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INFLUENCE OF *KANSEI* FACTORS INCLUDED IN MOTION INFORMATION ON *KANSEI* EVALUATION
– INVESTIGATION OF MULTIPLE EFFECTS BY HORIZONTAL CONTACT MOVEMENT AND CAMERAWORK–

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ABSTRACT

In most mobile information device interfaces, due to the limitations of hardware and software it is difficult to obtain feedback from the movement information to the observer's body sensations, and it is often pointed out that it is not easy for the observer to achieve ‘Presence’. This study focused on the *kansei* factors included in movement information by investigating the complex effects of the combination of different modes of expression, in order to understand how each motion pattern influences the observer's evaluation when the movement image is displayed by a mobile information device interface. We used bioinstrumentation for the subjective assessment of brain waves and a 5-step evaluation process. The results showed that the increase in the potential, were centered on FP1 and FP 2 depended on whether the image contents moved or not, and that the evaluation by the brain waves was connected with the pattern of movement at a certain level.

Keywords: ***Kansei* evaluation, Motion information, Bioinstrumentation**

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1. INTRODUCTION

In the imaging technology field, display systems such as stereoscopic displays [1] and multiview displays [2] are being developed to enhance the perceived realism of dynamic images, and the entertainment industry is continuing to develop first-person viewpoint [3] and intuitive control systems [4]. However, it is difficult to send motion-related feedback to the observer of the dynamic images when there are software and hardware limitations, such as in the interface of an information device. Motion itself is therefore a factor when evaluating realism, in addition to time and other special factors.

This study focused on *kansei* (sensibility) factors within the motion itself, investigating the effects of different modes of expression, other than the motion patterns, on the perceived realism of dynamic images. Subjective evaluations, evaluations through brain waves, and *kansei* evaluations were used for this research.

2. METHODOLOGY

Various efforts have been made to evaluate perceived realism by utilizing bioinstrumentation, but the repeatability of quantitative measurements is often an issue [5]. Acknowledging individual differences between the observers, the present study focused more on how each person perceives, as opposed to repeatability of the data. This led us to use an electroencephalogram (EEG) (Neurofax EEG-1100), which has good time-resolving capability that facilitates event-related potential (ERP) measurements for visual stimuli.

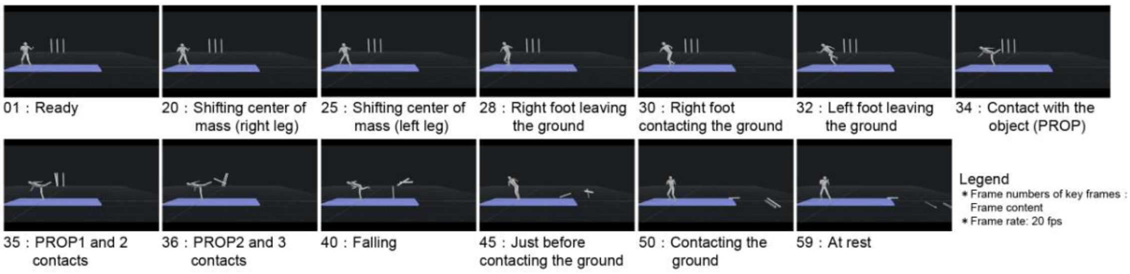
External multisensory integration of factors such as time, spatial, and bodily factors, in addition to internal image retention, are often considered to be the defining factors of perceived realism [6]. As the first step, a preliminary experiment to ensure the effectiveness of the experimental and measurement methods was conducted. In the preliminary experiment, spatial effect (depth), which is a spatial factor, and sense of motion (sense of change, flight), which is a time factor, were combined into a single attribute. The tracking effect was considered in multiple views for different camera angles using a third-person viewpoint to allow observation of the overall images (Figure 1).

