A Study on Preference of Physical Size of Motion Pictures by Methods of Experimental Psychology

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ABSTRACT

The size of screens of video display devices has expanded for years. We investigated factors affecting preference on the physical size of motion pictures by methods of experimental aesthetics and revealed that the longer viewing distance increased preferred size regardless of screen size.

1 INTRODUCTION

Screens of television and other visual display devices have been expanding over the past few decades. Retinal size of their video content also has continued to expand. The human visual system has different qualitative and quantitative characteristics depending on an eccentricity of a retina [1-3], therefore perceptual experience can be considered to alter as the image is magnified on a retina. Filmmakers' production methods also reflect this, but there is no scientific support for them.

On the other hand, such video production is thought to reflect human preferences for images. The field of research on mechanisms of visual aesthetic judgments and preferences is called experimental aesthetics, and it has been attracting a great deal of attention in recent years. The relationship between various visual features and aesthetic judgments and preferences has been studied in this field [4]. These visual preferences often influence our behavior. For example, where to sit in a movie theater, where to stand in a museum, or where to move an item to get a better view of is often related to a visual preference for size.

There are several studies on the visual preference for the size of objects in an image [5-8] showing that the real-world sizes of objects are well related. It was reported that small objects (e.g., strawberries and keys) were preferred to be drawn small in a frame, while large objects (e.g., a piano and a car) were preferred to be drawn large in a frame. It was also shown that the preferred image size was proportional to the logarithm of the size in the real-world [6-8]; this phenomenon was called the canonical size effect.

However, they [6-7] only used images of a single static object and did not include natural images with backgrounds or moving images. Our previous study [8] found the canonical-size effect even in the motion pictures of natural scenes and revealed also that longer viewing distance enlarged the preferred image size. However, since only a single size of the screen was used, details of the mechanisms were not clarified.

In this study, we used experimental psychological techniques to measure the size preference of images, i.e., preferred displaying angle of view, and investigated the factors affecting this preference by examining the effects of viewing environment by using three different sizes of screens and the two different viewing distances. The effects of the content of the images were also investigated. To preserve the generalizability of the results avoiding from specificity derived from the used material, we collected and created 100 different natural motion pictures and quantitatively examined the effects of varieties among the materials using statistical methods. Besides, 8K-resolution motion pictures were used as stimuli to avoid loss of image quality even when the image was enlarged.

All participants of the experiments were paid for their participation and provided written informed consent prior to the experiment, in keeping with the 1964 Declaration of Helsinki. The study was approved by the ethics committee on human research of Japan Broadcasting Corporation.

2 EXPERIMENT 1

The physical size of the motion picture which is perceived appropriate was estimated as a preferred displaying angle of view by using a classical psychophysical method, a method of constant stimuli.

2.1 Methods

Stimuli

One-hundred motion pictures (5 secs., 7,680×4,320 pixels, uncompressed) containing people, objects, and landscapes were used as the material. By resizing down from 25% to 100% in 7 steps of 12.5%, 700 moving images were generated (Fig. 1). All moving images were presented once in a randomized order in the experiment.

Apparatus

Three different sizes of screens were used to display the stimuli. A 55-inch (W123cm, H69cm) and an 85-inch (W190cm, H106cm) diagonal 8K resolution liquid crystal display (LCD) and a 300-inch (W670cm, H375cm)

screen with an 8K resolution projector were used. Two viewing distance conditions were set for each of the three screens, 0.75 and 1.5 times the height of each screen (Table 1).

Fig. 1 Process to produce stimuli. Reprinted from our previous study [8] under CC BY-NC-ND 4.0.

Participants

A between-participant design was adopted, where different groups of participants were engaged in the experiment for each of the six conditions, which were determined by the three sizes of the screens and the two viewing distances. The number of participants in the 0.75H condition was 85, 98, and 72, and 77, 77, and 77 in the 1.5H condition; for 55, 85, and 300-inch screens, respectively. The participants were adults who had a normal or corrected-to-normal vision with contact lenses.

Table 1 Viewing distance (cm) and screen size. H represents a length of screen height.

	55″	85″	300″
0.75H	52	80	281
1.5H	103	160	562

Procedures

In each trial, the visual stimulus of motion images was first displayed in the center of the screen for 5 secs., followed by a black screen. After the disappearance of the stimulus, participants reported their size preference. They reported whether they preferred watching the stimulus in a larger or smaller physical size than that shown (i.e., two-alternative forced-choice task: shrinking or enlarging) by pressing one of two buttons. The procedure is the same as our previous study except for the number of trials [8].

