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Stimulus Complexity and Meaningfulness Differently Affect the Viewing Duration, Recognition Performance, and Subjective Interest of the Viewer

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Abstract

The present study examines how the complexity and meaningfulness of visual materials affect viewers' interest in them. Twenty student participants viewed a total of 120 polygons with different levels of complexity (12, 24, and 48 sides) and "meaningfulness" (either high or low, based on subjective ratings made by other students). They were asked to look at these figures one by one for as long as they wished. Then, an incidental recognition test was administered wherein the original figure and a rotated version thereof were presented side by side and participants were asked to choose the original one. After the recognition test, participants rated the degree of subjective interest of each of the 120 stimuli on a 7-point scale. Results found that the more complex the stimuli, the longer the viewing time, regardless of the meaningfulness. Furthermore, the number of correct recognitions was higher for more meaningful stimuli than for less meaningful stimuli, regardless of the complexity. Subjective interest was higher for more meaningful stimuli than for less meaningful stimuli, but did not correlate with the length of viewing time. These findings suggest that viewing duration (which has often been used as a behavioral index of interest) is greatly influenced by the physical attributes of stimuli, but does not always predict subjective interest and subsequent memory performance. Rather, the results indicate that the meaningfulness of stimuli is more related to subjective interest and subsequent memory performance than complexity.

Key words: *Interest, Memory, Visual exploration, Orienting*

Introduction

Among things we encounter in everyday life, some objects interest us, while others do not. What makes objects interesting? Silvia (2005) proposed a cognitive appraisal theory of interest. This theory regards interest as an emotion and holds that interest is experienced through cognitive appraisal processes. In its simplest form, two components were assumed.

The first component is an appraisal of novelty, which is a factor related to unfamiliarity and complexity. Berlyne (1960), a pioneer of this research area, argued that four variables (called *collative* variables: complexity, novelty, uncertainty, and conflict) were related to curiosity and exploration. He demonstrated that the stimuli with these variables received a longer viewing duration than the stimuli without them (Berlyne, 1958). Similarly, Silvia (2005) conducted a free-viewing task for polygons with different complexity. Results suggested that the more complex the stimuli, the longer the viewing time. Moreover, subjective interest ratings were higher for more complex stimuli than for less complex stimuli.

The second component is an appraisal of coping potential. People tend to avoid extremely novel and complex stimuli. To explain this fact, Silvia (2005) added a second component of appraisal that is related to people's ability to understand a new thing they have encountered. When people feel they are able to understand it, their interest can be enhanced; when they do not feel they are able to understand it, their interest will be diminished.

Another line of research, education psychology, has suggested that interest is also related to memory. For example, Shirey and Reynolds (1988) presented undergraduate students with single sentences that were previously rated for interest by an independent group of students, and found that the students remembered the interesting single sentences more than they did the less interesting sentences. Little is known, however, whether this superiority effect is also obtained for other materials.

The present study examines how the complexity and meaningfulness of visual materials (i.e., polygons) affect viewing duration, recognition performance, and interest. The complexity of polygons was manipulated by changing the number of sides (12, 24, and 48 sides). The meaningfulness, which we supposed to be related to coping potential, was previously rated by an independent group, and high and low meaningful polygons were selected. First, participants were asked to look at each figure for as long as they wished. Then, an incidental recognition test was administered. Finally, a subjective rating of interest in each figure was obtained by a questionnaire. According to the cognitive appraisal theory of interest, the complexity and meaningfulness of stimuli would interactively affect the behavioral and subjective measures of interest and memory.

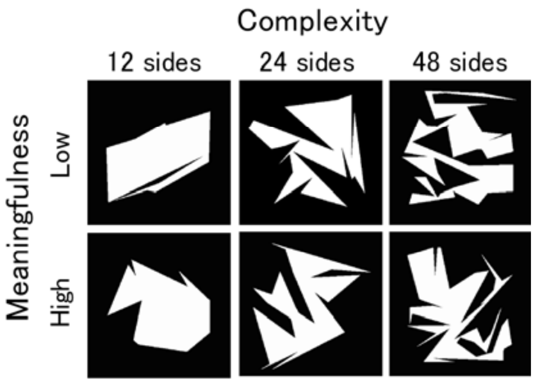

Figure 1. Examples of the stimuli used in the viewing task.

