Junichi Takahashi, Yousuke Kawachi & Jiro Gyoba

Internal Criteria Underlying Affective Responses to Visual Patterns

Introduction

Visual patterns produce various affective responses such as goodness, regularity, symmetry, preference, pleasure, and beauty. Most studies of pattern recognition have focused on goodness (e.g., Garner & Clement, 1963; Garner & Sutliff, 1974; Lachmann & Geissler, 2002; Lachmann & van Leeuwen, 2005a, 2005b, 2007; Sebrechts & Garner, 1981).

Pattern goodness is one of the most important factors in Gestalt theory. To understand pattern goodness from the perspective of redundancy, Garner proposed a concept of equivalent set size (ESS) (Garner & Clement, 1963). ESS is the set size of alternative representations of an equivalent pattern defined by the rotation and reflection (R & R) transformation. As shown in Figure 1, for ESS-1 patterns, alternative representations are not produced by transformation of clockwise rotation and reflection. ESS-4 patterns contained 4 alternative representations produced by clockwise rotations, but not by reflection. Moreover, ESS-8 patterns contained 4 alternative representations by clockwise rotations or reflections, respectively. The ESS is inversely correlated with the redundancy of visual patterns: the smaller the ESS value is, the greater the redundancy is. Garner and Clement (1963) examined whether the goodness rating could be defined by ESS by using five-dot patterns positioned on an imaginary matrix of 3 × 3 (see, Figure 2 (a)). The results showed that ESS was able to explain more than 70% of the variance of the goodness rating mean and demonstrated that the judged pattern goodness was inversely correlated with the ESS. Moreover, Imai, Ito, and Ito (1976) also showed, by using four- and five-dot patterns, that the goodness rating was not influenced by the number of dots constituting the dot patterns.

However, it may be difficult to define various affective responses such as preference, pleasure, and beauty on the basis of just physically-related variables such as pattern goodness. Gyoba (2007) proposed that it is necessary to use not only the goodness rating but also multidimensional analysis such as the semantic differential (SD) method in order to describe multiple affective responses aroused by the visual patterns. The SD method developed by Osgood, Suci, and Tannenbaum (1957) has been widely used for measuring affective responses to

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various stimuli such as visual patterns, objects, line drawings, or faces (e.g., Ishi, Gyoba, Kamachi, Mukaida, & Akamatsu, 2004; Locher, Smith, & Smith, 2001; Sakuta & Gyoba, 2006; Skrandies, 1998, 2011; Kawachi et al., in press; Suzuki, Gyoba, & Sakuta, 2005). The conventional SD technique requires participants to rate affective meanings for objects or materials on bipolar scales defined by contrasting adjective pairs such as "good-bad" . Then, the factors underlying the multivariate data are extracted by employing the factor analysis method in order to explain the affective contents in terms of a limited number of specific main factors. Generally, three factors are commonly extracted across various materials and different cultures: *Evaluation* (an example of representative adjective pair: likable-dislikable), *Potency* (hard-soft), and *Activity* (active-passive). Also, previous studies have confirmed these three factors based on the neurophysiological evidences (Skrandies, 1998, 2011; Kawachi et al., in press; Suzuki et al., 2005). Gyoba, Seto, and Ichikawa (1985) investigated the internal criteria involved in the visual patterns of Garner and Clement (1963) by using the SD method. The results showed that the pattern rating was influenced by several factors such as *Figural coherence*, *Evaluation*, *Potency*, and *Activity*. In particular, they showed that *Figural coherence* has a high correlation to physically-related variables such as complexity, symmetry, and goodness ratings. However, they also showed that the goodness rating was based not only on *Figural coherence* but also on several other factors which could not be defined only by physically-related variables. Therefore, they concluded that several internal criteria underlie various affective responses, such as complexity, beauty, and preference, besides the goodness that the visual patterns can generate.

Although there is ample evidence that the visual patterns produce many affective responses (e.g., Gyoba et al., 1985), the internal criteria underlying affective responses to visual patterns are not sufficiently understood. In particular, there is not enough evidence to judge whether pattern components such as the number of dots in the visual patterns could affect the affective rating, because most studies have employed the Garner and Clements patterns (i.e., five-dot patterns). Although Imai et al. (1976) showed that the goodness rating was not influenced by the number of dots, they used only four- and five-dot patterns. In the present study, we investigated the internal criteria underlying affective responses to five-, seven-, and nine-dot patterns by using the SD method. Moreover, to examine the effects of the number of dots on affective rating, we compared the factor scores of visual patterns calculated through factor analysis for five-, seven-, and nine-dot patterns.

