

Effects of Scouting Videos on Electroencephalogram during Motor Imagery in Football Players

— Changes in Alpha Power —

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Videos of opposing teams during football games are used to obtain information about the team and its players for analysis of tactics before important games. By editing such videos, scouting videos are developed to highlight the characteristics of the opposition's offensive and defensive play. We investigated the impact of a scouting video on Electroencephalogram (EEG) alpha power when evoking motor imagery. Subjects of the study were members of a football club at a sports-oriented college (n=6). Subjects watched a scouting video under an experimental condition, and viewed a landscape photograph under a control condition to develop imagery. Physiological indicators of EEG alpha power during the development of motor imagery were measured under both conditions. Results indicated that EEG alpha power was significantly higher when developing imagery under the experimental condition. Alpha power is an indicator of relaxation and concentrated attention that varies with level of awareness and arousal. Therefore, the above results suggest that the scouting video used under the experimental condition promoted the development of imagery with concentrated attention.

Keywords: sport mental training, coaching, central nervous system

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1. Introduction

The development of information processing technology has had a positive impact on the improvement of competitiveness in sports. In particular, videos are often employed due to their practicability. Recently, videos have been used for informational tactics in sports because of the development of video processing and editing software, and easy feedback by electronic devices. In soccer, scouting videos are used to analyze teams and players to obtain information on opponents before important games. Scouting videos are created by editing opponent game movement to indicate the characteristics of defense and offence (Ono, 2010). Sone (2008) reported the importance of creating game plans, analyzing the tactics of the opponents, and sharing information with players in preparation

for games. Scouting videos play an important role in the effective provision of information by coaches giving instruction on strategy and tactics. In addition, Matsutake and Sugo (2013) reported that viewing scouting videos helped players to develop clear motor imagery through use as simulation before actual games, revealing its potential for application in sports mental training (SMT). Motor imagery development in this report is defined as a psychological rehearsal of motor activities without physical motion (Kotani, 2004). Use of motor imagery has been regarded as a method of SMT for use by athletes for psychological conditioning in preparation for games (Lotze and Halsband, 2006). In addition, motor image means the performance of motor rehearsal without motion that can be observed externally (Crammon, 1997), which allows athletes to observe the processed image and orally report the content of that image.

However, this processing takes place in the brain, and cannot, therefore, be observed externally. To clarify the mechanism of motor imagery development, it is necessary to measure physiological reactions. In particular, the measurement of brain activity is considered important (Kotani, 2012).

Recent studies of brain activity during the development of motor imagery have illustrated the possibility of perceiving brain activity visually through the development of brain function imaging technology such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), and magnetoencephalography (MEG). Perro et al. (1996) and Roth et al. (1996) reported that common activity in motor and somatosensory areas could be observed by fMRI when motor imagery development and exercises were performed concurrently. Meanwhile, electroencephalogram (EEG) is a well-known method of measuring brain activity. Although EEG has lower spatial resolution compared with fMRI and PET, it has higher temporal resolution. Therefore, EEG is useful in observing temporal changes in brain activity. EEG makes it possible to measure brain activity easily and noninvasively, which allows for the participation of a greater number of subjects in experiments. Furthermore, EEG is capable of perceiving ongoing changes in brain function in each frequency band, including δ wave (0.5-3Hz), θ wave (4-8Hz), α wave (8-13), and β wave (13-30Hz) (Fujisawa, 1998). A previous study of EEG during motor imagery development revealed that high-quality motor imagery development was associated with an increase in α waves compared with time at rest due to its being concentrated (Shinagawa, 1992; Mori and Kuroda, 1996; Araki 2004). There is a reduction in the appearance of α waves in a state of arousal and stress as well as in a state of low arousal, a condition that makes us feel sleepy when we close our eyes (Hori, 2008). This showed that the amount of α waves changed in a reverse U-shape pattern against the level of arousal, and, therefore, that an increase in concentration during motion imagery leads to an increase in α waves under certain states of arousal. Tsuchiya (2005) supported this finding in research on the image method in SMT. Recently, investigators have conducted practical studies focusing on effective motor imagery development (Zippo et al., 2016; Mizuguchi et al., 2010). Matsutake and Sugo (2013) reported that scouting videos promote effective motor imagery development. In

this study, we measured electrocardiogram and respiration as physiological responses during motor imagery development utilizing heart rate, respiration rate, and low frequency (LF) and high frequency (HF) ratios as indicators. Physiological response indicates peripheral nervous system activity, allowing the observation of physiological changes during motor imagery development, but not the direct perception of brain activity. To perceive physiological changes during motor imagery development multi-directionally, therefore, it is necessary to examine central nervous system activity. To date, however, no studies have focused on EEG measurement to clarify the mechanism and impact of scouting videos on motor imagery. Clarifying the mechanism and impact of scouting videos to develop motor imagery would show their efficacy in SMT.