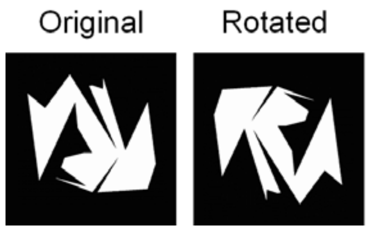

Figure 2. Examples of the stimuli used in the recognition test.

Methods

Participants

Twenty student volunteers at Hiroshima University participated in the study (10 men and 10 women, M = 21.1 years old). All participants were right-handed and had normal or corrected-to-normal sight, according to self-reports. They gave written informed consent.

Stimuli

Novel polygons with 12, 24, and 48 sides were made according to the procedure described in Wilson and Nunnally (1973). The meaningfulness of the polygons was rated using a 7-point scale (1 = *does not look like anything* to 7 = *looks like a nameable object*) by an independent group of 94 students (33 men and 61 women, M = 19.3 years old). According to the mean rating scores, 20 high meaningful polygons and 20 low meaningful polygons were selected for each complexity level so that the mean meaningfulness scores of the high and low categories did not differ significantly among the three complexity levels. The mean scores collapsed across complexity levels were 3.4 and 2.8 for high and low categories, respectively. Figure 1 shows examples of the figures. In addition, for a recognition test, a point-symmetric image of each figure was made by rotating the original figure 180°. Figure 2 shows examples of the figures. Each figure was presented on a 21-inch cathode ray tube (CRT) display. The size of the polygon was 8.8 × 8.8 cm and the visual angle was about 3.6°. The viewing distance was 140 cm.

Procedure

The experiment was performed in a dimly lit, sound-attenuated room, where participants sat on a comfortable chair. First, participants were asked to look at the 120 figures one by one for as long as they wished (free-viewing task). The stimuli were presented in a randomized order. Each stimulus disappeared when the participants simultaneously pressed two keys using both index fingers. The viewing duration was the interval between the stimulus onset and the key press and was measured in milliseconds. After the key press, the next stimulus appeared with a randomized interstimulus interval (ISI) between 800 and 1300 ms. Participants were instructed that they would be asked about their impressions of the drawings after this task, but that did not have to memorize them. Then, an incidental recognition test was administered. As shown in Figure 2, the original figure and a rotated version thereof were presented on the CRT side by side. The participants were asked to choose the original one by pressing one of the two keys. After the key press, the next stimulus appeared with a randomized ISI between 800 and 1300 ms. The stimulus order was randomized.

Both of the free-viewing task and the recognition test consisted of 3 practice trials and 120 experimental trials, which were divided into four blocks containing 30 trials each. Different polygons were used in the practice trials than were used in the experimental trials. A break of a few minutes was inserted between blocks and sessions. After the recognition test, participants completed a questionnaire in which they rated the degree of subjective interest in each stimulus on a 7-point scale (1 = *not interesting at all* to 7 = *very interesting*).

Data Reduction

The mean viewing time in the free-viewing task, the accuracy rate in the recognition task, and the mean interest rating in the questionnaire were calculated for each of six categories (i.e., three levels of complexity × two levels of meaningfulness). A Pearson's correlation coefficient between viewing time and interest rating was calculated for each participant.

Statistical Analysis

Repeated measures analyses of variance (ANOVAs) with factors of complexity (12, 24, and 48 sides) and meaningfulness (low vs. high) were performed on viewing time, accuracy rate, and interest rating data. Whenever appropriate, degrees of freedom were corrected using the Greenhouse-Geisser procedure. Post hoc multiple comparisons were made by two-tailed paired *t* tests with Bonferroni corrections. The significance level was set at .05 for all analyses.

Results

Free-Viewing Task

Figure 3 shows the mean viewing duration at each category. A Complexity × Meaningfulness ANOVA showed a significant main effect of complexity, $F(2, 38) = 14.136$, $p < .001$ $\varepsilon = .61$. Post hoc comparisons showed that the polygons with 48 sides were viewed for a longer period of time than for the polygons with 24 sides, which were viewed longer than for the polygons with 12 sides ($ps < .05$). The main effect of meaningfulness and the interaction were not significant, $F < 1$; F (2, 38) = 3.172, $p = .057$, $\varepsilon = .942$, respectively.

Recognition Test

Figure 4 shows the accuracy rate of each category. A Complexity × Meaningfulness ANOVA showed a significant main effect of meaningfulness, $F(1, 19) = 6.282$, $p = .021$, suggesting that more meaningful stimuli were recognized better than less meaningful stimuli were. The main effect of complexity and the interaction were not significant, $F(2, 38) = 1.017$, $p = .367$, $\varepsilon = .922$; $F(2, 38) = 1.363$, $p = .268$, $\varepsilon = .949$, respectively.