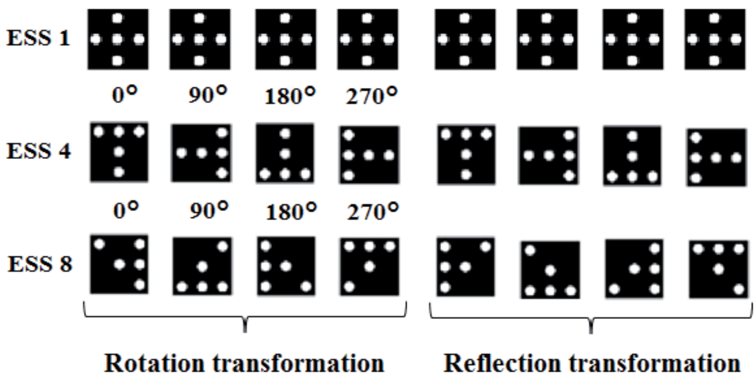


Fig. 1. Examples of visual patterns based on Garner's rotation and reflection (R & R) transformation principle (Garner & Clement, 1963). ESS = equivalent set size. The upper row shows alternative representations of a visual pattern from one set of ESS 1. The middle row shows alternative representations of a visual pattern from one set of ESS 4. The lower row shows alternative representations of a visual pattern from one set of ESS 8.

Method

Participants

Twenty naive participants were recruited from a group of graduate and undergraduate students of Tohoku University (5 men and 15 women). These people had not participated in other psychological experiments and were not informed the purpose of the present study. They had normal or correct-to-normal visual acuity and provided informed consent before participation.

Stimuli

Figure 2 shows the dot patterns used in the present study. The dot patterns positioned as five dots on an imaginary matrix of 3 × 3 were *five-dot patterns* (Figure 2 (a)). There are 17 dot patterns from Garner and Clement (1963), including two dot patterns at ESS 1, eight at ESS 4, and seven at ESS 8. The dot patterns positioned as seven and nine dots on the imaginary matrix of 5 × 5 were each *seven-* and *nine-dot patterns*, respectively. The *seven-dot patterns* (Figure 2 (b)) included three dot patterns at ESS 2, three at ESS 4, and five at ESS 8, which were modeled by Howe (1980). The *nine-dot patterns* (Figure 2 (c)), which were 24 dot patterns from Howe (1980), included five dot patterns at ESS 1, three at ESS 2, eight at ESS 4, and eight at ESS 8. The dot was white (64.5 cd/m^2, diameter of 1.4 degrees of visual angle), and the background was black (0.7 cd/m^2). The observation distance was 60 cm.

Apparatus

The presentations of stimuli and data collection were controlled by a computer (Precision 450, DELL). All the stimuli were generated by using Matlab (Mathworks Inc.) and Cogent Graphics (http://www.vislab.ucl.ac.uk/Cogent/index.html) and were displayed on a CRT monitor (Flex Scan E66T, EIZO) with a 60-Hz refresh rate.

Adjective-Pairs

Twenty-two adjective pairs were selected on the basis of our previous investigation and that of Gyoba et al. (1985) (Table 1).

Procedure

Each participant rated at his/her own pace the presented dot patterns on a CRT display on 22 adjectives as 7-point scales (e.g., 1, organized; 7, disorganized) printed on paper. All participants rated all *five-*, *seven-*, and *nine-dot patterns*: the order of conditions of dot number was counterbalanced across participants.

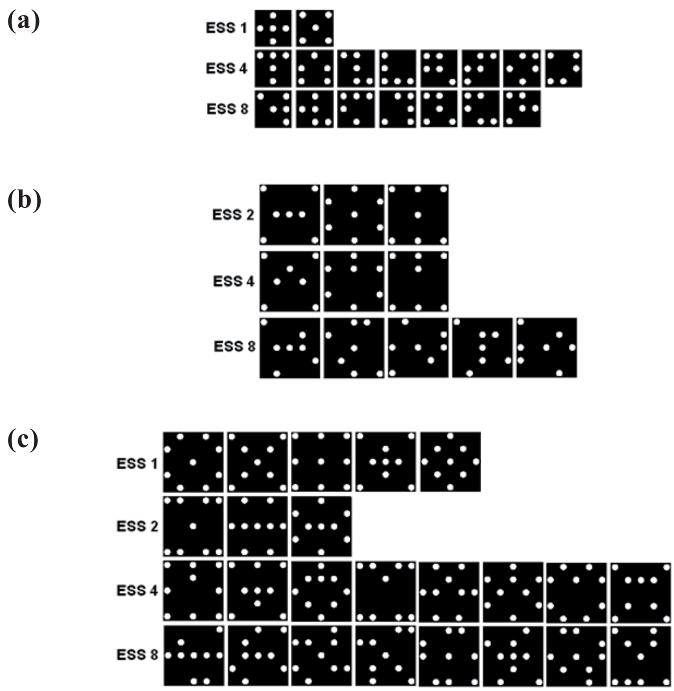


Fig. 2. Dot pattern samples for the set of stimuli in this experiment. ESS = equivalent set size. (a) The dot pattern comprises five dots on the virtual 3 × 3 matrix used by Garner & Clement (1963). (b) The dot pattern comprises seven dots on the virtual 5 × 5 matrix, which was prepared according to Howe's (1980) principle. (c) The dot pattern comprises nine dots on the virtual 5 × 5 matrix used by Howe (1980).