This study was carried out to clarify the impact of scouting videos on α waves during motor imagery development.

2. Methods

2.1. Subjects

Subjects of this study were six male football players aged between 20 and 22 on a college football team that placed first in the All Japan football championship. Six subjects regularly view scouting videos before official games to obtain information about their opponents. They did not have the experience of continual SMT.

2.2. Period and Location of the Experiment

The experiment was conducted in a sports-oriented college sports psychology laboratory at the end of July 2012.

2.3. Procedures

Subjects repeated two separate experiments; namely, viewing a landscape photograph to develop imagery under control conditions, and viewing a scouting video to develop imagery under experimental conditions. The two separate experiments were carried out on different days. Considering the operability of the conditions, we counterbalanced the order of the experiments. Furthermore, the experiment was conducted on

each subject separately in a room that enabled the limitation of external stimuli.

We first provided subjects with an explanation of the content of the experiment and obtained written consent. Subjects were then asked to sit in an easy chair and wear equipment designed to measure EEG. Subjects practiced abdominal breathing for relaxation before the measurement (Yamanaka, 2005) to equalize the baseline for both conditions. After this, we measured the EEG of each subject at rest with eyes closed (Rest) for five minutes for use as a baseline. At this time, we asked subjects to close their eyes and rest, but to resist falling asleep. Subjects viewed a landscape photograph for five minutes under control conditions on one day, and then viewed a scouting video for five minutes under the experimental conditions on the other day. Instructions were as described above. After viewing each item, we measured motor imagery development (Imagery) for five minutes. Imagery was measured with eyes closed. Subjects wrote the content of Imagery on an Image Story Setup Sheet prior to the experiment, and the examiner read the content based on the time each subject set in advance. After measurement of the Imagery, we removed the equipment from the subjects and asked them to write a review on their Imagery.

2.4. Content of Imagery

In order to control the content of imagery by each subject, we provided an Image Story Setup Sheet commonly used in image training. The Image Story Setup Sheet is used by subjects to frame the content of their image, set up scenes, situations, psychological conditions, and the environment, and record them in scenario form (Tsuchiya, 2005). In this study, we held a meeting to explain the experiments to subjects and asked them to fill out the Image Story Setup Sheet. We set the theme (a game against University X in the next season), date (October xx), location (Nagai Stadium), and weather (fine), and asked subjects to write their images freely. We set five minutes for imaging. We used the procedure and time for imagery development reported by Tachitani (2012). The major contents recorded by the subjects were concentration in the locker room, entrance ceremony, the subject himself shooting a goal, matching up with the opposing DF, and being happy to win the game.

2.5. Landscape Photograph and Scouting Video

The landscape photograph showed under the control condition was the entire football pitch. Before showing the photograph to subjects, we gave the following instructions: “You will view a landscape photograph for five minutes. You can blink your eyes, but please try to concentrate on observing the photograph for five minutes.” The video showed under the experiment condition was a game played by University X that the subjects would play against in the next season. The game video was edited into a five-minute version as a scouting video that included scenes of scoring, shooting, giving up points, and defensive-line breakthrough. Characteristic scenes were emphasized using slow motion, and repeated and continuous play. Prior to viewing this scouting video, we gave the following instructions: “The video you will watch is a game played by University X, which you will play against in the next season. The team in blue is the opponent in the next game. The scenes emphasized using slow motion, and played repeatedly or continuously are the characteristic scenes of University X team’s performance. This game was played at Nagai Stadium, the venue for your next game.” We did not provide direction about the content of the landscape photograph and scouting video when subjects were viewing the photograph and scouting video. Subjects viewed the photograph and the video while sitting in a chair at rest.

