Examination of the Individual Differences under the Same Image Viewing Environment by using NIRS

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***Abstract*—The individual differences in cerebral blood flow have been existing, so it is difficult to compare the data of cerebral blood flow for different people, and it is not known what kind of environmental influences such as time, temperature, sound etc. will have. Also, if an individual conducts an experiment more than once, it is not known whether the obtained data has reproducibility. In this experiment, in order to study the diversity of measurement data among individuals at same image viewing environment, two subjects simultaneously observe 30 images and consider whether the difference of subjects will affect the measurement cerebral blood flow. Also, in order to consider whether the experiment data of the same subject is reproducible or not, consider twice 30 images and examine whether it influences measurement of cerebral blood flow rate.**

Keywords—QoE; NIRS; Oxy-Hb

I. Introduction

Digital contents are developing to become higher definition, and larger screen, but the physical and psychological influences consider the user's emotions and sensitivity are unknown. Such influence is also related to the Quality of Experience (QoE) which is the user’s actually experiences, and it is important to evaluate the user's preference caused by various contents [1]. Therefore, as a research to evaluate QoE, we are conducting a neurophysiological approach based on biometric information to closer to human thought, as well as a psychology approach based on the questionnaire format that has been used as a conventional image quality evaluation method.

This neurophysiological approach uses changes in cerebral blood flow, but cerebral blood flow has individual differences and it is difficult to simply compare the data of different people. Moreover, it is not known how the environmental influences such as time, temperature, sound, and so on, give an effect on cerebral blood flow. Also, if the same subject performs the same experiment multiple times, it is not known whether the measurement data will differ. In this experiment, we examined the influence of measurement time on cerebral blood flow to examine the diversity of measured data among individuals and the reproducibility within the individual by physiological measurement by Near-infrared Spectroscopy (NIRS). At the same time, we perform psychometric measurements by subjective assessment and investigate changes in the channels and the change of oxygenated hemoglobin (ΔOxy-Hb) responsible for frontal lobe.

II. NIRS

NIRS is a method to noninvasively measure brain activity by measuring changes in cerebral blood flow using near infrared light that changes according to the state of bonding with oxygen. The NIRS measurement device used in this experiment is OEG-SpO2 from Spectratech [2]. There are 6 sending probes and 6 receiving probes, and it is possible to measure all 16 channels. During the experiment, NIRS was attached to the amount of the subject, and the Hb (hemoglobin) concentration change amount of the frontal lobe was measured at a sampling interval of about 0.0812 seconds. Along with brain activity, the values that can be obtained from NIRS are Oxy-Hb, Deoxy-Hb (deoxygenated hemoglobin), Total-Hb (total hemoglobin). We used ΔOxy-Hb in this experiment.

III. Experimental method

In this experiment, we conducted simultaneous measurements with different pair twice for each subject. Six male university students with normal vision participated, and measured the ΔOxy-Hb at the time of viewing image contents using NIRS. Subjective evaluation experiments on preferences in information experiments and questionnaires were conducted. For the experiment, 30 images were selected from the Nencki Affective Picture System (NAPS) as images contents. Psychological factors were classified by NAPS, and in this experiment, images of "happiness" are defined as "like" images and images of "disgust" are defined as "dislike" images.

IV. Experiment

The subjects were instructed to suppress the strongest blinking and head movement as much as possible and confirmed the presence of drowsiness and so as to prevent mixing of artifacts during NIRS measurement as much as possible. Also, in order to concentrate on watching video content, we conducted an experiment in a dark room as shown in Figure 1.

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Figure 1. Experimental environment.

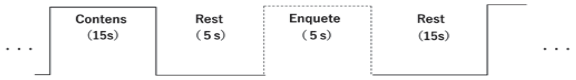

Figure 2. Flow of experiment.