Subjective Rating

Table 1 shows the mean interest scores of each category. A Complexity × Meaningfulness ANOVA showed a significant main effect of meaningfulness, $F(1, 19) = 29.207$, $p < .001$, suggesting that participants felt high meaningful stimuli were more interesting than low meaningful stimuli. The interaction effect was also significant, F (2, 38) =12.409, $p < .001$, $\varepsilon = .939$. Post

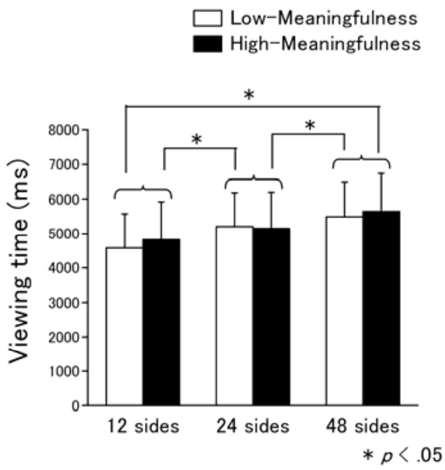

Figure 3. Mean viewing time at each category.

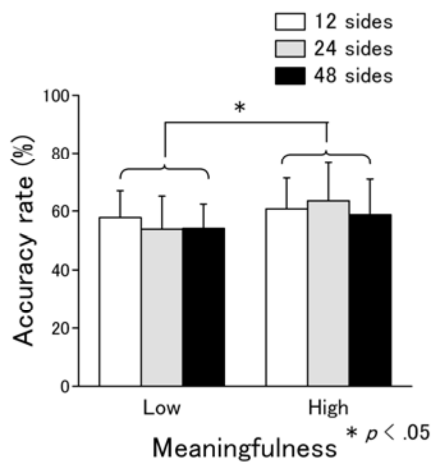

Figure 4. Mean accuracy rate at each category.

Table 1
The mean interest rating of each category

	Meaningfulness			
	Low		High	
	M	*SD*	*M*	*SD*
12 sides	3.64	0.80	3.71	0.88
24 sides	3.57	0.85	3.91	0.83
48 sides	3.54	1.05	4.05	1.00

Note: 1 = *not interesting at all* to 7 = *very interesting.*

hoc comparisons showed that participants felt high meaningful stimuli were more interesting than low meaningful stimuli for the stimuli with 24 and 48 sides, but not for the stimuli with 12 sides. The main effect of complexity was not significant, $F(2, 38) = .208$, $p = .681$, $\varepsilon = .559$. The correlation between viewing time and interest rating varied from –.41 to +.39 across participants. The mean value calculated after Fisher's Z transformation was $r = +.04$.

Discussion

The results indicate that the more complex the stimuli, the longer the viewing time. This result is consistent with previous studies (Berlyne, 1958; Silvia, 2005). However, stimulus complexity did not correlate with subjective interest nor did it affect recognition performance. On the other hand, the meaningfulness of stimuli did not affect viewing duration, but enhanced memory performance and increased subjective interest.

Although viewing duration has been used as a valid behavioral index of interest, the present study suggests that the behavioral and subjective indices may not always correspond with each other. While some studies showed that self-reported interest correlated with viewing duration (Silvia, 2006), others did not (Nittono, Shibuya, & Hori, 2007). Different indices appear to reflect different aspects of interest.

Stimulus meaningfulness affected subjective interest. In addition, the effect of meaningfulness on subjective interest was greater for the stimuli with higher complexity. This result supports the cognitive appraisal theory of interest, which states that people become interested in things that are novel as far as they are understandable (Silvia, 2005).

The accuracy rate of the recognition test was higher for more meaningful stimuli than for less meaningful stimuli, regardless of complexity. Many previous studies have reported that interest promotes learning from texts (Hidi, 2001; Shirey & Reynolds, 1988). The present study shows that this finding can be extended to materials other than texts, even without the explicit instruction of memorization.

In conclusion, the present study suggests that viewing duration (which has often been used as a behavioral index of interest) is greatly influenced by the physical attributes of stimuli, but does not always predict subjective interest and subsequent memory performance. Rather, the meaningfulness of stimuli is more related to subjective interest and subsequent memory performance than complexity.

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