2.6. Ethical Considerations

Prior to the experiment, we explained the content of the experiment both orally and in writing, and obtained consent from all subjects. This study was carried out after obtaining approval from the Ethical Committee of the relevant college (Approval No. 12-36).

2.7. Brain Wave Measurement and Analysis

Measurements were conducted using an electroencephalograph (Alliance Works V3.6.1R manufactured by Nicolet Biomedical Inc. We applied silver chloride electrodes (Ag-AgCl) to eight locations (Fp1, Fp2, Fz, Cz, C3, C4, O1, O2) in accordance with the International 10-20 System at an electrode impedance of 10k Ω or lower (**Fig. 1**). The EEG signal was derived by one electrode utilizing a

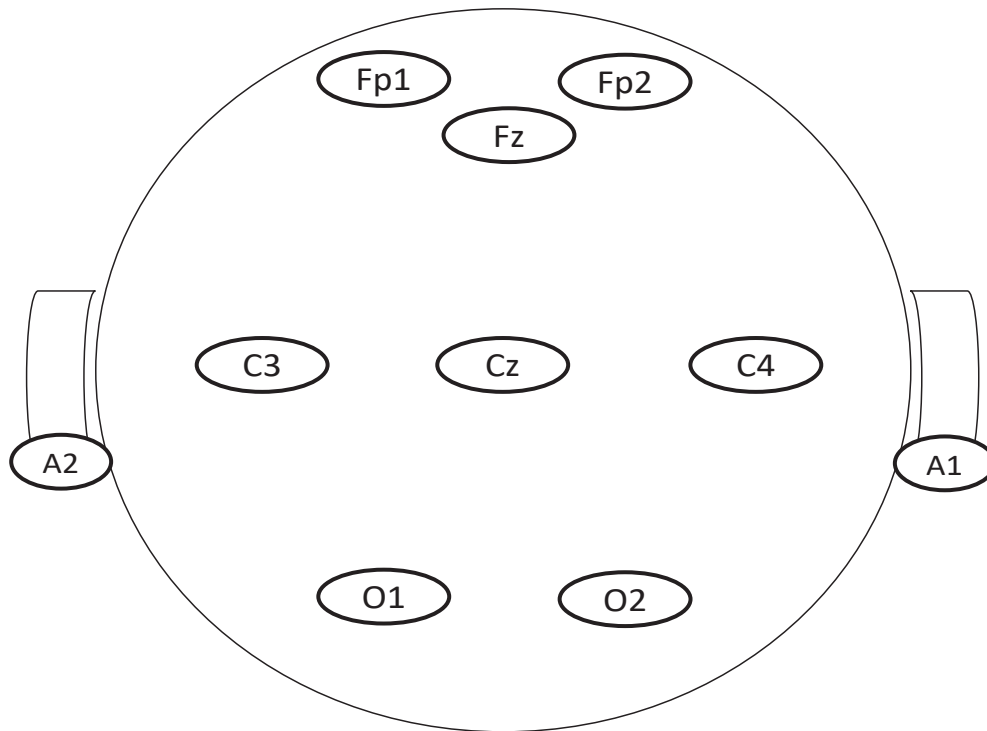


Figure 1 Electroencephalogram electrode locations

linked-ear reference electrode, and was converted from analog to digital at a 5-sec time constant (TC), 0.03 Hz low pass filter (LPF), 30 Hz high pass filter (HPF) and 200 Hz sampling frequency. To detect artifact contamination in EEG by eye movement and blinking, an electrooculogram (EOG) was used to record the electrical potential derived from the upper and lower part of the left eye.

EEG analysis software (Atamap II, manufactured by Kissei Comtec Co., Ltd.) was used to analyze EEG data. To perceive relaxation and concentration on the image during both Rest and Imagery, we analyzed the fifth minute of the five-minute period. In addition, Fast Fourier Transform (FFT) was applied to analyze frequency. We calculated the contents of each brain wave at different frequency bands (δ wave at 1-4 Hz, θ wave at 4-8 Hz, α wave at 8-13 Hz, and β wave at 13-30 Hz). In this study, we compared α wave content to examine the α -blocking mechanism.

