

# Influence of High-resolution 4K Displays on Psychological State During Content Viewing

Kiyomi Sakamoto<sup>1</sup>, Seiji Sakashita<sup>1</sup>, Kuniko Yamashita<sup>2</sup>, and Akira Okada<sup>2</sup>

<sup>1</sup>R&D Division, Panasonic Corporation, 3-1-1 Yagumo-nakamachi, Moriguchi City,  
Osaka 570-8501, Japan

{sakamoto.kiyomi, sakashita.seiji}@jp.panasonic.com

<sup>2</sup>Department of Human Life Science, Osaka City University, 3-3-138 Sugimoto,  
Sumiyoshi-ku, Osaka, 558-8585 Japan

{yamasita,okada}@life.osaka-cu.ac.jp

**Abstract.** We experimentally investigated the influence of high-resolution images on viewers' psychological state while viewing content at 4K and 2K on a 65-inch 4K TV. Their scores for "presence," "relaxed," "natural," "liked," "comfortable" and "precise" when viewing 4K scenic content were significantly higher than those for 2K content. Our results suggest that, when using a large (65-inch) screen, viewing 4K scenic content affords greater psychological refreshment and lower stress than when viewing similar material at 2K resolution.

**Keywords:** Emotional states, psychological measurements, high resolution 4K TV, TV viewing.

## 1 Introduction

Bigger and higher-definition screens and longer TV viewing times due to changing TV viewing styles, which are becoming more diverse due to broadening content, such as video games and Web pages in addition to conventional TV programs, make it increasingly necessary to consider the effects of these changes on visual fatigue and health. To develop TVs that keep visual fatigue to a minimum and to be able to propose optimum TV viewing conditions, these factors need to be investigated in addition to the conventional focus on image quality and presence. In modern society, people are exposed to different levels and types of stress that have major effects on them both physiologically and psychologically, making it increasingly important to reduce stress. The physiological and psychological relaxation effects caused by exposure to scenes of nature are attracting growing research interest, and several studies have been carried out on the beneficial effects of short walks in the forest and of viewing rose blooms [1]. High-definition TV technology, such as for 4K TV and 8K TV, continues to progress, but it is also important to ensure that HDTV has no negative impact on visual or general health by minimizing any visual fatigue or stress that might be caused by very high image quality and presence. We therefore explored and evaluated the influence of high-resolution 4K displays on psychological state during content viewing.

## 2 Methods

**Subjects.** Ten adults aged in their 20s participated in this experiment.

**Measurements:** The following items were investigated.

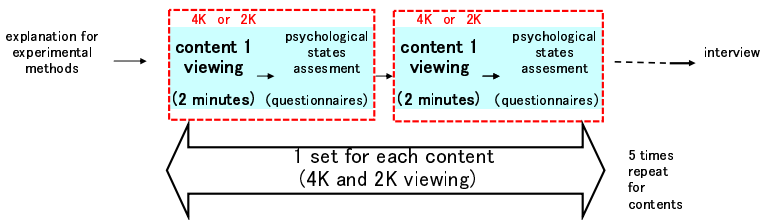
Participants’ psychological state, reported on a scale of 3 to -3 for 21 items, including “stressed-relaxed,” “presence-no presence,” “comfortable-uncomfortable,” and “like-dislike.” These psychological items were defined in the light of the results of pilot experimental interviews and those of our prior studies (Table 1).

### Apparatus

1. The display device was a 65-inch 4K TV (Panasonic TH-L65WT600).
2. The viewing distance was set at 1.5H (120 cm). Screen-to-eye distance was defined in relation to screen height (H). The recommended viewing distance for the 4K TV, defined as 1.5 times the display’s height for a 65-inch display, was 120 cm.
3. Test room illumination was set at 200 lx to simulate the average light level of a Japanese living room, based on JIS standardization.

**Procedure:** The participants engaged in TV viewing of five types of video content: three types with scenic content, including nature scenes and urban built-environment scenes, and two types of close-up of food and material content, including jewel, watch, fur and glass; etc. Each program comprised 2 minutes of 4K and 2 minutes of 2K content. After viewing each program, the participants gave a subjective assessment of their psychological state (“stressed-relaxed,” “presence-no presence,” “comfortable-uncomfortable,” “like-dislike,” etc.), on a score of 3 to -3 (Figure 1) (Table 1). To eliminate the order effect, the order of content and 4K or 2K resolution in the program were made different for each participant.

**Statistical analysis:** A paired t-test was performed to statistically analyze the influence of the high-resolution 4K displays on the subjects’ psychological state while viewing different types of content. The level of significance was set at  $p = 0.05$ .