When conducting simultaneous measurement, it was separated by a partition so as not to be influenced by the neighboring subject. The viewing time of the subject's image content is about 20 minutes in total, with a light break between the two. For one image content, it was presented for 15 seconds. As shown in Figure 2, a gray image was presented for 5 seconds after presenting the contents, and a questionnaire response of 5 seconds and a rest time of 15 seconds were set as the rest time in order for subjects to rest brain activity. In order to strengthen the relevance between the subject's sensitivity and subjectivity at the time of the experiment, we asked them to answer about "likes / dislikes" about the image contents viewed immediately with 5 grades (1: dislike - 5: likes). In order to consider causality in the presentation order, a plurality of presenting patterns were prepared and the subjects were asked to respond randomly.

V. Analysis Method

・Band pass filter

Bandpass filter processing was carried out to cut noise due to the device and body motion in the data of the signal value to be output and to obtain smooth data. By cutting high frequency components, we aim to reduce data information and observe the increase / decrease of ΔOxy-Hb. Aiming at leaving only the component of ΔOxy-Hb, a signal of 0.001 Hz to 0.1 Hz was passed through.

・Baseline correction

It is considered that baseline correction based on measured values at rest is necessary. The value of ΔOxy-Hb distributed as a spectrum frequency has a slope called a baseline in the spectrum. Here, baseline correction processing by quadratic curve interpolation is performed, and by correcting the value of ΔOxy-Hb at the start of viewing of the next image to zero, uniformity of change can be easily observed.

・Z-score

Conversion processing is performed on all data so that the data becomes 0 average and 1 standard deviation. By converting to z-score, it is possible to investigate how far away from the average value while also considering the degree of dispersion.

・Regression analysis

We calculated the approximate straight line from value of ΔOxy-Hb and its slope. And the, we investigated the increase/decrease of ΔOxy-Hb using its slope coefficient as a feature quantity.

・Correlation coefficient calculation

We investigated the correlation coefficient of 2 patterns. The first is the correlation coefficient of the slope coefficient between 2 subjects measured at the same time in order to investigate the influence of simultaneous measurement. The second is the correlation coefficient of the slope coefficient between 2 experiments in the same subject in order to investigate the reproducibility of ΔOxy-Hb.

VI. Results and Discussion

Figure 3 shows the changes in the cerebral blood flow of the channel 3 when viewing 1 like image of the two subjects for 15 seconds. The horizontal axis was the presentation time, and the vertical axis was ΔOxy-Hb.

In the image of Figure 4, the category of the image content is that of an animal, and the image of Figure 5 is that of the landscape category of the image content.

As a result of investigating the correlation coefficient between two people measured simultaneously, Landscape image group showed a high correlation in all channels. But, Animal image group has a low correlation. We considered that this is because the individual difference is likely to occur with respect to Animal images.

In two experiments in the same subject, it can be said that there is reproducibility since similar behavior was observed in more than half of the channels.

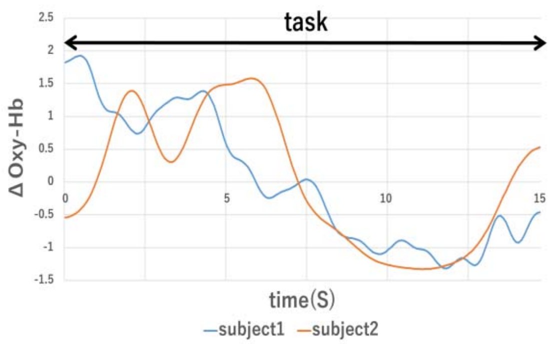

Figure 3. The amount of change in cerebral blood flow of subject 1 and subject 2.

Figure 4. Animal images. (NAPS)

Figure 5. Landscape images. (NAPS)

VII. Conclusion

In this paper, we investigated the influence of simultaneous measurement and the reproducibility of ΔOxy-Hb. As a result, the correlation coefficient was higher in more than half of the channels measured simultaneously. In addition, we found the influence of simultaneous measurement that the correlation coefficient for each category of content is high for Landscape image and low for Animal image. Moreover, it can be said that the correlation coefficient is high and the reproducibility is high in more than half of the channels in the same subject.

Acknowledgment

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References

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