For statistical processing, we examined interactions and main effects by the measurements under partially different conditions utilizing a two-way factorial analysis of variance (two-way ANOVA). When interactions were revealed, we conducted sub-effect tests; and when main effects were revealed by each factor, we conducted multiple comparisons. In this study, we measured eight locations. Because

no difference was observed among electrodes, we conducted two-way ANOVA for the location of each electrode. A significance level of less than 5% was used as the criterion for significant difference, and a significant level of less than 10% was used as the criterion for tendency. IBM SPSS statistics 21 (manufactured by IBM Japan, Inc.) was used for all statistical processing.

3. Results

Fig. 2 and 3 show the original brain waves used for analyzing Rest and Imagery under each condition. **Fig. 4** shows the results of two-way ANOVA for each location. We provide an explanation of the descriptive statistics and statistic values used for the two-way ANOVA for each section.

- 1) Fp1: Under the control condition, Fp1 during Rest was $4.20 \pm 0.86 \mu\text{V}$ while Fp1 during Imagery was $7.08 \pm 2.59 \mu\text{V}$. Under the experiment condition, Fp1 during Rest was $5.37 \pm 1.49 \mu\text{V}$ while Fp1 during Imagery was $11.08 \pm 2.70 \mu\text{V}$. The two-way ANOVA revealed no interactions ($F(1, 5) = 1.617$, n. s.).
- 2) Fp2: Under the control condition, Fp2 during Rest was $3.99 \pm 1.41 \mu\text{V}$ while Fp2 during Imagery was $7.75 \pm 1.93 \mu\text{V}$. Under the experiment condition,

