뇌신경재활
발표일시 및 장소 : 10 월 26 일(금) 13:15-13:27 Room E(5F)

OP-Scientific 1-1

BCI action observation game superiorly facilitates the mirror neuron system in stroke patients

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Introduction
The action observation (AO) training based on mirror neuron theory is a promising strategy to promote motor cortical activation and motor function in stroke rehabilitation. However, because patients get bored easily during AO, its use has been limited and it could not sufficiently induce the recovery after stroke. The aim of this study was to investigate the effects of combined brain computer interface (BCI)-AO game on the facilitation of mirror neuron system in stroke patients.

Methods
We made a BCI-AO game that provides real-time BCI feedback. The degree of user's watching was provided by flickering action video game using Entity Relationship Diagram and Steady state visual evoked potential. Fifteen hemiplegic stroke patients were recruited in this study. All participants watched a video of repetitive grasping actions under two different conditions: 1) BCI -AO game and 2) conventional AO (without flickering and BCI feedback). The study was performed in following order: rest, training, BCI-AO game, and conventional AO, the last two in a random order. EEG was collected from 19 electrodes, using a DSI-24 (wearable sensing, San Diego, USA). Data were sampled at a rate of 128 Hz. To assess the activation of mirror neuron system, mu suppression in 8-13Hz was computed primarily at central sites (sensorimotor) C3 and C4 during each condition. Mu suppression indices were calculated as the log ratio of the power during action observation relative to the power during rest. Scalp distributions of suppression in the mu rhythm were conducted for each condition. Because the lesions of the brain showed inconsistancies among patients, suppression indices were also computed at additional sites across the scalp, separately for affected and unaffected hemispheres in each condition. Paired t-test was used to compare the mu suppression indices between BCI-AO game and the conventional AO condition, and between affected and unaffected hemisphere.

Results

The mean age of the participants was 67.87±12.74 years and the mean time interval between stroke onset and the experiment was 20.86 days (Table 1). The overall mu suppression was stronger in the BCI-AO game than in the conventional AO. This effect was significant at C3, P3, P4, O1, and O2 (Figure 1). The magnitude of mu suppression at central sites was higher in the BCI-AO game compared to the conventional AO, and this difference was significant at the C3, but not at the C4. The magnitude of mu suppression was significantly higher in BCI-AO game compared with conventional AO at C3/C4, T3/T4, T5/T6, P3/P4, and O1/O2 in the affected hemisphere, and at C3/C4, T5/T6, P3/P4, and O1/O2 in the unaffected hemisphere (Figure 2).

Conclusion

These s support that the BCI-AO game has superiority in facilitating the activity of mirror neuron system compared with conventional AO. The BCI-AO game could be applicable and effective compared with conventional AO and it could promote the recovery after stroke.