Analysis of data

A sigmoid function was fitted to response ratios against stimulus size for each motion picture, and the 50% response point was obtained as the preferred size for that picture (Fig. 2). The analyses were performed for each condition separately.

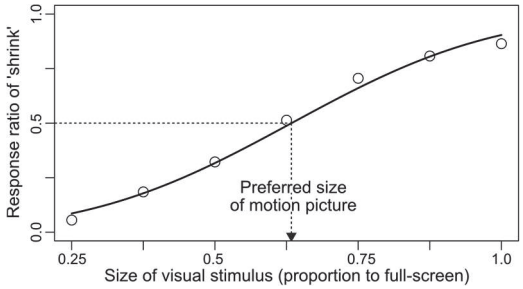

Fig. 2 Calculation of preferred size

2.2 Results & Discussions

All participants' responses were averaged for each of the 100 motion pictures, and the physical size (scaling ratio to the full-screen display) which induced a 50% response ratio was defined as a preferred size of the motion picture. The distribution of the preferred sizes for each screen size and viewing distance is shown in Fig. 3. An analysis of variance revealed a significant effect of the viewing distance, $F(1, 480) = 34.51$, $p < .0001$, $\eta^2 = 0.067$. Effects of the screen size, $F(2, 480) = 0.30$, $p = .74$, $\eta^2 = 0.001$, and the interaction between them, $F(2, 480) = 1.60$, $p = .20$, $\eta^2 = 0.007$ were not significant. The effect of the viewing distance on the individual motion pictures is shown in Fig. 4. The dots correspond to the individual pictures, the dotted line indicates constant preferred size on screens, the dashed line indicates constant preferred size on the retina, and the solid line indicates the regression line between the two viewing distances. The regression line was located above the dotted line with an almost similar slope as the dotted line, and it was shown that the preferred sizes of all pictures expanded at the longer viewing distance. The average of the ratios of each picture's preferred size between the two viewing distances was 1.23. This indicates that the preferred size at the viewing distance of 1.5 H is about 23% larger than that at 0.75 H.

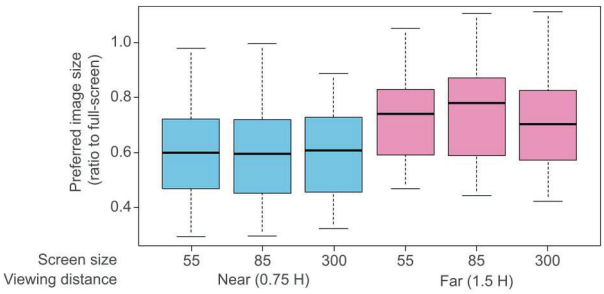

Fig. 3 Distributions of the preferred size

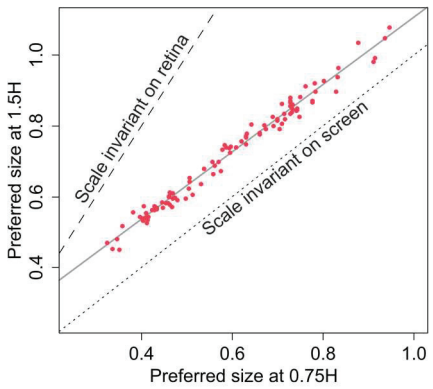

Fig. 4 Relationship between the averaged preferred size and the viewing distances

3 EXPERIMENT 2

Experiment 1 revealed that the viewing environment affected the size preference. In Experiment 2, we investigated the effects of the contents of the motion pictures, especially the main subjects within the images. We asked participants to identify the area in the motion pictures that can be considered main subjects and to estimate the real-world size of the area. We investigated the relationship between the estimated size and the preferred size obtained in Experiment 1.

3.1 Methods

Participants

Fifty adults with normal or corrected-to-normal vision participated in the experiment. They did not participate in Experiment 1.

Stimuli

The 100 motion pictures used in Experiment 1 were resized to 2K-resolution, compressed in MPEG-4 format, and used in Experiment 2.

Apparatus

PCs equipped with a 21-inch display were used to display stimuli and obtain responses. The experiment was performed in a normally lit room

Procedures

The participants first observed a motion picture displayed full-screen, and then a specific frame within the picture shown as a still image. They traced the area considered as the main subject with the mouse dragging and indicated the real-world size of the area by using a slider. This procedure was performed for five frames per motion picture.