Results

The Results of Factor Analysis

Table 1 shows the factor loadings after varimax rotation. A factor analysis was conducted on the combined data of the five-, seven-, and nine-dot patterns to confirm the general affective responses shared by all the dot patterns.

The data of one participant were excluded because the participant did not complete the rating. The factor analysis extracted four factors in terms of the principal factor method with varimax rotation (Table 1) [1]. The first factor accounted for 23.88% of the total variance, including regularity, complexity, and goodness scales. Thus, the first factor could be regarded as "*Figural coherence,*" which was proposed by Gyoba (2007). The remaining three factors represented "*Evaluation*" (16.28%), "*Potency*" (7.42%), and "*Activity*" (4.97%), according to the terminology of Osgood et al. (1957). The representative adjectives for each factor were as follows: "organized–disorganized" or "stable–unstable" for *Figural coherence*; "interesting–uninteresting" or "pretty–not pretty" for *Evaluation*; "square–round" or "hard–soft" for *Potency*; and "full–empty" or "narrow–spread" for *Activity*.

The results showed that the factor loadings of "good–poor" represented a high value not only in *Figural coherence* (.614) but also in *Evaluation* (.449). There was a similar result regarding "likable–dislikable" whose factor loadings showed a high value in *Evaluation* (.584) as well as in *Figural coherence* (.515). Furthermore, the factor loadings of "clear–dim" represented a high value in both *Potency* (.550) and *Figural coherence* (.524). These results strongly supported the compound judgment prescribed by multiple affective responses, as Gyoba (2007) proposed.

Adjective pairs (*Japanese*)	I	II	III	IV
organized–disorganized *(kisokutekina–fukisokuna)*	**.818**	.013	.162	.196
stable–unstable (*anteishita–fuanteina*)	**.811**	-.042	.061	.217
simple–complex *(tanjunna–hukuzatsuna)*	**.737**	-.033	.121	.046
clean–dirty *(kireina–kitanai)*	**.735**	.294	.141	.093
symmetrical–asymmetrical *(katamukinonai–katamuita)*	**.701**	-.147	-.009	-.017
coherency–incoherency *(matomatta–barabarana)*	**.631**	.092	.174	.369
good–poor *(yoi–warui)*	**.614**	.449	.114	-.068
static–dynamic *(seitekina–doutekina)*	**.595**	-.438	-.041	.061
meaningful–meaningless *(iminoaru–muimina)*	**.488**	.266	.102	.357
bright–dark *(akarui–kurai)*	.087	**.683**	-.040	-.071
interesting–uninteresting *(omoshiroi–tsumaranai)*	.036	**.680**	-.046	.120
lively–lonely *(niginakana–sabishii)*	-.160	**.667**	.003	.107
pretty–not pretty *(kawaii–kawaikunai)*	.376	**.646**	-.147	.039
likable–dislikable *(suki–kirai)*	.515	**.584**	.056	.116
light–heavy *(karui–omoi)*	-.064	**.485**	-.063	-.382
old–new *(furui–atarashii)*	-.361	**.417**	-.087	-.194
square–round *(kakubatta–marui)*	.171	-.261	**.687**	.005
hard–soft *(katai–yawarakai)*	.260	-.389	**.601**	.127
sharp–blunt *(surudoi–nibui)*	-.054	.219	**.578**	.023
clear–dim *(hakkirishita–bonyarishita)*	.524	.120	**.550**	.157
full–empty *(jyujitsushita–karano)*	.140	.411	.026	**.572**
narrow–spread *(sebamatta–hirogatta)*	.125	-.077	.036	**.355**
Eigen value	**5.25**	**3.58**	**1.63**	**1.09**
Contribution of each factor (%)	**23.88**	**16.28**	**7.42**	**4.97**
Cumulative contribution (%)	**23.88**	**40.16**	**47.58**	**52.55**

Note: Cronbach's α for scales based on Factor I (*Figural coherence*) = 0.89, Factor II (*Evaluation*) = 0.78, Factor III (*Potency*) = 0.72, and Factor IV (*Activity*) = 0.51