Point of view	Depth	Movements	Tracking by camera
. First person . Third person	. Yes . No	. Character only (referred to as "chara" hereafter; movement self-directed) . Object only (referred to as "prop" hereafter; movement through external factors) . Combinations — Chara + prop (Movement of chara / Movement of prop; Influence; Mutual influence); Multiple characters; Multiple props (Or objects moved with some form of intention)	. Chara . Prop . No tracking

Figure 1: Scope of preliminary experiment

3. CREATION OF STIMULI

In this study, the objects in motion were divided into two separate categories. One category represents individual movements of a single character (self-directed) or a single object (directed by external factors), and the other category represents compound movements of multiple characters or multiple objects with a subcategory of a character and an object affecting each other. Two different movements (Action01 and Action02), which are induced by contact events, were used in the preliminary experiment. In these movements, the direction of the force when the character and the object contacted each other was set to horizontal (Figure 2). Key frames were designated in 13 and 18 locations, respectively, in order to observe changes in the brain waves when observing the movements. The stimulus animations were displayed at a rate of 20 frames per second.



*Action01: The object (PROP) receives a horizontal force (EVENT) due to the movement of the character (CHARA), and the object starts moving. The contact point was set to the center of mass of the object.

*Action02: The character (CHARA) and the object (PROP) contact each other (EVENT) with opposing movements. The vehicle is an object that is being moved with some intention, but it is treated as an object.

Figure 2: Two examples of the animations (in default condition/no camera tracking)

Each factor was combined using the items underlined in Figure 1, and using Action01 and Action02, animations were rendered with 30 different patterns. These animations served as the stimuli. Note that combining all items would generate 36 patterns, but six side-view patterns with symmetry were eliminated, thus resulting in the final count of 30 patterns (Table 1).

Table 1: Combinations of items

ACTION 01										
Evaluation number	Rendering number (randomized)	Depth	Camera tracking			View				
			Character	Object	No tracking	Left/right	Front	Back	Top	Bottom
1	16	0	0	1	0	0	0	1	0	0
2	7	0	0	0	1	0	1	0	0	0
3	4	0	0	1	0	1	0	0	0	0
4	20	1	0	0	1	0	0	0	1	0
5	24	1	0	1	0	0	0	0	1	0
6	1	0	0	0	1	1	0	0	0	0
7	27	0	1	0	0	0	0	0	0	1
8	25	0	0	0	1	0	0	0	0	1
9	23	1	1	0	0	0	0	0	1	0
10	18	1	0	1	0	0	0	1	0	0
11	19	0	0	0	1	0	0	0	1	0
12	8	1	0	0	1	0	1	0	0	0
13	30	1	0	1	0	0	0	0	0	1
14	12	1	0	1	0	0	1	0	0	0
15	11	1	1	0	0	0	1	0	0	0
16	15	0	1	0	0	0	0	1	0	0
17	9	0	1	0	0	0	1	0	0	0
18	2	1	0	0	1	1	0	0	0	0
19	14	1	0	0	1	0	0	1	0	0
20	22	0	0	1	0	0	0	0	1	0
21	13	0	0	0	1	0	0	1	0	0
22	3	0	1	0	0	1	0	0	0	0
23	10	0	0	1	0	0	1	0	0	0
24	26	1	0	0	1	0	0	0	0	1
25	5	1	1	0	0	1	0	0	0	0
26	21	0	1	0	0	0	0	0	1	0
27	6	1	0	1	0	1	0	0	0	0
28	28	0	0	1	0	0	0	0	0	1
29	17	1	1	0	0	0	0	1	0	0
30	29	1	1	0	0	0	0	0	0	1

