1. INTRODUCTION

The mere exposure effect (MEE) is the phenomenon that repeated exposure to a stimulus promotes preference for that stimulus. Conventionally, the MEE has been observed as a result of successive presentation of a single object. This study instead examined whether the simultaneous exposure to multiple stimuli could modulate the MEE. The participants observed the stimulus display consisting of 1–25 stimulus elements and evaluated their preference for them. The results showed that the multiple element display produced a significant MEE when the stimulus elements were presented within the central visual field. More importantly, the exposure to the multiple element stimulus produced a stronger MEE when the number of elements was moderate. The present results suggest that the simultaneous exposure to multiple stimulus elements could facilitate the MEE but only when the number of stimulus elements does not exceed the capacity of processing resources.

Keywords: Mere exposure effect (MEE), Multiple exposures, Attention

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1. INTRODUCTION

The mere exposure effect (MEE) is the phenomenon that repeated exposure to a novel object increases the preference for the object [1, 2]. The most intriguing feature of this phenomenon is that mere (passive) observation promotes the positive evaluation, as suggested by the name of the phenomenon. Some studies have reported that the MEE could occur even with subliminally presented stimuli [3,4]. Originally, the MEE was reported as an increasing preference for visual stimuli [1], but it has been revealed that the MEE occurs in many sensory modalities, such as auditory, tactile, olfactory, and sense of taste domains [2,4-6].

One of the most popular hypotheses of the MEE proposes that increased fluency of stimulus processing would produce the MEE [2,7]. This kind of explanation postulates that the internal processing of the preferred stimuli is more fluent than the processing of the non-preferred stimuli. In the MEE, for example, the visual processing of a stimulus becomes more fluent with repeated exposure to the stimulus. The observers cannot distinguish between fluency achieved by the repeated exposure and fluency for the preferred stimulus. As a result, they evaluate the repeatedly presented stimulus as higher than the novel stimulus.

The perceptual fluency theory assumes that repeated stimulus processing causes the increase in processing fluency. In other words, multiple instances of stimulus processing boost the fluency and produce the MEE. In this study, we reconsider what the notion of “multiple instances” entails, which is critical to produce the MEE. In short, our question is whether simultaneous multiple exposures could produce the MEE as successive multiple exposures do.

According to the perceptual fluency theory, some manipulations in the features of the exposure stimuli, which could facilitate processing fluency, could also facilitate the MEE. For example, stimulating multiple retinal locations would facilitate processing fluency compared to stimulating a single location, if the former could provide more information to the central cognitive system. If this were the case, the MEE would be stronger for exposure to multiple objects than for exposure to a single object.

The goal of this study was to investigate the influence of multiple exposures on the strength of the MEE. As already mentioned, in previous studies, the MEE has been measured by the participants’ preference rate as a function of exposure frequency (i.e., the number of repetitive presentations of a stimulus) to a single object. On the other hand, here we assessed the preference rate not only as a function of exposure frequency but also as a function of the number of stimulus elements that constitute a single stimulus display. We predicted that if exposure to a multiple element display facilitated processing fluency, the stimulus display constituted by multiple visual elements would produce a stronger MEE than the stimulus display constituted by a single element.
2. EXPERIMENT 1

We examined whether the number of objects displayed in a single exposure could affect the strength of the MEE. In Experiment 1, participants were exposed to stimulus displays that consisted of 2, 6, or 24 elements (abstract polygonal shapes) arranged in a circular pattern.

2.1 Methods

2.1.1 Participants

Fifteen (4 male and 11 female) undergraduate students (mean age = 19.80, SD = 1.22) participated in the experiment. All participants were naive as to the current experimental purpose.

2.1.2 Apparatus and stimuli

The stimuli were presented on a 19-inch LCD monitor. The stimulus presentation and data acquisition were controlled with PsychoPy [8] installed on a PC. The stimulus display consisted of 2, 6, or 24 identical polygonal elements (Figure 1). Each element subtended about 1.3 degrees in visual angle. The elements were arranged in a circle with a 5-degree radius around the center of the stimulus display, so that all elements were presented at the same eccentricity. The element shapes were chosen with the criteria that they were difficult to verbalize and associate with familiar objects [9]. The combination of number of elements and shape of an individual element in a stimulus display was randomized across participants in order to avoid confounding their effect on preference. A fixation cross was shown at the center of the display. The stimulus color was white and the background color was gray.