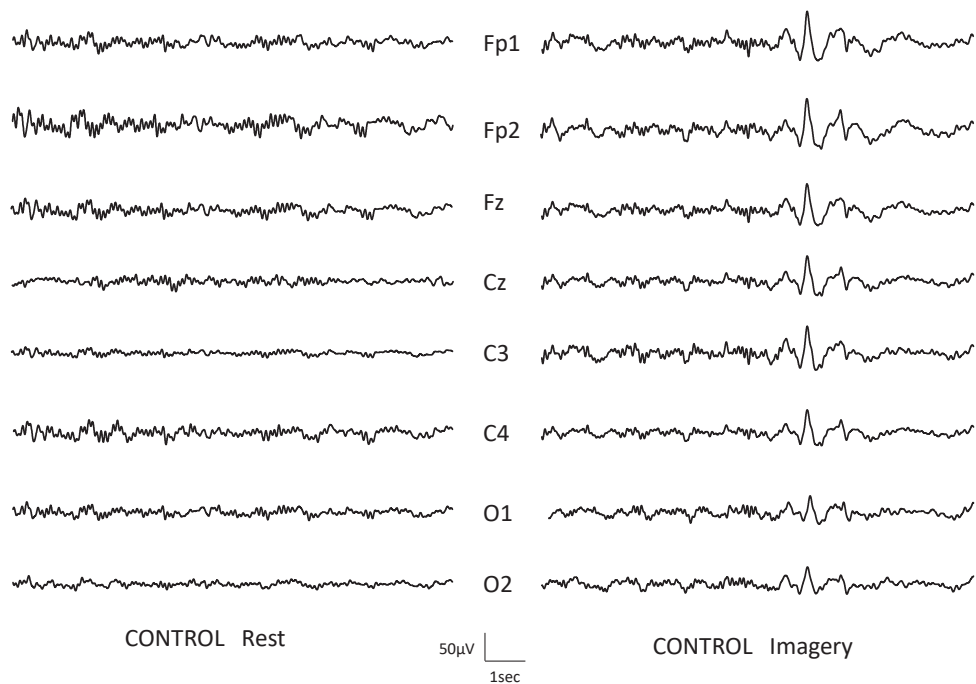


Figure 2 Control condition of raw waveform

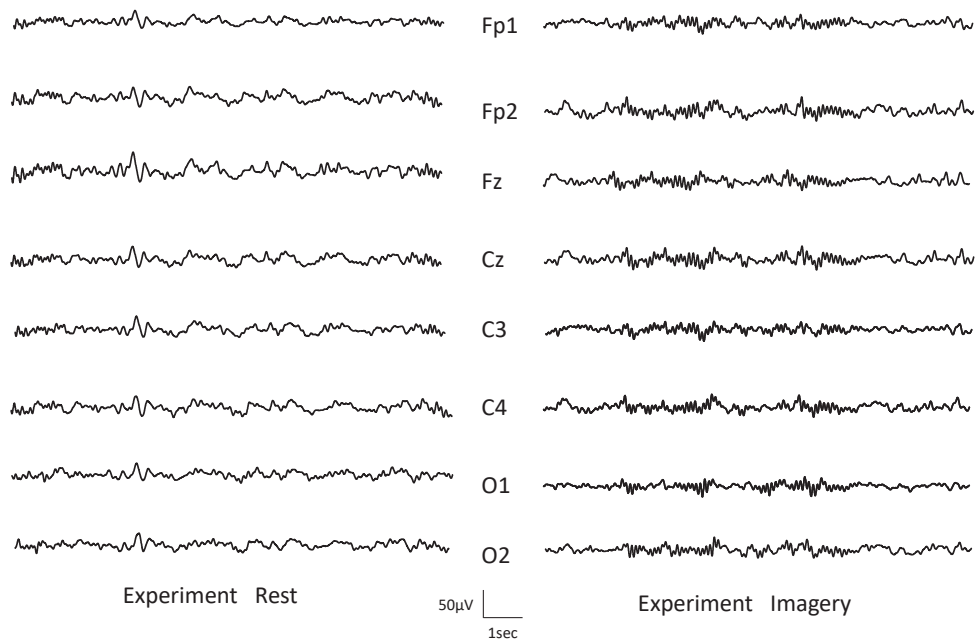


Figure 3 Experiment condition of raw waveform

- Fp2 during Rest was $7.04 \pm 1.59 \mu\text{V}$ while Fp2 during Imagery was $14.51 \pm 4.28 \mu\text{V}$. The two-way ANOVA revealed no interactions ($F(1, 5) = 1.991$, n. s.).
- 3) Fz: Under the control condition, Fz during Rest was $5.55 \pm 2.73 \mu\text{V}$ while Fz during Imagery was $6.73 \pm 30.27 \mu\text{V}$. Under the experiment condition, Fz during Rest was $7.60 \pm 1.95 \mu\text{V}$ while Fz during Imagery was $12.82 \pm 2.81 \mu\text{V}$. The two-way ANOVA revealed no interactions ($F(1, 5) = 8.000$, n. s.).
- 4) C3: Under the control condition, C3 during Rest was $4.70 \pm 0.84 \mu\text{V}$ while C3 during Imagery was $7.42 \pm 1.37 \mu\text{V}$. Under the experiment condition, C3 during Rest was $7.85 \pm 1.87 \mu\text{V}$ while Fz during Imagery was $12.77 \pm 1.39 \mu\text{V}$. The two-way