ACTION 02										
Evaluation number	Rendering number (randomized)	Depth	Camera tracking			View				
			Character	Object	No tracking	Left/right	Front	Back	Top	Bottom
1	29	0	0	1	0	0	0	0	0	1
2	27	0	1	0	0	0	0	0	0	1
3	10	1	0	0	1	0	1	0	0	0
4	18	0	0	1	0	0	1	0	0	0
5	11	0	1	0	0	0	0	1	0	0
6	14	1	0	1	0	0	1	0	0	0
7	25	0	0	0	1	0	0	0	0	1
8	2	1	0	0	1	1	0	0	0	0
9	12	0	1	0	0	0	1	0	0	0
10	28	1	1	0	0	0	0	0	0	1
11	3	0	1	0	0	1	0	0	0	0
12	22	1	1	0	0	0	0	0	1	0
13	9	1	0	0	1	0	0	1	0	0
14	20	1	0	0	1	0	0	0	1	0
15	7	0	0	0	1	0	0	1	0	0
16	15	1	1	0	0	0	0	1	0	0
17	4	1	1	0	0	1	0	0	0	0
18	6	1	0	1	0	1	0	0	0	0
19	13	1	0	1	0	0	0	1	0	0
20	17	0	0	1	0	0	0	1	0	0
21	23	0	0	1	0	0	0	0	1	0
22	1	0	0	0	1	1	0	0	0	0
23	5	0	0	1	0	1	0	0	0	0
24	16	1	1	0	0	0	1	0	0	0
25	8	0	0	0	1	0	1	0	0	0
26	19	0	0	0	1	0	0	0	1	0
27	21	0	1	0	0	0	0	0	1	0
28	30	1	0	1	0	0	0	0	0	1
29	24	1	0	1	0	0	0	0	1	0
30	26	1	0	0	1	0	0	0	0	1

4. EXPERIMENT

Two male university students received explanations of the experiment and its procedures, and agreed to participate.

The subjects, wearing an electroencephalographic cap, were asked to sit in a comfortable chair and assume a relaxed posture in order to minimize the effects of myoelectrical activity as much as possible. The experiment was conducted in such a way that the subjects would not need to move while observing the stimuli, as they did not need to manipulate the monitor displaying the animations (Figure 3).

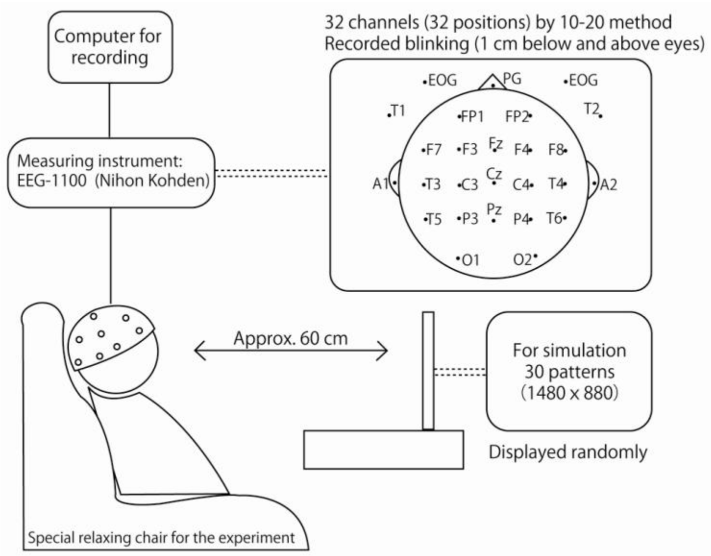
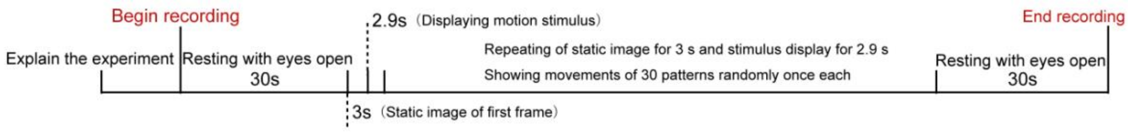


Figure 3: Experimental setup

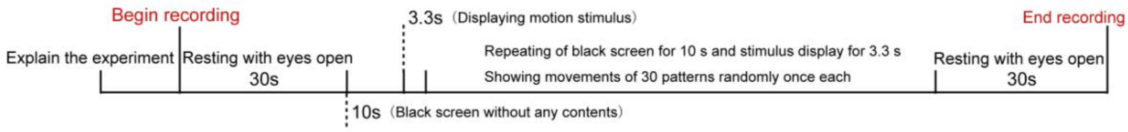
The stimuli were displayed on a 1480 x 880 pixel screen without any background images. The screen was placed at a distance of approximately 60 cm from the subjects. All objects other than those required for the experiment were removed from the view of the subjects. Because it has been pointed out that there is a correlation between the size of the screen that displays stimuli and perceived realism by the subjects, the screen used for this experiment was a small 15-inch screen, since the target application of this experiment is an information device with hardware limitations.