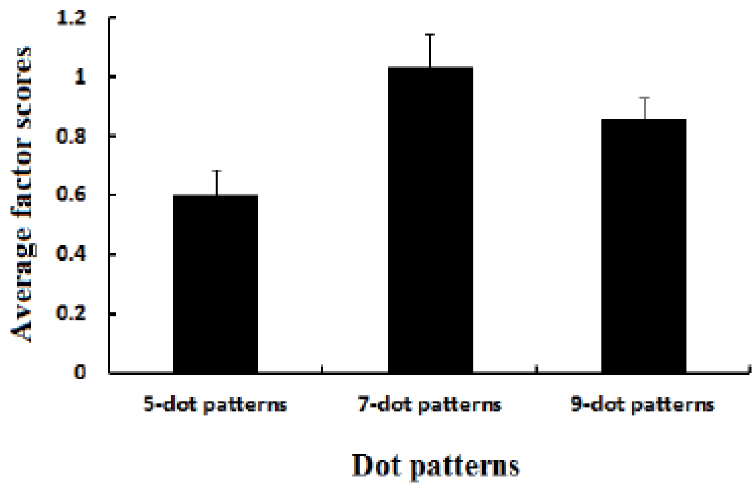
Table 1. Factor loadings after varimax rotation

Effects of the Number of Dots on Affective Rating

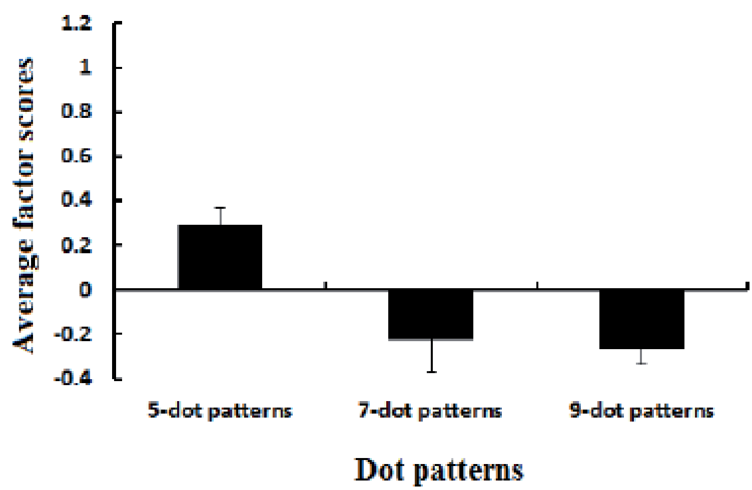
To investigate the effects of the number of dots constituting the dot patterns on affective rating, in *Figural coherence*, *Evaluation*, *Potency*, and *Activity* factors, we conducted a one-way ANOVA with dot number (five, seven, or nine) as within-participants factors on the factor scores of visual patterns. To control pattern redundancy based on ESS, we used only ESS 8 patterns in all five-, seven-, and nine-dot patterns.

Figure 3 (a) shows the factor scores of visual patterns based on *Figural coherence* between five-, seven-, and nine-dot patterns among ESS 8 patterns. The results showed a main effect of dot number, $F(2, 56) = 11.82$, $p < .001$, $\eta^2 = 0.40$. Posthoc analysis (Ryan's method) revealed that the factor scores of five-dot patterns were significantly lower than those of seven- and nine-dot patterns ($p < .05$).

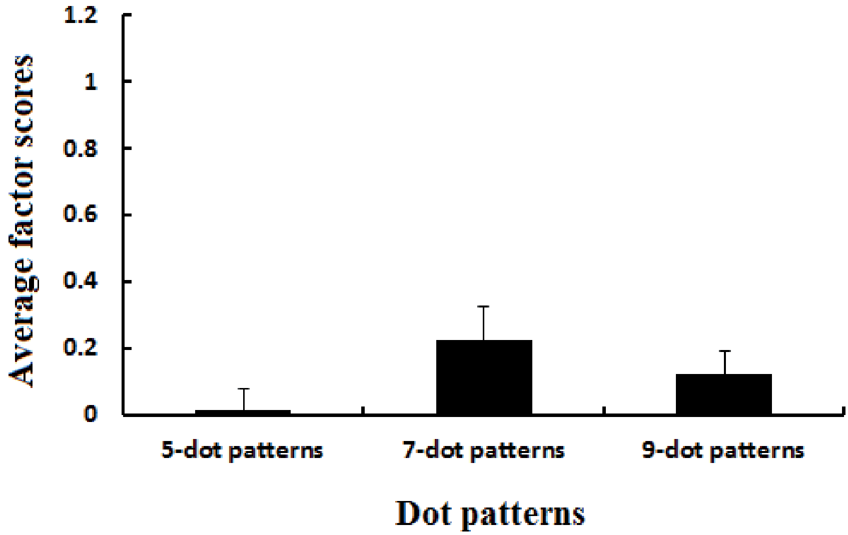
(a)