**Fig. 1.** The process of the viewing test using five types of content

**Table 1.** Subjective assessment items

Subjective assessment items (including 21 items)
Qualitative assessment of high resolution
“sharp focus–no sharp focus,”
“precision–lack of precision,”
“precise–coarse,”
“natural–artificial,”
“looks like a real object–doesn’t look like a real object,”
“clear–not clear,”
“realistic–not realistic,”
“dynamic–static,”
“feeling of depth–no feeling of depth”
“high quality–low quality,”
Emotional assessment of high resolution
“presence–no presence,”
“feeling of invigoration–no feeling of invigoration,”
“feeling of congruity– feeling of incongruity”
“impact–no impact,”
“good–bad,”
“comfortable–uncomfortable,”
“enjoyable–boring,”
“relaxed–stressed,”
“like–dislike,”
“aroused–sleepy,”
“no visual fatigue–visual fatigue”

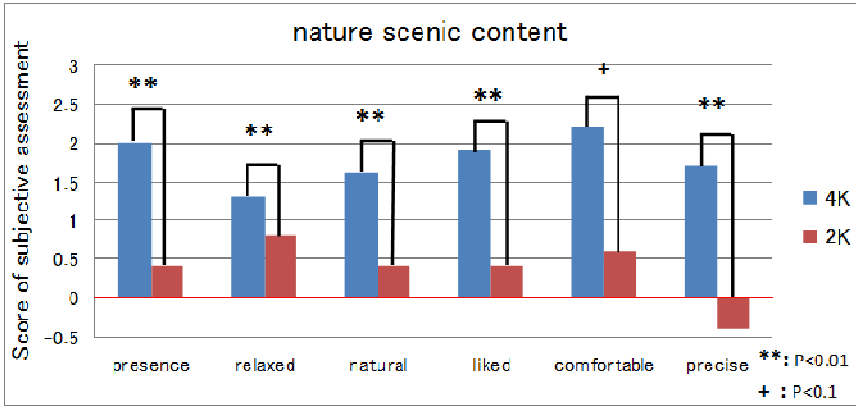
### 3 Results and Discussion

The results showed that the scores for “presence,” “relaxed,” “natural,” “liked,” “comfortable” and “precise” when viewing 4K scenic content, including nature scenes and urban built-environment scenes, were significantly higher than those for 2K scenic content (Figure 2). The participants may have felt as if they were viewing a real scene through a window when viewing 4K high-definition content on a large-screen TV. Conversely, when viewing close-up images of material content at 4K, only the score for “precise” was significantly higher than the corresponding scores for close-up images of material content at 2K, and the score for “natural” of 4K content tended to be higher than that for 2K (Figure 3). No significant differences were observed between the scores for 4K and 2K for food content. It is possible that these

results were caused by a sense of incongruity on the part of the subjects due to the much greater size of the displayed items than the same items in real life.

In brief, the positive scores for the majority of the psychological indices for 4K were significantly higher than those for 2K. Our results suggest that, when using a large (65-inch) screen, viewing 4K scenic content affords greater psychological refreshment and reduced stress than when viewing similar content at 2K resolution.

Further investigations will be needed to gain a more precise picture of the influence on psychological state of high-resolution 4K displays.



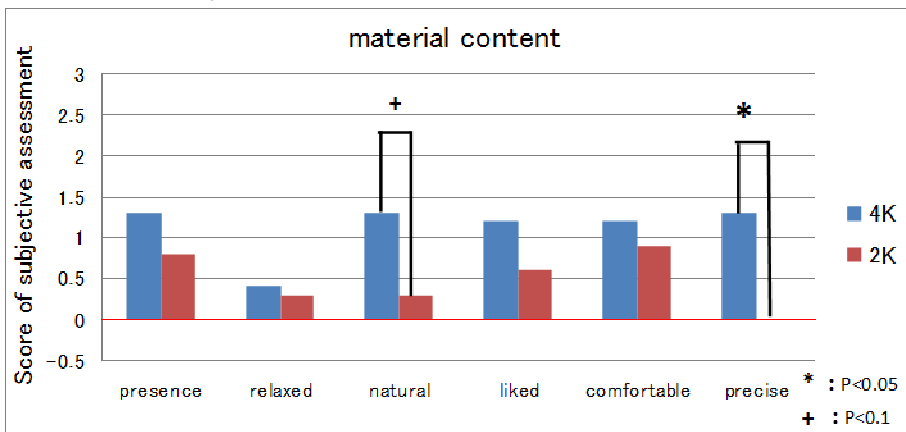
**Fig. 2.** Mean scores of subjective assessments at 4K and 2K when viewing nature scenes. (Eight participants)

A higher score indicates a more positive evaluation.

\*\* :  $p < 0.01$ , + :  $p < 0.1$

X-axis (subjective assessments at each resolution)

Y-axis (score of subjective assessments)



**Fig. 3.** Mean score of subjective assessment at 4K and 2K when viewing close-up images of material content (Eight participants)

A higher score indicates a more positive evaluation.

\*:  $p < 0.05$ , +:  $p < 0.1$

X-axis (subjective assessments at each resolution)

Y-axis (score of subjective assessments)

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