The 10-20 method was used for positioning the electrodes of the electroencephalograph. Thirty-one positions were measured using 32 channels (Figure 3). Electrodes were positioned 1 cm above and below the eyes of the subjects to measure the myoelectricity generated from blinking. In order to establish baselines, the two types of motions were shown to the subjects in a different manner. For Action01, the first frame of each animation was shown for 3 seconds, and then the actual animation was shown for 2.9 seconds. For Action02, a black screen was shown for 10 seconds, and then the animation was displayed for 3.3 seconds. For each action, 30 patterns were randomized and shown once per pattern (Figure 4).

After the stimuli had been shown, the same motions were shown again to the subjects after the brain wave equipment had been removed. They were then asked to rate the motion patterns on a 5-point scale based on the realism of the motions.



*Action01: Shows 2.9 seconds of the stimulus 3 seconds apart. The image of the first frame of the next animation is shown statically when the stimuli are not displayed.



*Action02: Shows 3.3 seconds of the stimulus 10 seconds apart. A black screen without any contents is shown when the stimuli are not displayed.

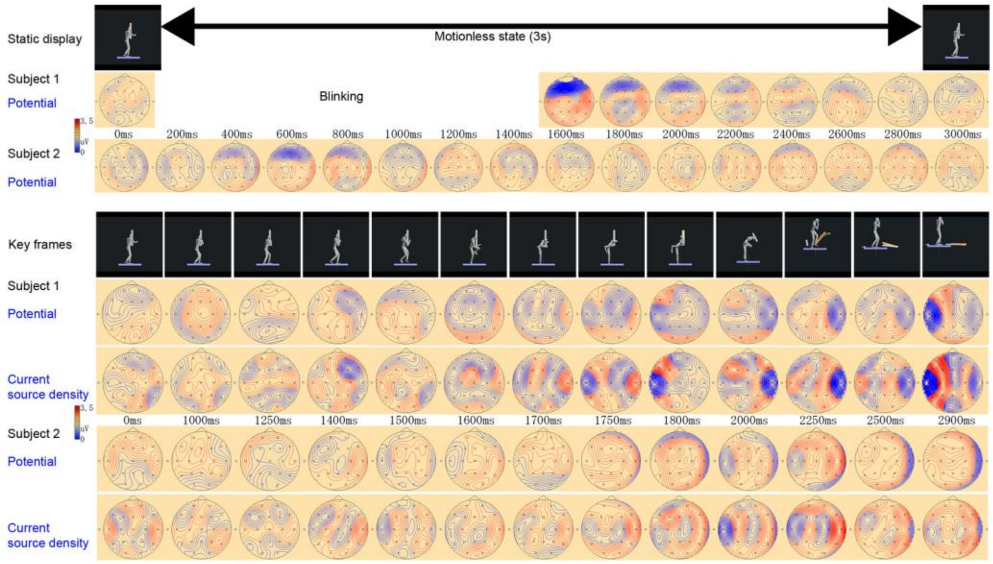
Figure 4: Process of displaying stimuli

5. DISCUSSION

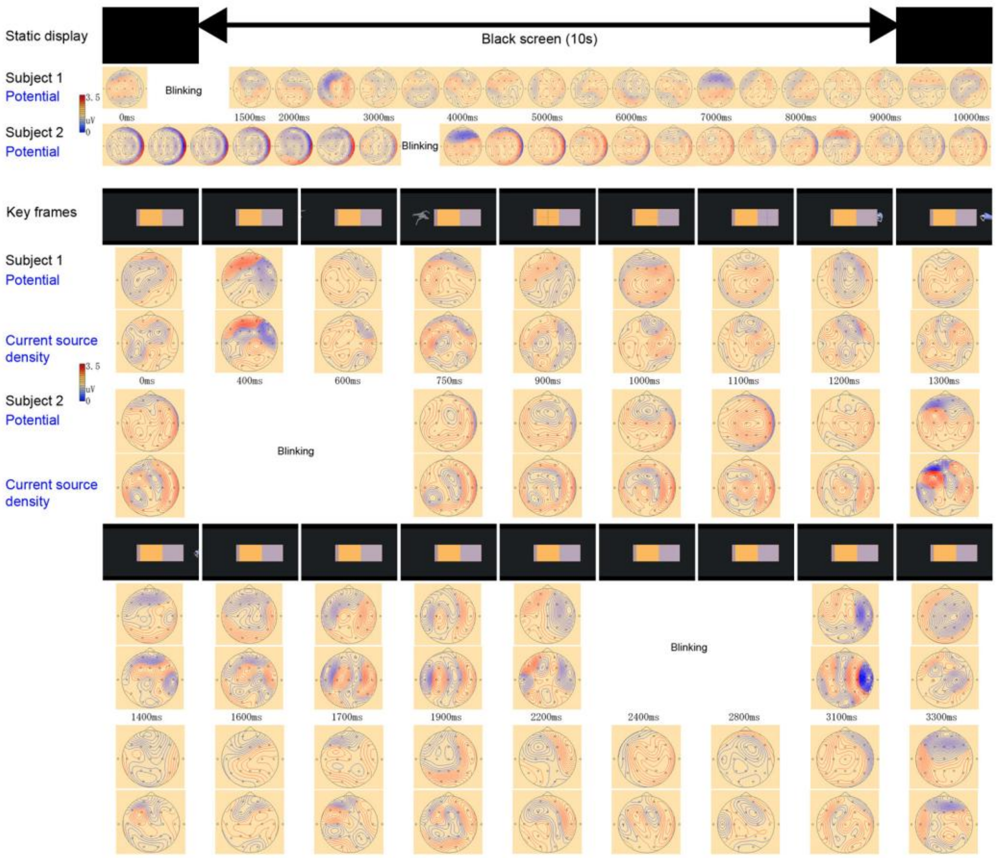
5.1. Corresponding relationships over time

Figure 5 shows the EEG map and the current source density of the subjects corresponding to the selected key frames of one pattern (the first pattern shown to the subjects at random) for each motion through time. Also, as a comparison tool, the EEG maps of the subjects before they viewed the motions or while viewing the static image are shown in the figure. The maps are shown at 200 ms intervals for Action01, and 500 ms intervals for Action02.