Table 1. Demographic and baseline characteristics of subjects

| Patient no.	Sex	Age	Days since onset	Etiology	Site of lesion	mRS	FMA upper	MMSE	MBI
1	M	48	42	Hemorrhage	Lt. thalamus (subcortical)	3	54	28	57
2	M	61	27	Infarction	Lt. med. medullary	2	63	29	76
3	F	74	75	Infarction	Lt. pontine	2	61	27	89
4	M	72	8	Infarction	Lt. MCA, PCA (cortical)	4	58	28	50
5	M	56	8	Infarction	Lt. thalamus (subcortical)	2	62	27	86
6	F	47	8	Infarction	Rt. Cerebellar	2	62	30	95
7	F	88	9	Hemorrhage	Rt. MCA (subcortical)	2	62	26	91
8	F	88	16	Infarction	Lt. pontine	4	59	25	8
9	M	69	26	Hemorrhage	Rt. MCA (subcortical)	4	28	30	53
10	M	82	30	Infarction	Rt. Cerebellar	2	61	28	78
11	M	61	24	Hemorrhage	Rt. MCA (subcortical)	3	64	25	54
12	M	78	14	Hemorrhage	Rt. MCA (cortical)	5	4	25	2
13	M	64	9	Hemorrhage	Rt. MCA (subcortical)	1	63	26	98
14	M	67	8	Infarction	Rt. lat medullary	4	64	30	57
15	F	63	9	Hemorrhage	Rt. Pontine	4	62	29	76
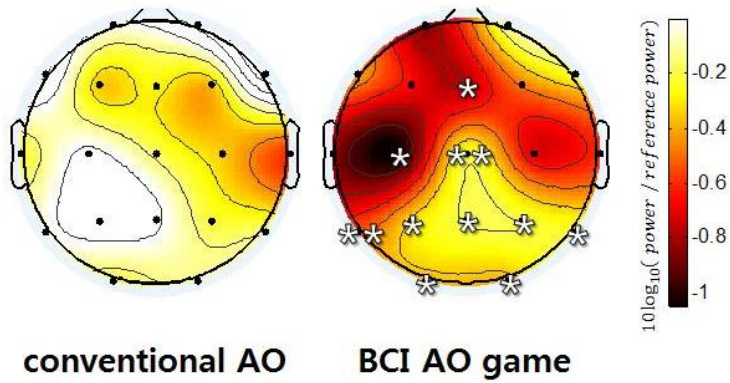
Fig1. Topographical representation of mu suppression in BCI-AO game and conventional AO conditions
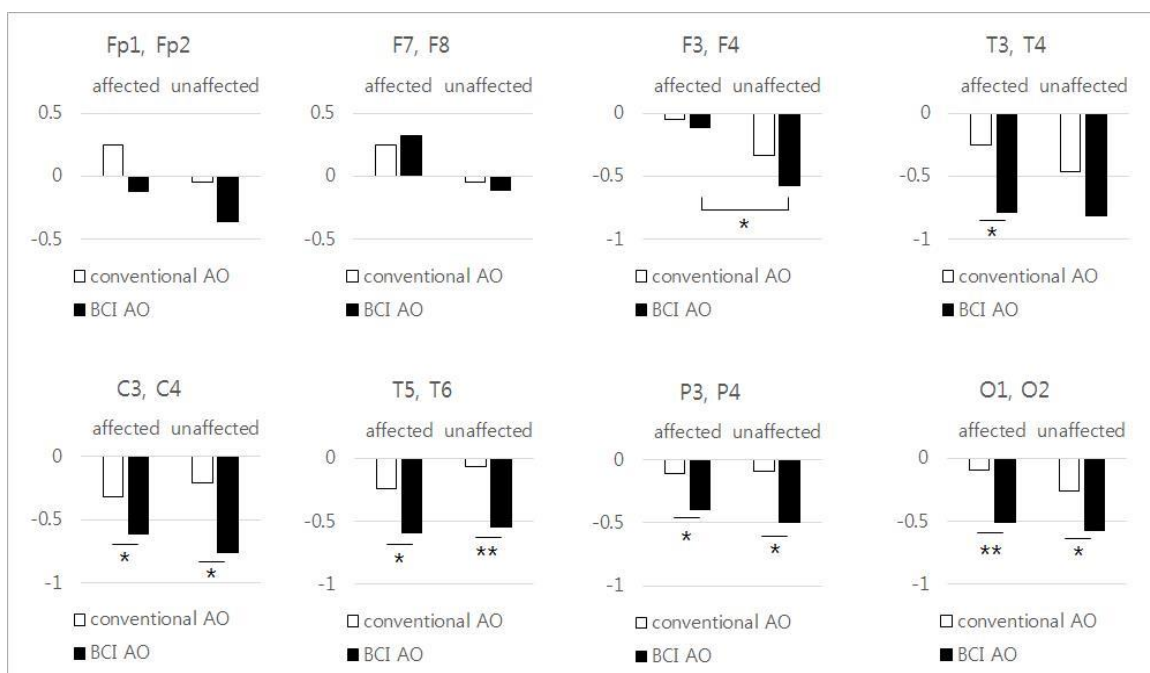

Fig2. Mu suppression expressed as log of the ratio of the power in BCI-AO game and conventional AO conditions, separately for affected and unaffected hemispheres