2.1.3 Procedure

The experiment consisted of an exposure phase and an evaluation phase. In the exposure phase, one of six stimulus displays (two sets of 2-element, 6-element, and 24-element displays) was presented 1, 5, 10, and 25 times in random order. Thus, the number of elements in the stimulus displays was roughly equivalent to the number of repetitive presentations. That enabled us to compare the effect of element numbers with the effect of exposure frequency on the strength of the MEE. The duration of each stimulus display was 2000 ms and the inter-stimulus interval was 500 ms. In this phase, the participants’ task was just to look at the stimuli while keeping their eyes on the fixation cross.

The evaluation phase started immediately after the exposure phase. In this second phase, a single element, which was selected from the elements of the stimulus displays in the exposure phase, was shown one by one in random order (“old stimulus”). In addition, a novel element that had not been presented in the exposure phase was presented (“novel stimulus”). The shapes of the novel stimulus were chosen with the same criteria as the old stimulus and differed between participants. The size of each stimulus element in the evaluation phase was exactly same as in the exposure phase. The participants’ task in this phase was to report their preference for each element using a 7-point scale. Each element was presented until the participants made the preference report.

2.2 Results and Discussion

To assess the changes in preference induced by the repetitive and/or multiple exposures to the polygonal shapes, we subtracted the mean preference ratio for the novel stimulus from that for the old stimulus. The group means from this calculation are shown in Figure 2.

The results revealed no effect of multiple exposures on the participants’ evaluation rate of the polygonal stimuli. In addition, even the exposure frequency did not affect the evaluation rate (i.e., no MEE was obtained), although our experimental setting (e.g., the way of stimulus presentation and evaluation) in Experiment 1 was quite similar to conventional MEE studies except for the stimulus configuration. A two-way repeated measures ANOVA (3: number of elements × 4: exposure frequency) revealed
that neither the main effects of number of elements, exposure frequency, nor their interaction were statistically significant \[ F(2, 28) = 0.16, p = 0.85; F(3, 42) = 1.08, p = 0.37; F(6, 84) = 0.54, p = 0.78, \] respectively.\

### 3. EXPERIMENT 2

In Experiment 1, the polygonal elements had been presented at 5 degrees eccentricity. The spatial resolution of our visual system in the periphery is quite low, and the stimulus elements were small and had complicated shapes. Thus, this way of stimulus presentation could have been responsible for the null effects of multiple exposure and exposure frequency in Experiment 1. To exclude this possibility, we conducted Experiment 2 where the polygonal elements were presented more centrally in the visual field.

#### 3.1 Methods

##### 3.1.1 Participants

Thirty-eight (14 male and 24 female) undergraduate students (mean age = 19.68, \( SD = 1.19 \)) participated in the experiment. All participants were naïve as to the current experimental purpose.

##### 3.1.2 Apparatus and stimuli

The apparatus and stimuli were the same as in Experiment 1 except for the spatial arrangement of the polygonal elements.

The stimulus display consisted of 1, 9, or 25 identical polygonal elements arranged on an invisible square grid (Figure 3). The sizes of the square grids consisting of 1, 9, or 25 objects were 1.3, 4, and 8 arc degrees, respectively.

##### 3.1.3 Procedure

Participants observed the stimulus displays in the exposure phase and rated their preference for each object in the evaluation phase as in Experiment 1.

In the exposure phase, one of the six stimulus displays (two sets of 1-element, 9-element and 25-element displays, in which polygonal elements were different in shape) was presented 1, 5, 10, and 25 times in random order. The duration of each stimulus display was 2000 ms and the inter-stimulus interval was 500 ms.

#### 3.2 Results and Discussion

We calculated the changes in preference the same way as for Experiment 1. Figure 4 shows the mean preference modulation as a function of exposure frequency. A two-way repeated measures ANOVA (3: number of elements × 4: exposure frequency) revealed a significant main effect of exposure frequency \[ F(3, 111) = 3.46, p < 0.05. \] Neither the main effect of number of objects nor the interaction was significant \[ F(2, 74) = 1.49, p = 0.23; F(6, 222) = 0.44, p = 0.85, \] respectively.

The preference increased along with the increase in exposure frequency, suggesting the occurrence of the MEE. Thus, the absence of the MEE in Experiment 1 might have been caused by the peripheral presentation of the stimuli. However, the number of stimulus elements in a single stimulus display did not affect the strength of the MEE.

#### 4. EXPERIMENT 3

In Experiments 1 and 2, the number of elements in a stimulus display could change from trial to trial. We suspected that this might have caused the null effect of the simultaneous multiple exposures on the MEE. It has been shown that we can expand and narrow the area of our “attentional scope”. Therefore, for example, when a single object is presented in a trial, a participant’s attentional scope will be narrowed so as to focus on the single object. In a subsequent trial with a larger number of objects, the participant might attend only to one or a few stimuli within the narrowed attentional scope. This way, participants ignore the objects that are outside the attentional scope, which could have led to the null effect of multiple stimulation in the previous experiments.
To rule out this possibility, we separated the experiment into blocks, keeping the size of the stimulus display (1, 9, or 25 elements) consistent within each block. We also increased the maximum exposure frequency to 200 to test the possibility that an effect of multiple exposures would appear only for a larger number of repetitions.