From these samples, an increase in electrical potential was observed in the frontal region of the head (centered around FP1 and FP2), regardless of the conditions prior to displaying the stimuli or the duration of the animation. In the Action02 sample, it appears that the vehicle does not move at all, because the camera chases the vehicle and the depth of view is not displayed. Thus, the electrical potential centered around FP1, FP2, and CZ decreased during 1.5 seconds of the second half of the stimulus display. This indicates that the increase in the potential centered around FP1 and FP2 correlates more with lack of motion, rather than the existence or lack of contents displayed on the screen.



*Action01 extraction example:
Combination pattern No. 16 (view: back; depth: none; camera tracking: object = PROP3)



*Action02 extraction example:
Combination pattern No. 29 (view: bottom; depth: none; camera tracking: object = vehicle)

Figure 5: Corresponding time relationships of key frames of movements with potential map and current source density

5.2. Calculation of amplitude differences

Based on the initial observations, the amplitude difference in each region for each stimulus viewing was calculated after dividing the obtained data into the stimulus viewing time and non-viewing time in order to compare them in more detail. FOCUS analysis software (Nihon Kohden) was used for FFT processing. For each of the 32 channels, five band values for each frequency were obtained. Within these obtained values, amplitude differences for the θ, α, and β bands were further calculated, and were considered for the FP1 and FP2 frontal head region (Figure 6).

