Original Article

Effects of sensory awareness, imagery and observation on electroencephalography in adult with psychological stress

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Abstract. [Purpose] The aim of the present study was to examine the effects of brain activation using sensory awareness, imagery, and observation in adults with psychological stress. [Participants and Methods] The participants of the study were 30 adults with psychological stress. They responded to questionnaires, including a stress response inventory. Data for brain activation were collected for sensory awareness, imagery, and observation using electroencephalography. To determine the neurological changes in the brain, this study analysed the relative power of sensory motor rhythm of the participants using electroencephalography. [Results] Results showed that the relative power of the sensory motor rhythm was significantly greater during awareness and imagery of sensory than during observation. [Conclusion] The results of this study suggest that awareness, imagery, and observation of sensation should be considered as useful modalities in people with psychological stress.

Key words: Electroencephalography, Observation, Sensory

INTRODUCTION

Psychological stress occurs when a person perceives environmental demands beyond his or her adaptive capacity1). Generally, stressful events affect the occurrence of a physical disease via affective states such as anxiety and depression1). Long-term exposure to chronic stress can be extremely harmful since it causes long-term or even permanent changes in several emotional, physiological, and behavioural responses that in turn affect disease development2).

Stress is likely to reduce the efficiency of cognitive function. Particularly, those who are under severe or chronic stress have overall impaired intellectual functions causing distortions and misinterpretations of situations, unproductive and ineffective thinking tendencies, and indecisiveness. However, since cognitive function and stress are related to each other, it may be difficult to distinguish whether a cognitive symptom is a stress response3). Such a tendency related to stress may cause such a cognitive symptom. These factors can also occur in patients receiving physical therapy and are part of the physical therapist’s consideration because they can affect treatment effectiveness.

A previous study examined coactivation-based cortical plasticity at psychophysical level in humans, according to a tactile stimulation protocol using electroencephalography (EEG)5). Their results demonstrate that sensory input in combination with cognitive factors, such as attention or imagery, induces cortical plasticity. However, there was no comparison among awareness, imagery, and observation, and the stimulation was limited to one part of the body.

Therefore, this study aimed to compare the effects of awareness, imagery, and observation on brain activity and to examine the difference of stimulating part of the hand or the back of adults with psychological stress.

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PARTICIPANTS AND METHODS

Before participating in the study, all participants consented according to guidelines of the Institutional Review Board. Participants were evaluated via a self-report questionnaire, the stress response inventory. Participants with scores above 81 were included in this study. Individuals were excluded from this study if they met one of the following exclusion criteria: (1) epilepsy, (2) mental disorders, and (3) sensory impairments.

To minimize external bias during the experimental process, participants were asked to maintain their sitting position without moving and with closed eyes until the experiment was completed. The five experimental conditions were as follows: awareness of hand tactile sensation, imagery of hand tactile sensation, awareness of back tactile sensation, imagery of back tactile sensation, and observation of back tactile sensation for another person. EEG was used in each of these five conditions.

The electroencephalograms of the participants were measured using a CANS 3000 QEEG-8 (LAXTHA, Inc., Daejeon, Republic of Korea), which measured the participants’ sensory motor rhythm (SMR) to compare the five conditions. EEG was recorded using Ag/AgCL cup electrodes attached to the scalp at C3 and C4 according to the international 10/20 system. In addition, a relative power analysis was conducted for each participant’s SMR. For statistical analysis, this study conducted a descriptive analysis and repeated-ANOVA test using PASW ver. 18.0 (SPSS Inc., Chicago, IL, USA). The significance level was set at p<0.05.

RESULTS

In total, 30 participants with psychological stress were included in the study (average age 21.8 years); eight were male (26.6%), 22 were female (73.3%). The stress response inventory average score was 99.1. As seen in Table, among the five conditions, the condition for observing the others was the significant lowest in the C3 and C4 (p<0.05). Among the five conditions, the significant highest was the imagery of back tactile sensation (p<0.05) (Table 1) (Table 2).

DISCUSSION

Brain activation via sensory information is important for processing information in humans. Brainwave examination using EGG is a noninvasive method that displays functional changes in the cerebrum and provides various useful data within a short time.

We compared the changes in EEG results that were measured in five conditions under eye closure in adults with psychological stress. The five experimental conditions are as follows: awareness of hand tactile sensation, imagery of hand tactile sensation, awareness of back tactile sensation, imagery of back tactile sensation, and observation of back tactile sensation for another person.

The SMR was lowest when participants observed another person and was most activated in imagery of back tactile sensation in adults with psychological stress. The SMR is functionally bound to the primary motor and sensory cortices, found centrally within the brain. The SMR can discriminate between three motor imagery classes from ongoing EEG and use this output to navigate in imagery.

Table 1. Differences according to conditions in the C3 SMR (N=30)

| Variable                             | Mean ± SD   | F   | p    |
|--------------------------------------|-------------|-----|------|
| Awareness of hand tactile            | 11.82 ± 11.38 | 10.58 | 0.000 |
| Imagery of hand tactile              | 16.96 ± 19.90 |     |      |
| Awareness of back tactile            | 16.63 ± 17.28 |     |      |
| Imagery of back tactile              | 23.09 ± 24.27 |     |      |
| Observation of back tactile with other person | 4.66 ± 2.79 |     |      |

Table 2. Differences according to conditions in the C4 SMR (N=30)

| Variable                             | Mean ± SD   | F   | p    |
|--------------------------------------|-------------|-----|------|
| Awareness of hand tactile            | 12.32 ± 12.65 | 10.4 | 0.000 |
| Imagery of hand tactile              | 15.67 ± 18.41 |     |      |
| Awareness of back tactile            | 15.27 ± 15.61 |     |      |
| Imagery of back tactile              | 22.62 ± 25.02 |     |      |
| Observation of back tactile with other person | 4.34 ± 2.71 |     |      |
According to the arousal level, increasing power of the SMR at the C3 and C4 was revealed\(^{10}\). Based on previous studies, it was suggested that among the five conditions, the activation of SMR during imagery of back tactile sensation in this study would cause the highest activity in the brain of adults with psychological stress with low attention level\(^{11}\). In fact, adults with psychological stress have low attention and may show a different pattern of brain activation than non-stressed adults. Therefore, this study investigated and examined the effects of brain activation using sensory awareness, imagery, and observation in adults with psychological stress.

This is also considered by physical therapists because they can occur in patients receiving physical therapy and can affect the effectiveness of treatment. Future studies should be conducted with more participations. Also, we believe that there might be more meaningful results when applied to the participations who are in physical therapy.

**Conflict of interest**
None.

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