

BRAIN WAVES FOR 3D VISUALIZATIONS

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1.INTRODUCTION

It is necessary to build a consensus in public works and developments. Previously it had not been important to build a consensus between stakeholders in it. However, recently consensus building have been more important for agreeing with stakeholders. For successful consensus process, various 3D visualizations such as CG(computer graphics) and objects made by 3D printer have been often used. However, it has not been clarified that how effective 3D visualizations is for consensus building. In recent years brain waves are used as an index of emotions. Because brain waves can be measured by portable electroencephalography (EEG) devices¹⁾. By analysis of brain waves using EEG, relationships between emotion and 3D visualizations in consensus process may be able to clarify. If effectiveness of 3D visualizations is indicated, people understand it well through consensus building and stakeholders can reach agreements.

The purpose of this study is to examine differences of brain waves for 3D visualizations. In this study, CG and objects made by 3D printer are used as samples of 3D visualizations.

2.BRAIN WAVES

Table 1 shows characteristics of brain waves. δ frequency is the slowest of the frequencies and is experienced in deep, dreamless sleep and in very deep, meditation where awareness is separated. θ is experienced vivid visualizations, great inspiration and creativity. α brain waves are optimal time to program the mind for success and it also heightens your imagination, visualization, memory and concentration. β brain waves are associated with normal waking consciousness, heightened state and critical reasoning. This range is the most recently discovered and is the fastest frequency at above 38Hz. γ waves are associated with insight and high-level information processing.

Table 1: Characteristics of brain waves

waves	frequency (Hz)	condition
δ wave	0.5-4	Deep slowest frequency, Unconsciousness
θ wave	4-8	Suitable for visualizations, inspiration, creativity and insight
α wave	8-14	Most optimal concentration, learning...etc
β wave	14-38	Normal waking consciousness and heightened, critical reasoning
γ wave	38-70	Insight and high-level information processing

3.METHODOLOGY

In this study, characteristics of brain waves for 3D visualizations were analyzed using portable measurement tool for brain waves.

3.1 Measurement tool for brain waves

In this research, Mindwave was used as measurement tool. This tool can measure 5 brain waves as shown in table1 and then calculate attention and meditation levels from the brain waves. Attention and meditation have been defined by original method. The attention is defined that emotion and psychology like when to identify and maintain a single thought, to stare at a specific object, to focus on something you like, to calculate math and to listen intently to someone talking. The meditation is defined that emotion and psychology like when to take a deep breath and slowly exhale, to deliberately relax all muscles, to clear mind of any specific thoughts, to let mind wander and drift, and to close eyes.

3.2 Experiment

Figure3 shows experimental tools of spheres objects. Upper left shows a sphere made by 3D printer. Lower left shows a sphere made by CG. Upper right shows a sphere with holes made by 3D printer. Lower right shows a sphere with holes made by CG. The experiments were carried for 5 subjects.



Figure 1: Experimental image of measuring brain waves

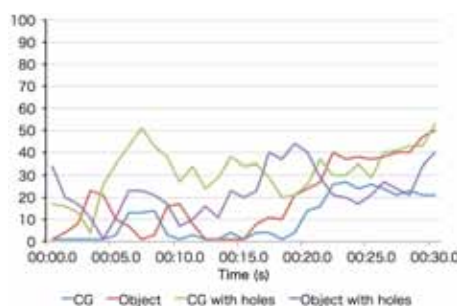


Figure 2: Attention level on subject A

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(1)The object of sphere

Figure1 shows experimental image of measuring brain waves of sphere object. The sphere object was made by 3D printer. When subjects were handling the sphere object, their brain waves were measured simultaneously.

(2)The CG of sphere by desktop PC

When subjects were watching the sphere by desktop PC, their brain waves were measured simultaneously. The sphere was made by CG.

(3)The object of sphere with holes

When subjects were handling the sphere object with holes, their brain waves were measured simultaneously. The sphere object with holes was made by 3D printer.

(4)The CG of sphere with holes by cellphone

When subject were watching the sphere with holes by cellphone, their brain waves were measured simultaneously. The sphere with holes was made by CG.

4.RESULTS

These experiments indicated the comparisons between brain waves for object and CG. Figure2 shows attention and meditation levels on subject A for 3D visualizations. Furthermore the average of attention levels (AL) and meditation levels (ML) as calculated.

4.1 Attention**(1) Subject A**

All AL increased gradually. The average of AL for object of sphere (OS) was higher than that of CG of sphere (CS). Similarly, the average of AL for CG of sphere with holes (CSH) was higher than that of object of sphere with holes (OSH).

(2) Subject B

All AL increased gradually. The average of AL for OS was higher than that of CS. Similarly, the average of AL for OSH was higher than that of CSH.

(3) Subject C

CS and OS AL changed stable. The average of AL for CS was higher than that of OS. Similarly, the average of AL for OSH was higher than that of CSH.

(4) Subject D

OSH increased gradually. But except for OSH decreased gradually. The average of AL for CS was higher than that of OS. Similarly, the average of AL for CSH was higher than that of OSH.

(5) Subject E

All AL changed stable. The average of AL for CS was higher than that of OS. Similarly, the average of AL for OSH was higher than that of CSH.

4.2 Meditation**(1) Subject A**

CS ML changed unstable. But except for CS levels changed unstable. The average of ML for CS was higher than that of OS. Similarly, the average of ML for OSH was higher than that of CSH.

(2) Subject B

All ML decreased gradually. The average of ML for CS is higher than OS. Similarly, the average of ML for OSH was higher than that of CSH.

(3) Subject C

CS decreased gradually. But except for CS decreased gradually. The average of ML for OS was higher than that of CS. Similarly, the average of ML for OSH was higher than that of CSH.

(4) Subject D

Final level of CSH increased . But except for CSH final levels decreased. The average of ML for OS was higher than CS. Similarly, the average of ML for CSH was higher than that of OSH.

(5) Subject E

The ML of OS decreased. The ML of the others was unsteadily. The average of ML for CS is higher than OS. Similarly, the average of ML for OSH was higher than that of CSH.

The results on all subjects showed that the AL of OS was higher than that of CS and the AL of CSH was higher than that of OSH. On the other hand, the results showed that the ML of OS was higher than that of CS and the ML of OSH was higher than that of CSH.

5.CONCLUSIONS

In this research, brain waves for 3D visualizations were examined by a portable EEG device. The results showed significant findings on relationships between brain waves and 3D visualizations. Especially, the experimental result showed that meditation levels of object were higher than that of CG. However the relationship between 3D visualizations and brain waves in consensus building could not be clarified well. For more accurate experiments, each subject's inherent characteristic of brain waves have to be considered.