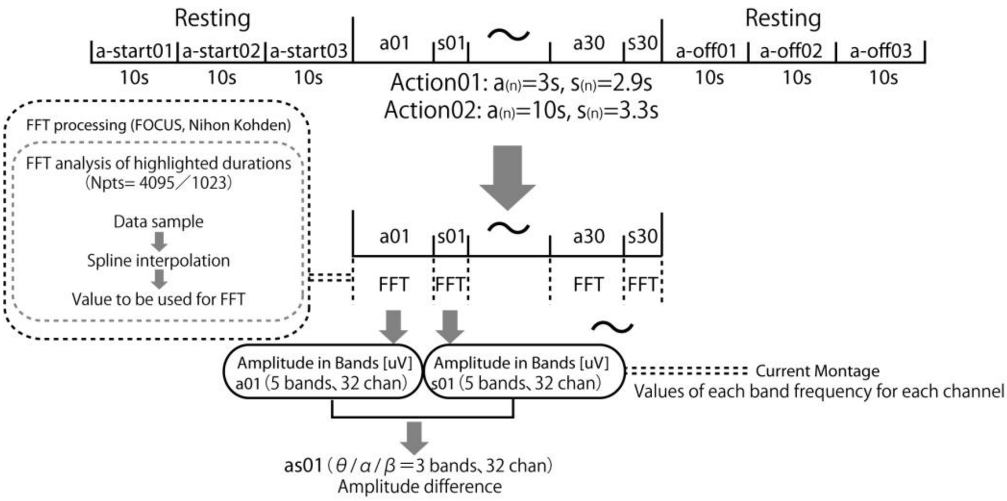


Figure 6: Calculation of amplitude difference spectrum

Figure 7 shows the subjective evaluation trends, with the number of times the stimulus was shown indicated on the horizontal axis and the corresponding amplitude differences plotted on the vertical axis. For Action01, the two subjects showed similar changes in amplitude differences for the θ band and α band. In the case of Action02, the amplitude differences exhibited a tendency of repeated increases and decreases. In other words, the subjects showed somewhat similar reactions to the order of stimuli viewing of different patterns. This result indicates that the differences in pattern combinations relate to the evaluations by the subjects through their brain waves.

A total of 30 t-tests were carried out in order to confirm the validity of analysis using amplitudes. The reaction of subject01 to Action01 was used. More specifically, the two amplitudes measured by FP1 and FP2 for the time when the stimulus was displayed (a01 – a30) and when the stimulus was not displayed (s01 – s30) were used as the samples for the t-tests. Because the resulting P-values for both the one-sided and two-sided tests were smaller than α, an alternative hypothesis was adopted. Hence, viewing of the stimuli was effective from an amplitude perspective. This result corresponds with the observations of the electrical potential, indicating that data analysis using the amplitude is meaningful.

