Motor task-based difference in brain networks : Preliminary results

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Introduction

Background

- The pathways of various brain regions are still unclear because analysis of EEG power spectra hardly represents interactions in the brain
- In existing studies, they represented brain network properties of stroke during motor tasks
- Most existing studies analyzed each pattern of brain network according to type of motor tasks as the Active and MI tasks rather than identifying the distinction between the Active and MI tasks
- Need to compare Active and MI task

Purpose

- We focused on examining this difference of network characteristics between the Active and the MI tasks

Hypothesis

- Centrality and SW of the Active task are bigger than those of the MI task with primary motor cortex as the center because our protocol focused on motor execution

Experimental design

Participants : 4 stroke chronic patients

No	Age	Sex	AH	Diagnosis	Grip Strength /Grasp		Purdue Pegboard Test		FMA		MAS/Elbow	
					AH	UH	AH	UH	AH	UH	AH	UH
1	58	M	Rt.	Lt. medial medullary infarct	NT	23.3	6	14	31	66	1	0
2	52	F	Rt.	Lt. MCA infarction, border zone	0	14.6	2	15	52	62	0	0
3	57	M	Rt.	Lt. pons infarction	8	27.6	6	12	40	66	1+	0
4	46	F	Rt.	Lt. BG infarction	1	16	7	15	54	66	1	0
Mean	53.25	M	Rt.		2.25	20.38	5.25	14	44.25	65	0.5	0
Std.	5.5	(50%)	(100%)		3.86	6.14	2.22	1.41	10.78	2.0	0.58	0

* AH : Affected Hand, UH : Unaffected Hand

* MAS : Modified Ashworth Scale

It is expected that patients will be more immersed in and more encouraged to participate in the rehabilitation therapy

Haptic device

- Grasp movement
- Motor task : Active & Motor imagery task
- Total 42 trials per each motor task

Experimental protocol

Analysis

EEG data analysis

- Calculating brain connectivity using PLV (Lachaux, 1999)
- Time window 1s, 250ms shift

Interesting frequency band

- mu(8-12Hz), low beta(13-20Hz), high beta(21-30Hz), gamma(31-50Hz) band

Results

Significant frequency band in motor task

- Significant difference of graph theory index between the Active and MI tasks (two sample t-test, p<0.05)
- There is statistical difference between two motor tasks in the high beta band**

Change of small-worldness (in high beta band)

- Small-worldness index in the Active and MI tasks are smaller than 1 (Left figure)
- Small-worldness index of the Active task were decreased depending on baseline, whereas the MI task have little change. This results show that brain network of the Active task have time-dependent properties than those of the MI task (Right figure)
- There are no significant difference of Small-worldness index between Active and MI tasks according to each time window**

Change of centrality (in high beta band)

- The node degree of Active on affected hemisphere is increased in the initial motor task phase (0 - 1 s), and shift to unaffected hemisphere (First row)
- Those of MI task have different characteristics (Second row)
- The node degree of the Active task is statically bigger than MI task in affected hemisphere.**
- Parietal area during (3 - 4 s) and (4 - 5 s), "return phase" of grasp movement, is significantly bigger than MI task (Third row)
- Early stage (1 - 2 s) have statistical difference in the affected hemisphere (two sample t-test, p<0.01)**

Conclusion

- We found differences of the networks properties involved in the Active and MI tasks with respect to centrality and small-worldness
- We were able to explain the possibility depending on the temporal change of brain network between the two motor tasks in the high beta band
- We will compare stroke patients and healthy control group for further study

Graph index (Rubinov, 2010)

Parameter	Formula	Description
Degree	$k_i = \sum_{j \in N} a_{ij}$	The number of link connections between each node
Small worldness Index	$L^w = \frac{1}{n} \sum_{i \in N} \frac{\sum_{j \in N, j \neq i} d_{ij}^w}{n-1}$, $C^w = \frac{1}{n} \sum_{i \in N} \frac{2d_i^w}{k_i(k_i-1)}$, $S = \frac{C/C_{rand}}{L/L_{rand}}$	This is acquired by the clustering the coefficient and the characteristic path lengths This index value is bigger than 1 if the network of each group has SW properties.

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