4.1 Methods

4.1.1 Participants

Twenty-three (11 male and 12 female) undergraduate students (mean age = 19.96, SD = 1.00) participated in the experiment. All participants were naïve as to the current experimental purpose.

4.1.2 Apparatus and stimuli

The apparatus and stimuli in Experiment 3 were the same as those used in Experiment 2.

4.1.3 Procedure

We divided the experiment into three blocks, keeping the size of the stimulus display constant within each block (1, 9, or 25 elements). Each block consisted of the exposure phase and evaluation phase, similar to the previous experiments. Half of the participants completed the 1-element block, 9-element block, and 25-element block in that order, and the remaining half completed the experiment in the reverse order.

In the exposure phase, the stimulus display was presented for only 100 ms so that participants could not shift their gaze from one object to another. Each stimulus display was presented 1, 5, 9, 25, 50, 100, 150, or 200 times in random order. These presentation numbers were chosen so that the maximum total presentation duration (200 repetitions × 100 ms) was equal to the condition where the strongest MEE was obtained in Experiment 2 (10 repetitions × 2000 ms). The procedure for the evaluation phase was exactly the same as for Experiments 1 and 2.

4.2 Results and Discussion

We calculated the modulation of preference the same way as in Experiments 1 and 2. Figure 5 plots the mean preference modulation as a function of stimulus exposure frequency. A two-way repeated measures ANOVA (3: number of elements × 8: exposure frequency) revealed a significant main effect of the number of presentations [F(7, 154) = 6.58, p < 0.00]. As shown in Figure 5, preference increased along with exposure frequency, suggesting the occurrence of the MEE.

However, as Experiment 2, the main effect of number of stimulus elements was not significant in Experiment 3 either [F(2,44) = 0.28, p = 0.76]. Moreover, the interaction between number of elements and exposure frequency did not reach statistical significance [F(14,308) = 1.54, p < 0.10].

Again, we failed to obtain the effect of simultaneous multiple stimulation on the MEE. The results indicate that the mechanism responsible for the MEE might register only a single stimulus (location) per presentation. However, it is also possible that the difference in stimulus arrangement between exposure phase and evaluation phase might be responsible for the null effect of the multiple stimulation in Experiment 3.

5. EXPERIMENT 4

In the experiments described so far, the arrangements of the stimulus elements were quite different between exposure phase and evaluation phase. For example, in the exposure phase, the stimulus elements were arranged circularly (Experiment 1) or arranged on an invisible square grid (Experiments 2 and 3), while a single element was presented in the evaluation phase. It is possible that the participants recognized the global shape of the stimulus display in the exposure phase (i.e., large circle in Experiment 1 or large squares in Experiments 2 and 3) and did not recognize the shape of individual stimulus elements. This might have caused the null effect of multiple exposures.

To test this possibility, we presented multiple stimuli not only in the exposure but also in the evaluation phase with the same stimulus arrangement as in Experiment 4.

5.1 Methods

5.1.1 Participants

Sixteen (5 male and 11 female) undergraduate students (mean age = 20.38, SD = 1.54) participated in the experiment.
5.1.2 Apparatus and stimuli

The apparatus and stimuli in Experiment 4 were the same as those used in Experiment 3.

5.1.3 Procedure

In this experiment, the stimuli in the evaluation phase were exactly the same as those in the exposure phase. That means, for example, if the stimuli consisted of 25 elements presented in the exposure phase, the participants evaluated stimuli consisting of 25 elements in the exposure phase as well. All other procedural aspects were the same as those in Experiment 3.

5.2 Results & Discussion

We calculated the modulation of preference the same way as for Experiment 3. Figure 6 plots the mean preference modulation as a function of stimulus exposure frequency. A two-way repeated measures ANOVA (3: number of elements × 8: exposure frequency) revealed a significant main effect of the number of elements \[ F(2, 30) = 4.77, p < 0.00 \]. Multiple comparison with the Ryan’s method found significant differences between the 1- and 9-element condition and between the 9- and 25-element condition \( (p < 0.05) \). The 9-element condition produced a significantly stronger MEE than the 1- and 25-element conditions. The main effect of the number of presentations was significant, indicating the occurrence of the MEE \[ F(7, 105) = 4.59, p < 0.01 \]. The interaction between number of elements and exposure frequency was not significant \[ F(14, 210) = 0.43, p = 0.97 \].