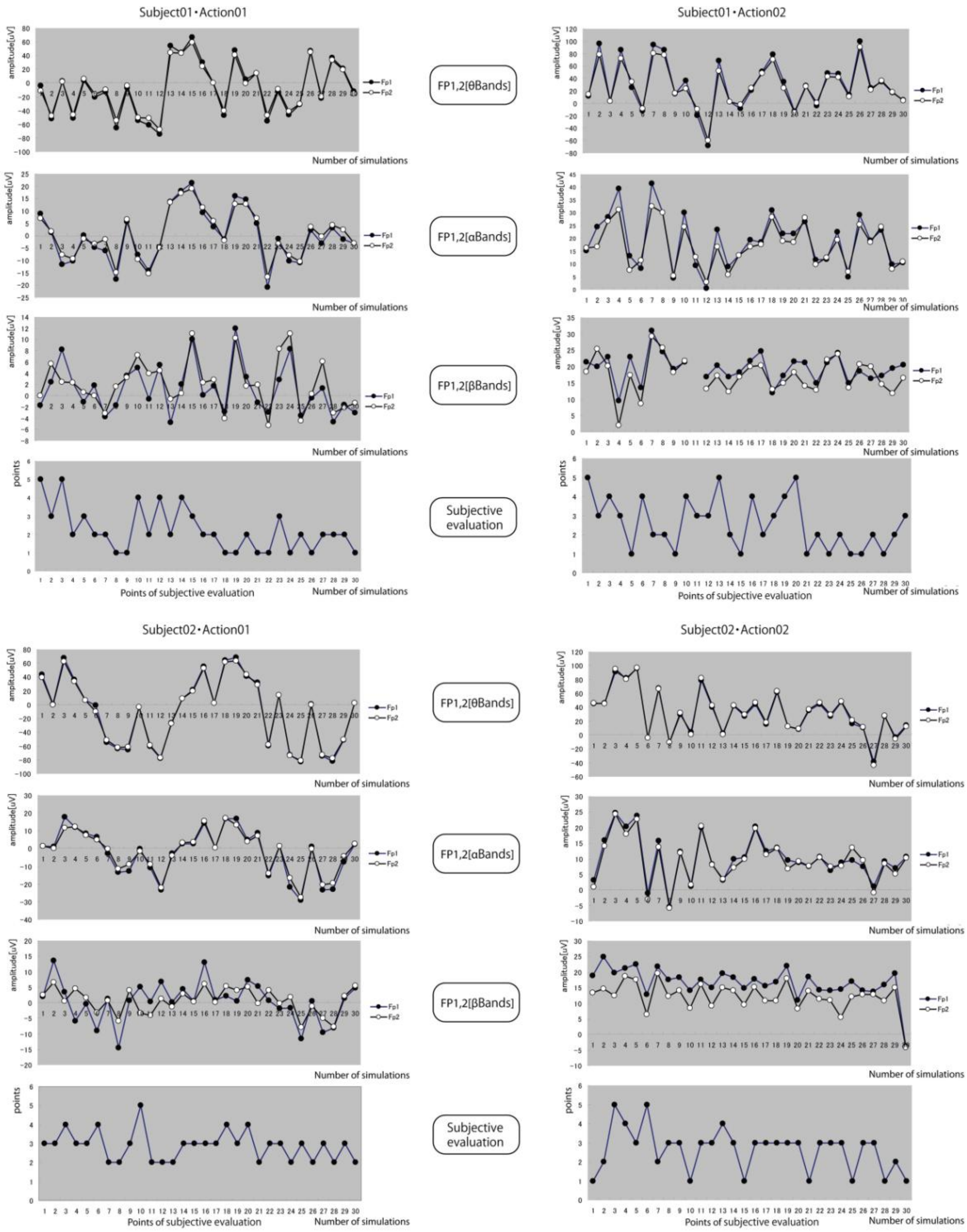


Figure 7: Subjective evaluation trends, FP1 and FP2 3-band trends

5.3. Comparison between changes in amplitude differences and subjective evaluations

Multiple linear regression analysis using the scores from the subjective evaluations as the objective variables, and the changes in amplitude differences of the 32-channel θ, α, and β bands as the explaining variables, did not yield a significant result (Table 2)

Table 2: Changes in amplitude differences and linear regression analysis results of subjective evaluations

		Amplitude difference	Multiple correlation coefficient	Significance probability
Action01	Subject01	θ	0.75	0.22
		α	0.81	0.09
		β	0.74	0.25
	Subject02	θ	0.69	0.11
		α	0.78	0.15
		β	0.75	0.23
Action02	Subject01	θ	0.62	0.24
		α	0.80	0.12
		β	0.59	0.18
	Subject02	θ	0.63	0.26
		α	0.67	0.07
		β	0.75	0.22

Based on the multiple linear regression analysis results, the number of mismatches between the subjective evaluation and the increases and decreases in the amplitude differences centered around FP1 and FP2 were highlighted in order to better understand the nature of the mismatches (the numbers highlighted in gray in Table 3).

Some distinctive characteristics were exhibited by the mismatches seen between the subjective evaluations and the changes in amplitude difference of the brain waves (Table 3). The situation when the camera tracked the object in the animation was marked multiple times (12 out of 18 times for Action01, and 11 out of 18 times for Action02). As for the viewing angle, the side view was hardly marked at all (4 out of 36 times). This shows that 'camera tracking an object' camerawork had a relatively large impact on the subjective evaluations of the subjects, while the side-view angle had the smallest impact.