(b)



(c)



(d)

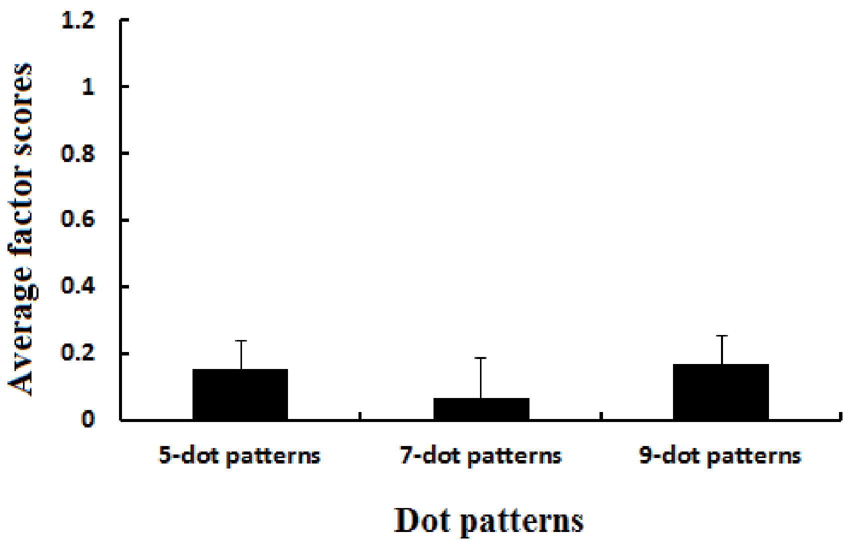


Fig. 3 Results of the factor scores of visual patterns between five-, seven- and nine-dot patterns among ESS 8. The factor scores of *Figural coherence* (a), *Evaluation* (b), *Potency* (c) and *Activity* (d).

Figure 3 (b) represents the factor scores of visual patterns based on *Evaluation* between five-, seven-, and nine-dot patterns among ESS 8 patterns. The results showed a main effect of dot number, $F(2, 56) = 9.75, p < .001, \eta^2 = 0.35$, indicating that the factor scores were significantly higher when the participants rated the five-dot patterns than when they rated the seven- and nine-dot patterns ($p < .05$). Furthermore, Figure 3 (c) and 3 (d) show the factor scores of visual patterns based on *Potency* and *Activity* between five-, seven-, and nine-dot patterns among ESS 8 patterns. However, there were no significant differences between five-, seven-, and nine-dot patterns: for *Potency,* $F(2, 56) = 2.30, p > .10, \eta^2 = 0.11$; for *Activity,* $F(2, 56) = 0.33, p > .10, \eta^2 = 0.18$.

Discussion

In the present study, we investigated the internal criteria underlying affective responses to five-, seven-, and nine-dot patterns by using the SD method. Moreover, we examined whether the number of dots constituting the visual patterns affects the affective rating.

According to the factor analysis, we extracted four factors representing the affective rating among five-, seven-, and nine-dot patterns. These factors could be classified as *Figural coherence*, *Evaluation*, *Potency*, and *Activity* factors, in accordance with previous studies (Gyoba et al., 1985; Osgood et al., 1957). The results are consistent with those of previous study (Gyoba et al., 1985) and suggest that many affective responses that visual patterns arouse are based not only on physically-related criteria of *Figural coherence*, but also on several criteria represented by factors such as *Evaluation*, *Potency*, and *Activity*.

Moreover, to examine whether the number of dots could influence the affective rating, we compared the factor scores of visual patterns calculated through factor analysis for five-, seven-, and nine-dot patterns. The results revealed significant differences in the factor scores between five-, seven-, and nine-dot patterns in *Figural coherence* and *Evaluation*, but not in *Potency* and *Activity*. We now discuss the differences in the factor scores.

