Temporal-Spatial Analysis of Acupuncture Effect:A Functional Connectivity Study

Y. Zhang[1], J. Tian[1,2], W. Qin[2], X. Pan[3], J. Liang[1], and L. Bai[1]

[1]Life Science Research Center, XiDian University, Xi'an, ShaanXi Province, China, People's Republic of, [2]Key Laboratory of Complex Systems and Intelligence Science, Institute of Automation, Chinese Academy of Sciences, Beijing, China, People's Republic of, [3]3. State Key Laboratory of Cognitive Neuroscience and Learning, Beijing Normal University, Beijing, China, People's Republic of

Introduction:

Acupuncture, a traditional Chinese healing technique, is gaining popularity as an alternative and complementary therapeutic intervention in the Western world. In the current study, we mainly research the temporal-spatial functional connectivity of acupuncture effect. We first applied a hierarchical cluster analysis combined with dendrogram sharpening [1] to investigate the spatial functional connectivity and then the results were used to further study the temporal functional connectivity through the temporal cluster analysis (TCA) [2] during the two resting state: post-acupuncture and post-sham resting state.

Method:

The study was performed on 18 right-handed healthy subjects. In the first stimulation, real acupuncture at ST.36 lasted for 1.5 minutes. Then, 12.5 minutes resting state continuous scan was performed. Second stimulation was sham acupuncture, the needle manipulation and depth are identical to that used in real acupuncture, but performed at a nonacupoint 2-3 cm apart from ST.36. Subjects were scanned in a GE 3T Signa scanner (TE 30 ms, TR 1.5s, matrix 64x64, FOV 240mm, flip angle 90, in-plane resolution 3.75x3.75 mm). After preprocessing the fMRI data, Cluster analysis was performed individually on each subject. The dendrogram sharpening algorithm was applied twice with (child, core) parameters set to (2, 40) on the first run and (10, 40) on the second run. Then, choosing different regions from distinct clusters which we have got, we implemented the TCA algorithm to postprocess the data to detect the temporal peaks of the specific region in the environment of Matlab..

Result:

Figure.1a shows the single linkage dendrogram for the simulated data set. Figure.1b shows the once-sharpened data of figure.1a, resulting tree clearly reveals the presence of two distinct clusters in the data set. After implementing on the fMRI data, we obtained two obvious distinct clusters: cortex includes premotor, SI and SII and subcortex includes amygdale, thalamus and caudate nucleus. Therefore we chose premotor and thalamus as the representative of both distinct clusters to perform TCA. The results of TCA curves are presented in Figure.2, during post-acupuncture resting state thalamus has two peaks at 75 and 400 scans, and so do the premotor at 370 and 400 scans, and during post-sham resting state thalamus has only one peak at 390 scans, while premotor also has two peaks at 360 and 460 scans.

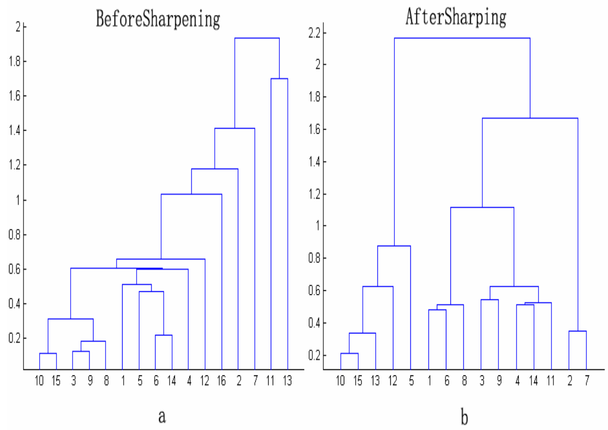

Fig.2 Dendrogram Sharpening

Discussion:

Dendrogram sharpening might be a very helpful tool for analysis of activation pattern in fMRI. This approach is model free and does not require prior assumption about the number and location of the clusters. Because of the large amount of fMRI data makes it difficult to detect networks of brain activity. Sharpening significantly simplifies the identification by reducing the data set and preserving its structure. As Fig.2 shows, we can see the temporal differences of thalamus and premotor chosen from distinct clusters, which indicates that TCA is an effective way to detect the temporal functional connectivity of clusters in acupuncture fMRI data.

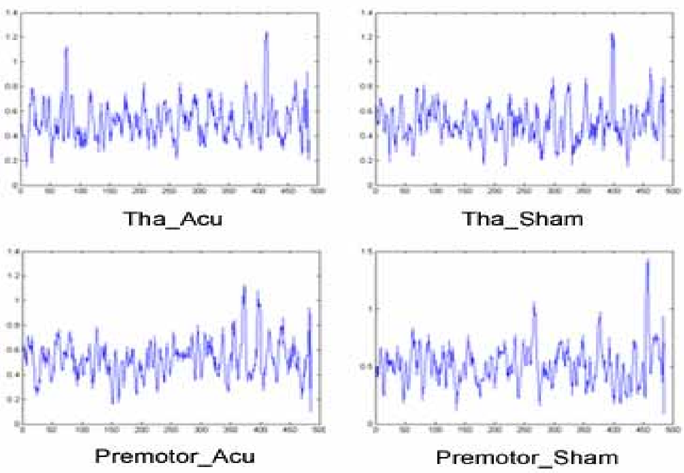

Fig.3 Result of TCA

Reference:

[1]. Larissa Stanberry, Rajesh Nandy, Dietmar Cordes. Cluster Analysis of fMRI Data Using Dendrogram Sharpening, Human Brain Mapping, 20:201-219, 2003.

[2]. Yijun Liu, Jiaohong Gao, The temporal response of the brain after eating revealed by functional MRI, Nature, Vol 405, 2000.