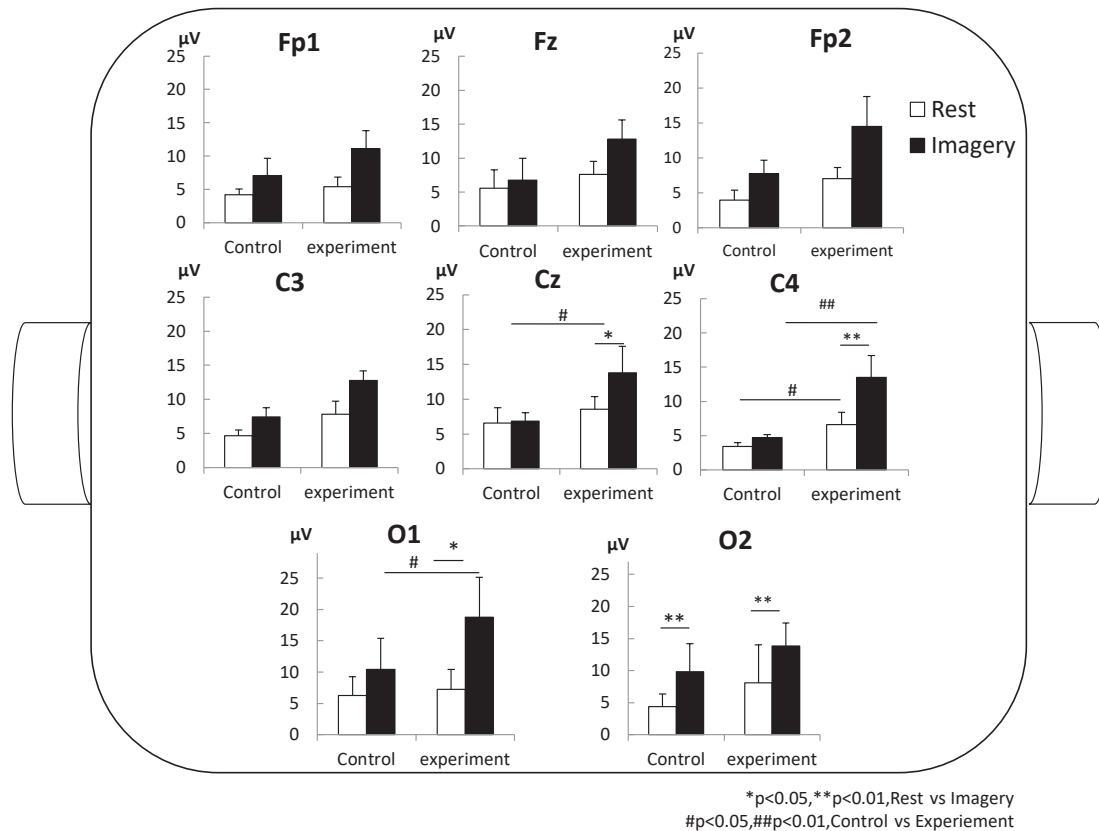


Figure 4 Mean alpha power recorded at each location

ANOVA revealed no interactions ($F(1, 5) = 4.252$, n. s.).

- 5) C4: Under the control condition, C4 during Rest was $3.40 \pm 0.60 \mu\text{V}$ while C4 during Imagery was $4.70 \pm 0.48 \mu\text{V}$. Under the experiment condition, C4 during Rest was $6.61 \pm 1.78 \mu\text{V}$ while C4 during Imagery was $13.50 \pm 3.20 \mu\text{V}$. The two-way ANOVA revealed interactions ($F(1, 5) = 14.984$, $p < 0.05$), and main effects by time ($F(1, 5) = 31.926$, $p < 0.001$). Sub-effect tests revealed a significant difference in α wave content between Rest and Imagery under the experiment condition. Comparison of the Rest and Imagery between the control and experiment conditions revealed significantly high values under the experiment condition.
- 6) Cz: Under the control condition, Cz during Rest was $6.06 \pm 2.18 \mu\text{V}$ while Cz during Imagery was $6.83 \pm 1.23 \mu\text{V}$. Under the experiment condition, Cz during Rest was $8.56 \pm 1.81 \mu\text{V}$ while Cz during Imagery was $13.81 \pm 3.77 \mu\text{V}$. The two-way ANOVA revealed interactions at a significance level of 10% ($F(1, 5) = 8.063$, $p < 0.05$), and significant main effects by two factors ($F(1,$

$5) = 8.063$, $p < 0.05$). Sub-effect tests revealed a significant difference in α wave content between Rest and Imagery under the experiment condition. Comparison of Rest and Imagery between the control and experiment conditions revealed significantly high values under experiment conditions.

- 7) O1: Under the control condition, O1 during Rest was $6.30 \pm 2.98 \mu\text{V}$ while O1 during Imagery was $10.45 \pm 4.93 \mu\text{V}$. Under the experiment condition, O1 during Rest was $7.22 \pm 3.22 \mu\text{V}$ while O1 during Imagery was $18.79 \pm 6.37 \mu\text{V}$. The two-way ANOVA revealed interactions ($F(1, 5) = 18.450$, $p < 0.05$), and main effects by two factors ($F(1, 5) = 82.793$, $p < 0.001$). Sub-effect tests revealed a significant difference in α wave content between Rest and Imagery under the experiment condition. Comparison of Rest and Imagery between the control and experiment conditions revealed significantly high values under experiment conditions.
- 8) O2: Under the control condition, O2 during Rest was $4.37 \pm 1.98 \mu\text{V}$ while O2 during Imagery was $9.84 \pm 4.33 \mu\text{V}$. Under the experiment condition,

O2 during Rest was $8.06 \pm 5.95 \mu\text{V}$ while O2 during Imagery was $13.81 \pm 3.63 \mu\text{V}$. The two-way ANOVA revealed interactions at a significance level of 10% ($F(1, 5) = 4.278, p < 0.1$), and main effects by two factors ($F(1, 5) = 229.494, p < 0.001$). Sub-effect tests revealed a significant difference in α wave content between Rest and Imagery under both control and experiment conditions.

