

Graph Theory-based EEG Connectivity in Epileptic Children Receiving Ketogenic Diet Therapy

由腦波網路圖形理論 看生酮飲食治療兒童癲癇之療效相關性

高雄長庚 兒童神經科主治醫師 蘇亭毓

洪碧 蓮 醫師、彭徐鈞 博士

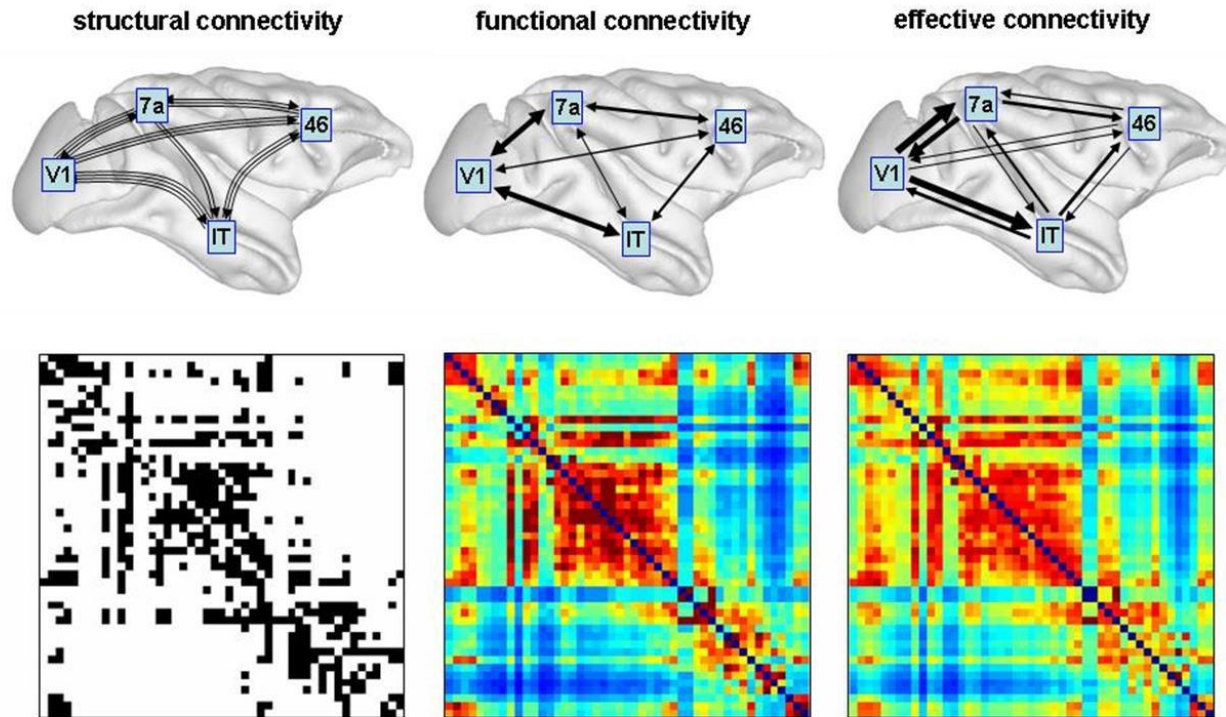


高雄長庚紀念醫院
Kaohsiung Chang Gung Memorial Hospital



臺北醫學大學
TAIPEI MEDICAL UNIVERSITY

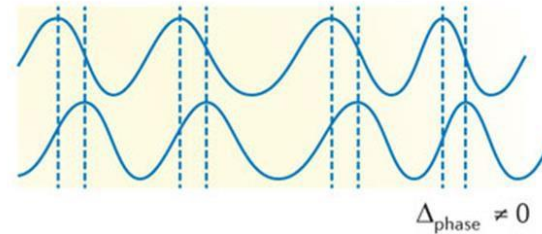
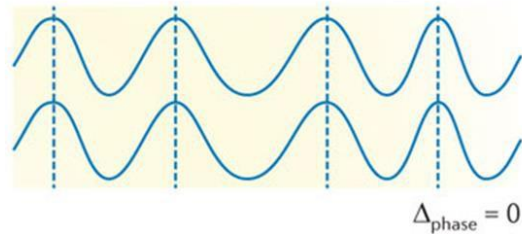
Connectivity in Brain



