神経質でない (unneurotic) - 神経質な (neurotic)	1.078	-0.183	-0.280
	ゆるんだ (relaxed) - 緊張した (nervous)	1.038	-0.093	-0.064
	暖かい (warm) - 冷たい (cold)	0.933	0.272	-0.066
	穏やかな (gentle) - 厳格な (strict)	0.881	-0.080	0.117
	くつろいだ (relaxed) - 張りつめた (nervous)	0.870	-0.052	0.140
	陽気な (cheerful) - 陰気な (gloomy)	0.771	0.354	0.094
	明るい (bright) - 暗い (dark)	0.660	0.313	0.237
	楽しい (happy) - 寂しい (lonely)	0.633	0.460	0.172
	柔らかな (soft) - 固い (hard)	0.614	0.005	0.348
	やさしい (gentle) - 乱暴な (rough)	0.543	-0.493	0.450
Factor 2 (Individuality)	個性的な (individualistic) - 平凡な (ordinary)	-0.276	0.943	-0.021
	興奮的な (exciting) - 沈静的な (calm)	0.160	0.936	-0.045
	動的な (dynamic) - 静的な (static)	0.093	0.929	-0.118
	感情的な (emotional) - 理知的な (rational)	0.014	0.925	-0.086
	不安定な (unstable) - 安定した (stable)	-0.362	0.763	-0.406
	派手な (flashy) - 地味な (plain)	0.244	0.757	0.184
	面白い (interesting) - つまらない (boring)	-0.114	0.664	0.659
Factor 3 (Preference)	好きな (like it much) - 嫌いな (dislike it much)	-0.124	-0.097	1.068
	美しい (beautiful) - 醜い (ugly)	0.005	-0.082	0.985
	良い (good) - 悪い (bad)	0.001	0.059	0.966
	快い (pleasant) - 不快な (unpleasant)	0.083	-0.005	0.914

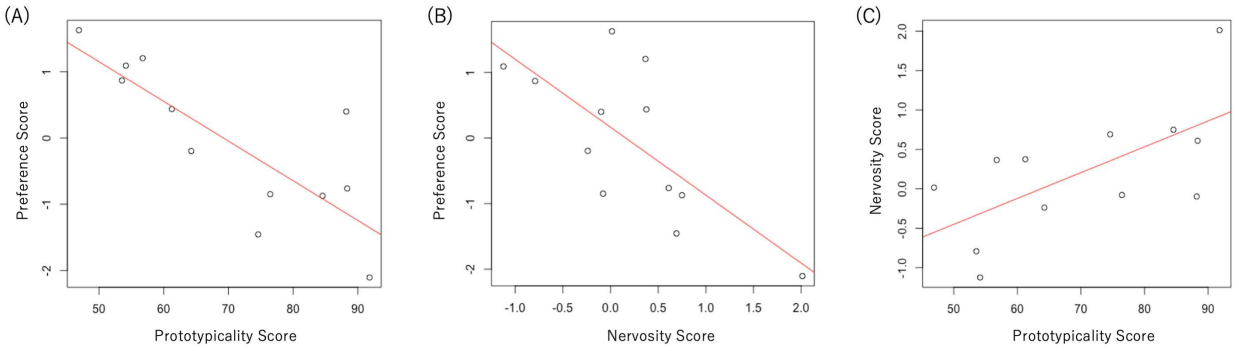

Figure 5 Relationships among prototypicality score, nervosity score and preference score with regard to acquired Gogh-style paintings.

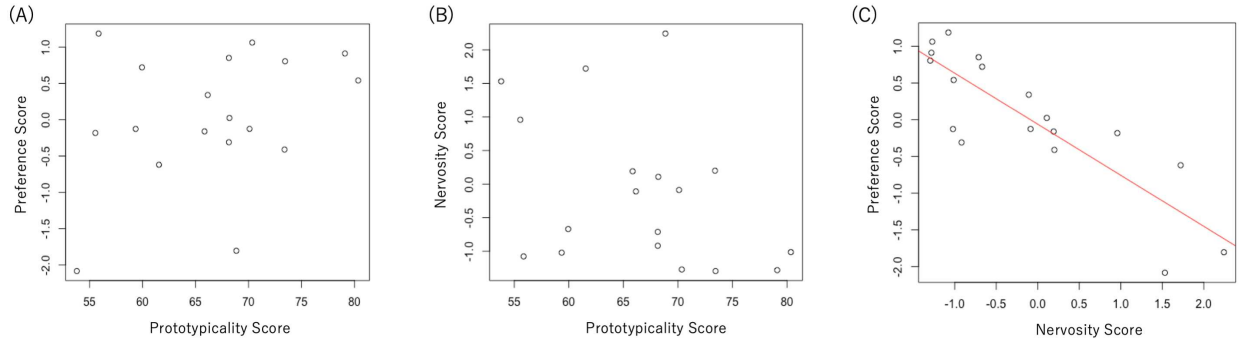

Figure 6 Relationships among prototypicality score, nervosity score and preference score with regard to acquired Gauguin-style paintings.