In regard to the differences in the factor scores of *Figural coherence*, the factor scores of visual patterns were lower when the participants rated the five-dot patterns compared to the seven- and nine-dot patterns. These results meant that the participants rated the five-dot patterns as "stable," "simple," or "good," whereas they rated the seven- and nine-dot patterns as "unstable," "complex," or "poor." Meanwhile, Imai et al. (1976) showed that the goodness rating was not influenced within the range of four to five dots. Most studies (e.g., Garner & Clement, 1963) have shown that the goodness rating is affected by one or more whole symmetries defined by the R & R subset size (i.e., ESS) of Garner's five-dot patterns. However, some studies (e.g., Howe, 1980) suggest that partial symmetry, defined as two dots of the pair being symmetric about their common axis, may also affect the goodness rating. For example, Howe (1980) measured the goodness rating by using nine-dot patterns. This enables us to manipulate the degree of not only the whole symmetry but also the partial symmetry, which differs from the use of five-dot patterns. The results showed that the goodness rating was higher when observers rated the pattern goodness of the patterns that involved whole symmetry rather than those involving partial symmetry. This finding provides an explanation for why there were no effects of dot number on goodness rating in the results of Imai et al. (1976). The effect of the partial symmetry, not the whole symmetry, could not be sufficiently examined in four- and five-dot patterns, so the observers tended to rate the pattern goodness on the basis of the whole symmetry in both the four- and five-dot patterns. In our study, because seven- and nine-dot patterns could yield partial symmetries better than four- and five-dot patterns, observers might rate the pattern goodness of the seven- and nine-dot patterns depending on the partial symmetry and the whole symmetry. Thus, as Howe (1980) reported that the goodness rating decreased when observers used the partial symmetry, we could assume that the participants rated the five-dot patterns as "stable," "simple," or "good," whereas they rated the seven- and nine-dot patterns as "unstable," "complex," or "poor" in redundancy-related ratings such as complexity, symmetry, and goodness.

In regard to the results of *Evaluation*, the factor scores of five-dot patterns were higher than those of seven- and nine-dot patterns. As shown in Table 1, *Evaluation* was related to affective responses such as "interesting–uninteresting," "pretty–not pretty," and "likable–dislikable." In this study, the participants tended to rate the five-dot patterns as "uninteresting," "not pretty," or "dislikable," whereas they rated the seven- and nine-dot patterns as "interesting," "pretty," or "likable." Gyoba (2007) indicates that the "poor" or "complex" visual patterns (five-dot patterns of ESS 8) were rated as more "interesting," "pretty," or "likable" than the "good" or "simple" ones (five-dot patterns of ESS 4). In the present study, the goodness rating of seven- and nine-dot patterns was lower than that of five-dot patterns. In correspondence with the previous finding, our results show that the "poor" or "complex" patterns (i.e., seven- and nine-dot patterns) were rated as more "interesting," "pretty," or "likable" than the "good" or "simple" patterns (i.e., five-dot patterns). A previous study (e.g., Imamoglu, 2000) suggests that simple stimuli may appear to be too predictable and hence boring; in contrast, complex stimuli may appear to be unpredictable and more pleasing when the complexity is still within the range of predictability. Thus, in our present study, visual patterns rated as "complex" might enhance the rating of *Evaluation* to "interesting," "pretty," or "likable" (Hekkert & van Wieringen, 1990; but see, Graham, Friedenberg, McCandless, & Rockmore, 2010).

Regarding the results of *Potency* and *Activity*, there were no significant differences in the factor scores between five-, seven-, and nine-dot patterns. As shown in Table 1, *Potency* was related to affective responses such as "square–round", "hard–soft" and "sharp–blunt", whereas *Activity* was related to "full–empty" or "narrow–spread". Thus, in this study, the participants rated the five-, seven-, and nine-dot patterns as the same levels of *Potency*, such as "square," "hard," and "sharp," and *Activity*, such as "full" and "narrow".

Although there are few previous studies (e.g., Tinio & Leder, 2009; Wilson & Chatterjee, 2005) which examined the relationship between the physically-related variables such as perceptual stability or balance and subjective rating of beauty or preference, these previous studies could examine only one aspect of multiple affective responses. Our present study, by using multivariate data, could extend the findings of previous studies and provide meaningful evidence concerning the relationship between the physically-related variables such as goodness, regularity, symmetry and complexity and multiple affective responses such as preference, pleasure and beauty.

In conclusion, we indicated that a pattern component of the dot number affects the way of weighting each internal criterion. The present study points out the interaction between the internal criteria and the elements comprising visual patterns. Considering various pattern components such as the number, size, color, orientation, etc. of components in the visual patterns, future work needs to elucidate in detail the effects of *Figural coherence*, *Evaluation*, *Potency*, and *Activity* factors on not only the affective ratings conducted in this study, but also on various pattern recognition tasks.

Summary

Previous studies on pattern recognition have shown that pattern goodness is highly correlated to physically-related variables such as the redundancy of visual patterns. However, it may be difficult to define various affective responses such as preference, pleasure and beauty on the basis of just physically-related variables. Therefore, we need to investigate what internal criteria underlie affective responses evoked by visual patterns. In our investigation, 20 participants rated 52 dot patterns, which comprised five-, seven-, and nine-dot patterns on 22 adjective-pair scales, through the semantic differential method. By using the principal factor analysis, we extracted 4 factors: *Figural coherence*, *Evaluation*, *Potency*, and *Activity*. Furthermore, we compared the factor scores of visual patterns calculated by the analysis for five-, seven-, and nine-dot patterns in *Figural coherence*, *Evaluation*, *Potency*, and *Activity*. The results showed significant differences between the five-dot patterns and the seven- and nine-dot patterns in the factor scores of *Figural coherence* and *Evaluation*, but not in those of *Potency* and *Activity*. These results clarified the internal criteria underlying affective responses to visual patterns and indicated the effects of the dot number comprising the visual patterns on the weighting of each internal criterion.