To evaluate the facilitation of the MEE via simultaneous exposure to multiple stimuli, we also compared the slopes of the regression lines between the 1-, 9-, and 25-element conditions. The slope of each observer was calculated with the exposure frequency (0, 1, 5, 9, 25, 50, 100, 150, and 200) and means of evaluation points obtained for the stimulus presented for each frequency. Table 1 shows the group means of the calculated slopes, with larger slopes indicating faster increments of MEE strength with increasing exposure frequency.

A one-way repeated measures ANOVA with the factor of number of stimulus elements (1, 9, and 25) was conducted with the mean slope values of individual observers. The results again revealed the effect of multiple exposure on MEE strength. The main effect of the number of stimulus elements was significant \[ F(2, 30) = 4.34, p < 0.05 \]. The multiple comparison with Ryan’s methods revealed that the slope was steeper in the 9-element stimulation condition than in the 1-element and 25-element stimulation conditions. We also conducted the same slope analysis with the data from Experiments 1, 2, and 3 but found no significant effect of the number of stimulus elements on the slope of the regression lines \( (p > .1) \).

We obtained a stronger MEE when the stimulus display consisted of 9 elements both in the exposure phase and evaluation phase compared with the effects obtained in the single element condition. The results suggest that multiple exposures may facilitate the MEE. However, the MEE obtained with the 25-element stimulus was not stronger than the MEE obtained with the single element stimulus. The results suggest that the effect of simultaneous exposure to multiple stimuli on the MEE would depend on the number of elements in the stimulus display. We will discuss this point later.

6. GENERAL DISCUSSION

The goal of this study was to clarify whether simultaneous exposure to multiple objects, rather than repeated presentation of a single object, could modulate the strength of the MEE. We predicted that if the mechanism responsible for the MEE received multiple signals from different retinal locations, the MEE would be stronger when participants were exposed to multiple stimulus elements than when they were exposed to a single element stimulus. Our results suggest that simultaneous multiple exposure to visual stimuli could indeed facilitate the MEE.

In Experiment 1, we presented multiple stimulus elements in the peripheral visual field. In this experiment,
even the effect of exposure frequency on preference ratings was non-significant. Thus, even the MEE (i.e., an increase in preference due to repetitive stimulus exposure) itself was not observed. This negative result might be attributable to the peripheral stimulation during the exposure phase, since the MEE was obtained with the multiple element stimuli when the elements were arranged in the central visual field (Experiment 2). However, in Experiments 2 and 3, exposure to multiple element stimuli did not facilitate the MEE, even when multiple stimuli were presented in the central visual field. The null effect of multiple exposure might be caused by the changes in the stimulus arrangements between exposure and evaluation phase. In Experiments 2 and 3, the observers always evaluated the preference of a single stimulus element even if the stimulus was presented as a multiple array in the exposure phase. Indeed, when the stimulus display consisted of 9 elements in the evaluation phase as well as the exposure phase, the stimulus received higher preference scores than the single element stimulus display (Experiment 4). The results indicate that the multiple stimuli facilitated the MEE but only if the evaluation display also consisted of multiple stimuli. In other words, the effect of multiple exposure might be context dependent, that means, the multiple exposure could facilitate the preference of the multiple element display, but this effect could not be adapted to the single stimulus element.

In our experiment, the effect of multiple exposure was obtained only with the 9-element display and not with the 25-element display. This suggests a trade-off between the multiple exposure effect and attentional resource allocation in the MEE. We need more resources to process multiple objects in the visual field. Meanwhile, it has been shown that the MEE only occurs for stimuli to which participants pay attention [10]. This suggests that the MEE occurs only when enough attentional resources have been allocated for stimulus processing. Thus, the multiple stimuli could elude the facilitation effect if the number of stimuli in a display exceeds attentional capacity. This might explain the null effect of multiple exposure in the 25-element condition in Experiment 4. In addition, the failure to obtain the MEE in Experiment 1 could also be explained by the lack of attention to the peripheral stimuli.

7. CONCLUSION

At least one of the current experimental settings of simultaneous exposure to multiple objects did facilitate the MEE. The results indicate that the mechanism responsible for the MEE could register multiple stimulus signals from the single exposure to a stimulus display. Our results also suggest that the allocation of spatial attention might be important to obtain the MEE [10]. In conclusion, our results revealed the effect of multiple exposure on the MEE for the first time, and suggest that the trade-off between the multiple exposure effect and attentional resource allocation might influence the strength of the MEE.

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