The positive NS-PTS correlation tallies with the reports that Vincent van Gogh suffered from mental disorders, possibly Miniere's disease[14], PTSD[15], acute intermittent porphyria[16], and/or epilepsy[17], and the mental disorders linked with his artistic creativity[18, 19]. Thus, it is reasonable to interpret the correlation as that, when watching a painting by van Gogh, people tend to use the intensity of the sense of nervosity that the painting elicits as a crucial clue for evaluating its prototypicality. As to the positive NS-PFS correlation, it accords with our daily experience that nervosity is not a pleasant feeling. These two correlations made us consider the possibility that the observed negative PTS-PFS relationship was a spurious one which was bridged by nervosity, as shown in Figure 7. In addition, considering van Gogh's great fame in Western painting, it is interesting to find in an empirical manner that non-experts in Western painting tend to dislike typical Gogh paintings.

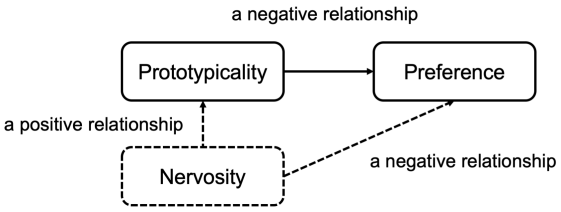

Figure 7 Summary of results of data analyses of Experiment 1.

With regard to the acquired Gauguin-style paintings, no significant relationship was detected between PTS and PFS. Furthermore, although a negative relationship exists between NS and PFS, as in the case of the acquired Gogh-style paintings, no significant relationship exists between NS and PTS. This is fairly understandable because nervosity has never been reported to be a characteristic of Gauguin's paintings in our literature review. The observation that the inability of nervosity to mediate between prototypicality and preference accompanied the absence of a significant prototypicality-preference relationship deepened our suspicion that nervosity acted as a confounding factor in the case of the acquired Gogh-style paintings.

These results suggest that, in different painting styles, different prototypicality-preference correlations will be detected owing to to different psychological mechanisms (including mediating effects of confounding factors such as nervosity) that underlie the correlations.

6. Summary

This study aims to experimentally clarify whether the relationship between prototypicality and preference of paintings varies across styles. Two psychological experiments, one with style learning (Experiment 1) and one without style learning (Experiment 2), are conducted to remove the effects of potential confounding factors.

Experiment 1 is completed. The factor analysis of the affective evaluation data obtained in Experiment 1 show that the affective evaluation of Gogh and Gauguin's paintings is composed of three psychological dimensions Nervosity, Individuality and Preference. In terms of the acquired Gogh-style paintings, the correlation analysis detected a significant negative linear relationship between prototypicality and preference. However, because we found that nervosity positively correlated with prototypicality and negatively

correlated with preference, we conjecture that the detected negative prototypicality-preference relationship is a spurious one bridged by nervosity. This speculation is further supported by the results of the correlation analyses of the acquired Gauguin-style paintings in which the incapacity of nervosity to mediate between prototypicality and preference accompanied the absence of a significant prototypicality-preference relationship. Regarding the acquired Gauguin-style paintings, nervosity negatively correlated with preference, but had no significant relationship with prototypicality. These results imply the possibility that, in different painting styles, different prototypicality-preference correlations will be detected due to different psychological mechanisms underlying the correlations, such as mediating effects of confounding factors.

7. Next Research Step

Our next step is to finish Experiment 2 and to conduct a comparison of the results of Experiment 1 and Experiment 2. Through the comparison, we will clarify whether nervosity actually is a confounding factor that bridges the detected prototypicality-preference correlation regarding the acquired Gogh-style paintings, as well as the core questions in our study, that is, whether there exists a direct relationship between prototypicality and preference in terms of the acquired Gogh-style paintings and in terms of the acquired Gauguin-style paintings.

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