Keywords: Dot patterns, affective responses, redundancy, semantic differential (SD) method, Factor analysis.

Zusammenfassung

Frühere Studien über das Erkennen von Mustern haben gezeigt, dass die Qualität von Mustern in einem hohen Mass mit physikalisch entsprechenden Variablen korreliert, wie z.B. der Redundanz visueller Muster. Es ist jedoch schwer, verschiedene emotionale Reaktionen wie Vorliebe, Freude und Schönheit nur auf der Basis physikalisch verwandter Variablen zu definieren. Es muss daher untersucht werden, welche inneren Faktoren den emotionalen Reaktionen, die durch visuelle Muster hervorgerufen werden, zugrunde liegen. In unserer Untersuchung bewerteten 20 Teilnehmer anhand der semantischen Differentialmethode 52 Muster, die auf 22 adjektivischen Paar-Skalen Muster aus jeweils fünf, sieben und neun Punkten beinhalteten. Unter Verwendung der Hauptfaktorenanalyse wurden vier Faktoren ausgewählt: symbolische Kohärenz, Bewertung, Stärke und Aktivität. Weiters wurden die Faktorenpunktzahlen der visuellen Muster, die aus der Analyse der fünf-, sieben-, und neunpunktigen Muster bei symbolischer Kohärenz, Bewertung, Stärke und Aktivität berechnet wurden, miteinander verglichen. Die Ergebnisse zeigten signifikante Unterschiede zwischen den fünfpunktigen Mustern und den sieben- und neunpunktigen Mustern bzgl. der Faktorenpunktzahlen bei symbolischer Kohärenz und bei Bewertung, jedoch nicht bei Stärke und Aktivität. Diese Ergebnisse verdeutlichen die einer emotionalen Reaktion auf visuelle Muster zugrundeliegenden inneren Faktoren und zeigen die Auswirkung der Punkteanzahl der visuellen Muster auf die Bewertung jedes einzelnen inneren Kriteriums.

Schlüsselwörter: Punktemuster, affektive Reaktion, Redundanz, semantische Differentialmethode, Faktorenanalyse.

Author's Note

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References

Garner, W. R. & Clement, D. E. (1963): Goodness of pattern uncertainty. *Journal of Vernal Learning and Verbal Behavior* 2, 446-452.

Garner, W. R. & Sutliff, D. (1974): The effect of goodness on encoding time in visual pattern discrimination. *Perception & Psychophysics* 16, 426-430.

Graham, D., Friedenberg, J. D., McCandless, C. H. & Rockmore, D. N. (2010): Preference for art: Similarity, statistics, and selling price. *Proceedings of SPIE* 7527, 75271A.

Gyoba, J. (2007): First-order and second-order pattern psychophysics. *Proceedings of the 23rd annual meeting of the international society for psychophysics*, 23-28.

Gyoba, J., Seto, I. & Ichikawa, S. (1985): Problems of goodness judgment of patterns: Correspondence of analysis of SD technique and transformational structure theory. *Japanese Journal of Psychology* 56, 111-115.

Heise, D. R. (1969): Some methodological issues in semantic differential research. *Psychological Bulletin* 72, 406-422.

Hekkert, P. & van Wieringen, P. C. W. (1990): Complexity and prototypicality as determinants of the appraisal of cubist paintings. *British Journal of Psychology* 81,483-495.

Howe, E. S. (1980): Effects of partial symmetry, exposure time, and backward masking on judged goodness and reproduction of visual patterns. *Quarterly Journal of Experimental Psychology* 32, 27-55.

Imai, S., Ito, T. & Ito, S. (1976): Effect of intra-pattern transformation structures upon goodness judgments of two-dimensional patterns. *Japanese Journal of Psychology* 47, 202-210.

Imamoglu, C. (2000): Complexity, liking and familiarity: Architecture and non-architecture Turkish students' assessments of traditional and modern house facades. *Journal of Environmental Psychology* 20, 5-16.

Ishi, H., Gyoba, J., Kamachi, M., Mukaida, S. & Akamatsu, S. (2004): Analyses of facial attractiveness on feminized and juvenilised faces. *Perception* 33, 135-145.

Kawachi, Y., Kawabata, H., Kitamura, S. M., Shibata, M., Imaizumi, O. & Gyoba, J. (in press). Topographic distribution of brain activities corresponding to psychological structures underlying affective meanings: An fMRI study. *Japanese Psychological Research*.