Table 3: Extracted characteristics of number of mismatched trends

Action01−Subject01				Action01−Subject02				Action02−Subject01				Action02−Subject02			
Evaluation number	Rendering number	Camera tracking	View	Evaluation number	Rendering number	Camera tracking	View	Evaluation number	Rendering number	Camera tracking	View	Evaluation number	Rendering number	Camera tracking	View
		Object	Left/right			Object	Left/right			Object	Left/right			Object	Left/right
1	16	1	0	1	16	1	0	1	29	1	0	1	29	1	0
2	7	0	0	2	7	0	0	2	27	0	0	2	27	0	0
3	4	1	1	3	4	1	1	3	10	0	0	3	10	0	0
4	20	0	0	4	20	0	0	4	18	1	0	4	18	1	0
5	24	1	0	5	24	1	0	5	11	0	0	5	11	0	0
6	1	0	1	6	1	0	1	6	14	1	0	6	14	1	0
7	27	0	0	7	27	0	0	7	25	0	0	7	25	0	0
8	25	0	0	8	25	0	0	8	2	0	1	8	2	0	1
9	23	0	0	9	23	0	0	9	12	0	0	9	12	0	0
10	18	1	0	10	18	1	0	10	28	0	0	10	28	0	0
11	19	0	0	11	19	0	0	11	3	0	1	11	3	0	1
12	8	0	0	12	8	0	0	12	22	0	0	12	22	0	0
13	30	1	0	13	30	1	0	13	9	0	0	13	9	0	0
14	12	1	0	14	12	1	0	14	20	0	0	14	20	0	0
15	11	0	0	15	11	0	0	15	7	0	0	15	7	0	0
16	15	0	0	16	15	0	0	16	15	0	0	16	15	0	0
17	9	0	0	17	9	0	0	17	4	0	1	17	4	0	1
18	2	0	1	18	2	0	1	18	6	1	1	18	6	1	1
19	14	0	0	19	14	0	0	19	13	1	0	19	13	1	0
20	22	1	0	20	22	1	0	20	17	1	0	20	17	1	0
21	13	0	0	21	13	0	0	21	23	1	0	21	23	1	0
22	3	0	1	22	3	0	1	22	1	0	1	22	1	0	1
23	10	1	0	23	10	1	0	23	5	1	1	23	5	1	1
24	26	0	0	24	26	0	0	24	16	0	0	24	16	0	0
25	5	0	1	25	5	0	1	25	8	0	0	25	8	0	0
26	21	0	0	26	21	0	0	26	19	0	0	26	19	0	0
27	6	1	1	27	6	1	1	27	21	0	0	27	21	0	0
28	28	1	0	28	28	1	0	28	30	1	0	28	30	1	0
29	17	0	0	29	17	0	0	29	24	1	0	29	24	1	0
30	29	0	0	30	29	0	0	30	26	0	0	30	26	0	0

6. CONCLUSIONS AND FUTURE CONSIDERATIONS

Under the conditions of the preliminary experiment, the increases in electrical potential centered around FP1 and FP2 in the frontal head area were related more to the movements displayed on the screen, rather than the existence or non-existence of the display contents. This is evidence of a relationship between the movement patterns and the evaluations of the subjects through their brain waves.

The mismatches between the subjective evaluations and the biometric measurements of the subjects were the most affected by the camerawork when the camera 'tracked the objects' in the animations. Also, the side view produced the largest number of matches between the subjective evaluations and the biometric measurements. These conditions will be considered as constraining conditions in the next experiment.

A meaningful result was not obtained for the subjective evaluations due to the limited number of subjects. There was feedback from a subject that the subject evaluated 'realism' based on whether the animation was 'fun.' Hence, there is a need to reconsider the definition of 'realism' for the experiment. Our future plan is to increase the number of subjects so as to consider the differences between the subjects as a whole and as individuals.

Regarding the conditions of the combinations in the experiment, there were many instances when the control was lax. For example, the horizontal viewing angle could not be maintained when the depth expression and the camera tracking were combined together, even though it has been noted that variations in horizontal viewing angle have an impact on perceived realism [7]. These and other uncertainties need to be reconsidered.

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