4. Discussion

The purpose of this study was to clarify the impact of viewing scouting videos on α waves during the development of motor imagery. As a result, scouting video viewing under the experiment condition revealed a significant difference in α wave content in C4 and Cz in the central region and O1 and O2 in the occipital region during both Rest and Imagery. In addition, C4, Cz, and O1 revealed a significantly high value under the experiment condition during Imagery. Hori (2008) reported that α waves decrease under a state of high arousal such as during exercise or mental excitement, and the amount of α waves changes in a reverse U-shape pattern against the level of arousal. Furthermore, Laufs et al. (2003) reported that α waves are useful as an indicator of relaxation and concentration because they change along with the level of awareness and arousal. The results of this study revealed that α waves increased from Rest to Imagery under the experiment condition during motor imagery development in the same image rehearsal, which indicated a difference from the state of arousal during the motor imagery development under the control conditions. This suggested that the experiment conditions of motor imagery development after watching a scouting video produced an appropriate state of arousal to make subjects more relaxed and concentrated compared with the control conditions. While scouting video viewing had an impact on α waves, it is also necessary to consider the competitiveness of subjects. Subjects of this study were athletes who had taken first place at the all Japan football championship, and they were all top-level football players at a university. According to a study carried out by Araki (2004), EEG measurement of high-performance athletes (field and track, archery, golf) during motor imagery development revealed that α waves appeared more than at rest. While the types of athletic event used in this study were different from those targeted by Araki (2012), the

subjects of both studies had high competitiveness, and it is highly likely that the high competitiveness had an influence on changes in α waves from Rest to Imagery. Furthermore, scouting videos were used on a daily basis, which promoted the development of motor imagery and had an impact on the results. From the above, watching a scouting video was thought to promote an appropriate state of arousal during motor imagery development. The image rehearsal in SMT followed the flow of (1) the selection of tasks, (2) creation of image story, (3) relaxing, and (4) imagery development (Tsuchiya, 2005). Considering the setup of tasks and characteristics of sports events, it is believed that watching scouting videos prior to relaxation during image rehearsal for goal sports creates a state of concentrated image experience that promotes higher quality motor imagery development with concentrated attention. Matsutake and Sugo (2013) examined the effects of scouting videos utilizing heart rate, breathing rate, LF/ HF ratio, and image diagnostic test as indicators using a protocol similar to this study, and reported the effects of promoting clear imagery development. Using our investigation as a supplementary study, we propose the use of scouting videos in image rehearsal for individuals engaged in goal sports education.

This study, however, has some problems that need to be addressed. In this study, we measured EEG during the development of motor imagery under two conditions. In order to clarify the mechanism that determines α wave amount during the development of motor imagery, we should also have subjects remain at rest without motor imagery after Rest under the control condition. Furthermore, it was impossible to clarify whether the increase of α waves seen from Rest to Imagery under both conditions was caused by imagery development or low arousal due to the lapse of time. In order to clarify that motor imagery can increase the amount of α waves, we should set a condition in which subjects are at rest without developing motor imagery. Furthermore, subjects of this study viewed the scouting video under the experiment condition while they viewed the landscape photograph under the control condition for comparison. In order to suggest that scouting videos are useful for image rehearsal because they promote motor imagery development with concentrated attention, we need to compare with other videos and conduct a more detailed examination of their influence. In addition, while scouting videos are

used by coaches at team meetings with the intention of teaching players or emphasizing important matters, the scouting video in this study was not accompanied by instructions from a coach. For this reason, the intention of the video, which may be the most essential aspect of their use, was missing. In the future, a more detailed examination of content and the method of showing scouting videos is required.

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- Effects of Scouting Videos on Physiological and Psychological Responses during Motor Imagery in Football Players. Vol.11, 28-35, 2013

Membership in Learned Societies

- Japan Society of Physical Education, Health and Sport Sciences.
- Japanese Society of Sports Psychology
- Japanese Society of Science and Football