Lachmann, T. & Geissler, H. G. (2002): Memory search instead of template matching? Representation-guided inference in same-different performance. *Acta Psychologica* 111, 283-307.

Lachmann, T. & van Leeuwen, C. (2005a): Individual pattern representations are context independent, but their collective representation is context dependent. *The Quarterly Journal of Experimental Psychology* 58A, 1265-1294.

Lachmann, T. & van Leeuwen, C. (2005b): Task-invariant aspects of goodness in perceptual representation. *The Quarterly Journal of Experimental Psychology* 58A, 1295-1310.

Lachmann, T. & van Leeuwen, C. (2007): Goodness takes effort: perceptual organization in dual-task settings. *Psychological Research* 71, 152-169.

Locher, P. J., Smith, J. K. & Smith, L. F. (2001): The influence of presentation format and viewer training in the visual arts on the perception of pictorial and aesthetic qualities of paintings. *Perception* 30, 449-465.

Miron, M. S. & Osgood, C. E. (1966): Language behavior: The multivariate structure of qualification. In R. B. Cattell (Ed.): *Handbook of multivariate experimental psychology*. Chicago: Rand McNally.

Osgood, C. E., Suci, G. J. & Tannenbaum, P. H. (1957): *The measurement of meaning.* Urbana: University of Illinois Press.

Skrandies, W. (1998): Evoked potential correlates of semantic meaning-A brain mapping study. *Cognitive Brain Research* 6, 173-183.

Skrandies, W. (2011): The structure of semantic meaning: A developmental study. *Japanese Psychological Research* 53, 65-76.

Sebrechts, M. M. & Garner, W. R. (1981): Stimulus-specific processing consequences of pattern goodness. *Memory & Cognition* 9, 41-49.

Sakuta, Y. & Gyoba, J. (2006): Affective impressions and memorability of color-form combinations. *The Journal of General Psychology* 133, 191-207.

Suzuki, M., Gyoba, J. & Sakuta, Y. (2005): Multichannel NIRS analysis of brain activity during semantic differential rating of drawing stimuli containing different affective polarities. *Neuroscience Letters* 375, 53-58.

Tinio, P. P. L. & Leder, H. (2009): Just how stable are stable aesthetic features? Symmetry, complexity, and the jaws of massive familiarization. *Acta Psychologica* 130, 241-250.

Wilson, A. & Chatterjee, A. (2005): The assessment of preference for balance: Introducing a new test. *Empirical Studies of the Arts* 23, 165-180.

Foot note

Samples of at least 5 to 10 times the number of variables are needed, suggesting that our present study needs 110 to 220 samples because we used 22 couples of adjectives. Although the averaged rating data for many stimuli given by one participant are treated as one observation in a study using many types of questionnaire, in several studies employing the SD method, the rating for one stimulus given by one participant has been treated as one observation; correlations are calculated over a total of "the number of participants × the number of stimuli" (see Heise 1969; Miron & Osgood 1966; Osgood et al. 1957). In our present study, we used 19 participants and 52 dot patterns (17 dot patterns in the *five-dot patterns* condition, 11 dot patterns in the *seven-dot patterns* condition, and 24 dot patterns in the *nine-dot patterns* condition). Thus, we used 988 samples (19 participants × 52 dot patterns) for a factor analysis. Therefore, the number of samples is satisfactory to conduct a factor analysis.

Junichi Takahashi, born in 1983, is currently working at Department of Psychology, Graduate School of Arts and Letters, Tohoku University, Japan. Research interests are in visual short-term memory and affective properties of the pattern recognition.

Address: Department of Psychology, Graduate School of Arts and Letters, Tohoku University, 27-1 Kawauchi, Aoba-ku, Sendai, 980-8576, Japan.
E-Mail: j_taka@sal.tohoku.ac.jp

Yousuke Kawachi, born in 1979, has been a lecturer at Kansei Fukushi Research Institute, Tohoku Fukushi University, Japan. He received his Ph. D. from Tohoku University. Research interests are in how sensory information within vision and across sensory modalities is integrated into an event representation.
Address: Kansei Fukushi Research Institute, Tohoku Fukushi University, 6-149-1, Kunimigaoka, Aoba-ku, Sendai, Miyagi, 989-3201, Japan.
E-Mail: yousuke.kawachi@gmail.com

Jiro Gyoba, born in 1954, has been a Professor at the Graduate School of Arts and Letters, Tohoku University, Japan. He received his Ph. D. from Tohoku University. Research interests are in psychology of visual cognition, aesthetic perception, and human information processing.
Address: Department of Psychology, Graduate School of Arts and Letters, Tohoku University, 27-1, Kawauchi, Aoba-ku, Sendai, 980-8576, Japan.
E-Mail: gyoba@sal.tohoku.ac.jp