3.2 Results and discussion

The averages of the real-world sizes of main subjects for each motion picture were obtained and its logarithms were found strongly correlated to the preferred sizes averaged over the screens and viewing distances, r = 0.779, $p < .0001$, $R^2_{adj}=0.603$ (Fig. 5).

This result shows that the canonical size effect was observed also in motion pictures of natural images with background areas as well as in still images of a single stationary object [6-7].

A multiple regression analysis on the preferred size averaged over the screens with the real-world size of the main subjects and the viewing distance revealed that the real-world size, $p < .0001$, and the viewing distance, $p < .0001$, showed significant correlation without an interaction, $p = .599$, $R^2_{adj}=0.6215$. Therefore, it is suggested that the canonical size effect and the viewing distance effect would occur simultaneously and independently.

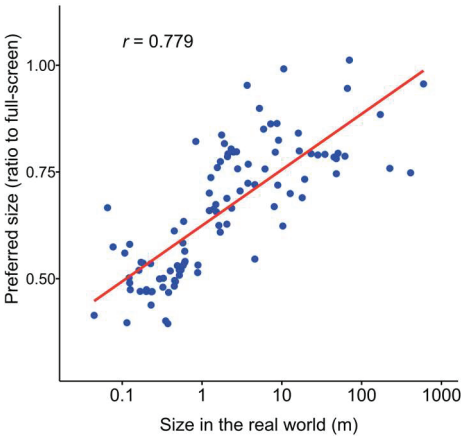

Fig. 5 The relationship between the real-world size of the main subject and the preferred size

4 GENERAL DISCUSSION

In this study, we measured the preferred physical size of the motion pictures by using psychophysical methods and investigated the mechanism of this preference. As a result, it was found that the viewing environment and the content of the motion pictures affected the preference. It was found that the preferred size was affected by the relative viewing distance, and the preferred size was about 23% larger when the viewing distance was doubled.

The logarithm of the real-world size of the areas assessed as main subjects in the pictures showed a strong positive correlation with the preferred size. This trend looks similar to the canonical size effect shown in the previous studies [6-7] using the still images of single objects without background areas. Therefore, it was suggested that we could predict the size preference of the motion pictures to a considerable extent depending on the real-world size of the main subject.

These results suggest that it would be helpful to take these factors into account when creating motion pictures that are preferred by viewers. In recent years, it has become common to create motion pictures by cropping rectangular regions from omnidirectional images, and it

may be possible to automate this processing by using our findings. However, these findings were obtained completely isolated from the context of the preceding and following, so the filmmaker's intention should be given greater priority.

According to the interviews conducted by the authors to TV program producers, it was reported that they assumed the size of the screen for typical viewers and adapted their pictures to that size and that the assumed size had been getting gradually larger. The results of Experiment 1 showed that the size of the screen did not affect the preferred size, which at first glance seems to contradict the expertise of the TV program producers. However, several previous studies have reported that the preferred viewing distances vary depending on the size of the screen [9-11]. These studies showed that the growth of the preferred viewing distance was slower than the growth of the screen size, i.e., the larger the screen size, the relatively shorter viewing distance was preferred. Therefore, the TV program producers' expertise was supported by combining these studies and our findings.

In addition, a study that investigated the relationship between screen resolution and preferred viewing distances [12] reported that shorter viewing distances were preferred for images with higher resolution, even when the screen size was the same. Therefore, it is suggested that both larger size and higher resolution of the display system would tend to shorten the viewing distance, and together with our findings of this study, it is suggested that the creation of pictures considering these factors may be preferable for the production of high-definition images for large screens.

5 CONCLUSIONS

We investigated the factors affecting the preference of physical size of motion pictures by methods of experimental aesthetics. We measured the preferred size of a displaying angle of view of motion pictures and examined the effects of viewing environments and content of the pictures. The longer viewing distance increased the preferred size regardless of the screen size. The logarithm of the real-world size of objects assessed as main subjects in the pictures showed a strong positive correlation with the preferred size. This suggests that even in the motion picture of the natural image canonical size effect would occur. Previous studies [9-11] investigating the preferred viewing distance revealed that the relative viewing distance becomes shorter when the screen becomes larger. By combing this finding with our data, it was suggested that for the larger screen the smaller motion pictures would be preferred.

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