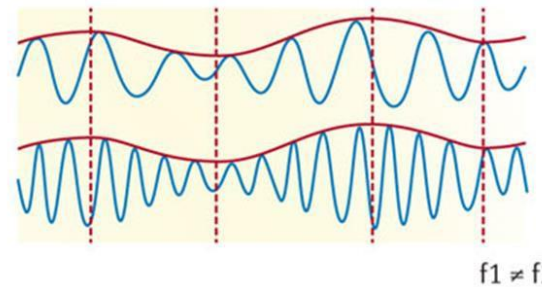
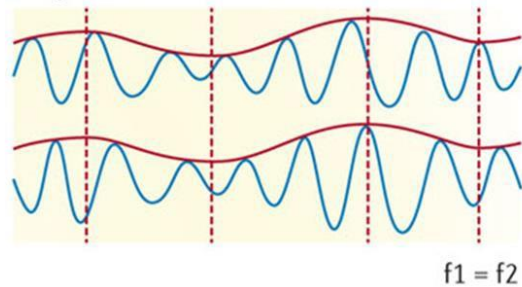
Friston K. **British Medical Bulletin** (1996)

Redefining “Correlation”

a Phase coherence



b Amplitude correlation



Nature Reviews | **Neuroscience**

Siegel M et al. **Nature Reviews Neuroscience** (2012)

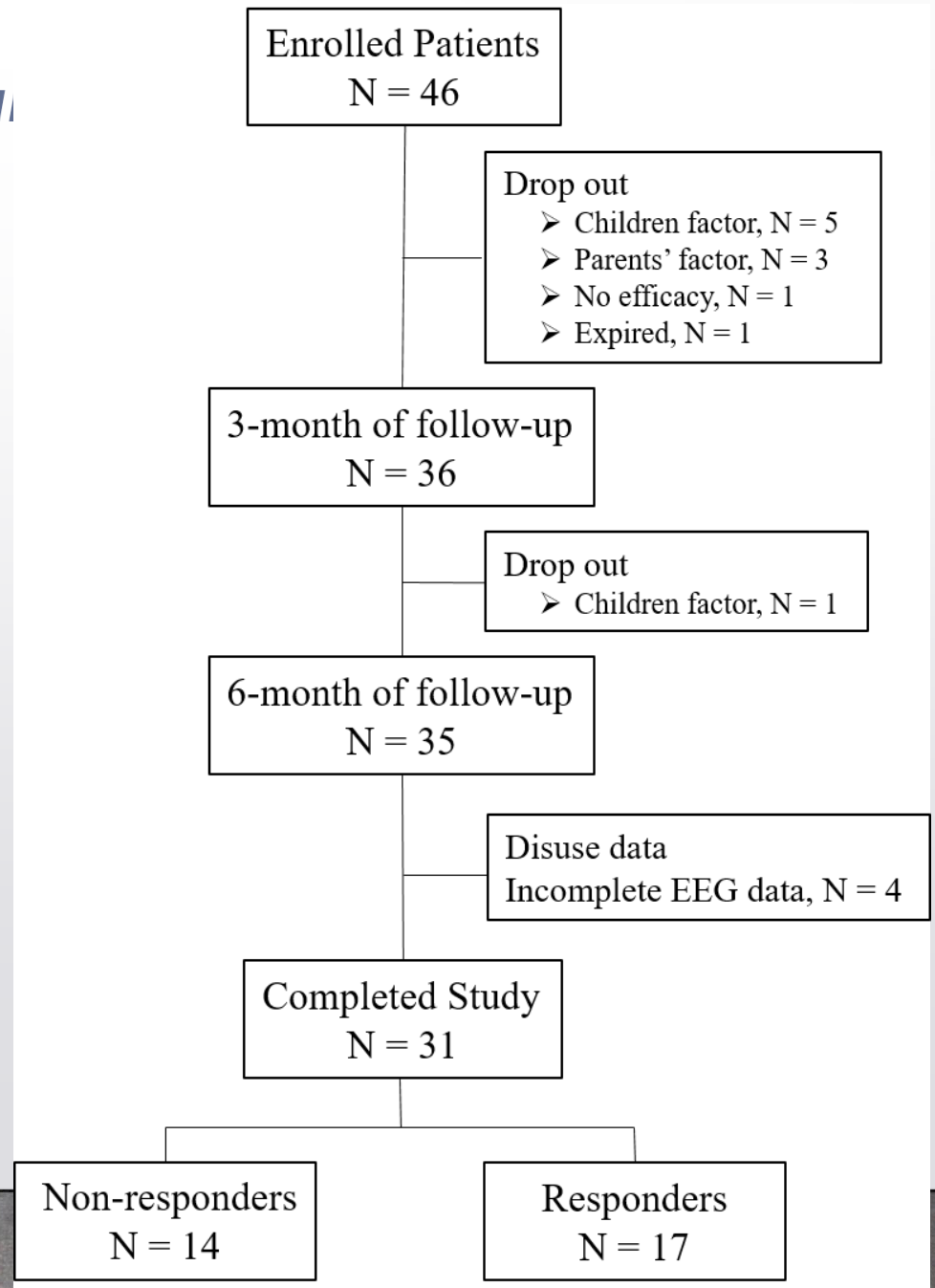


Ketogenic diet therapy (KDT)

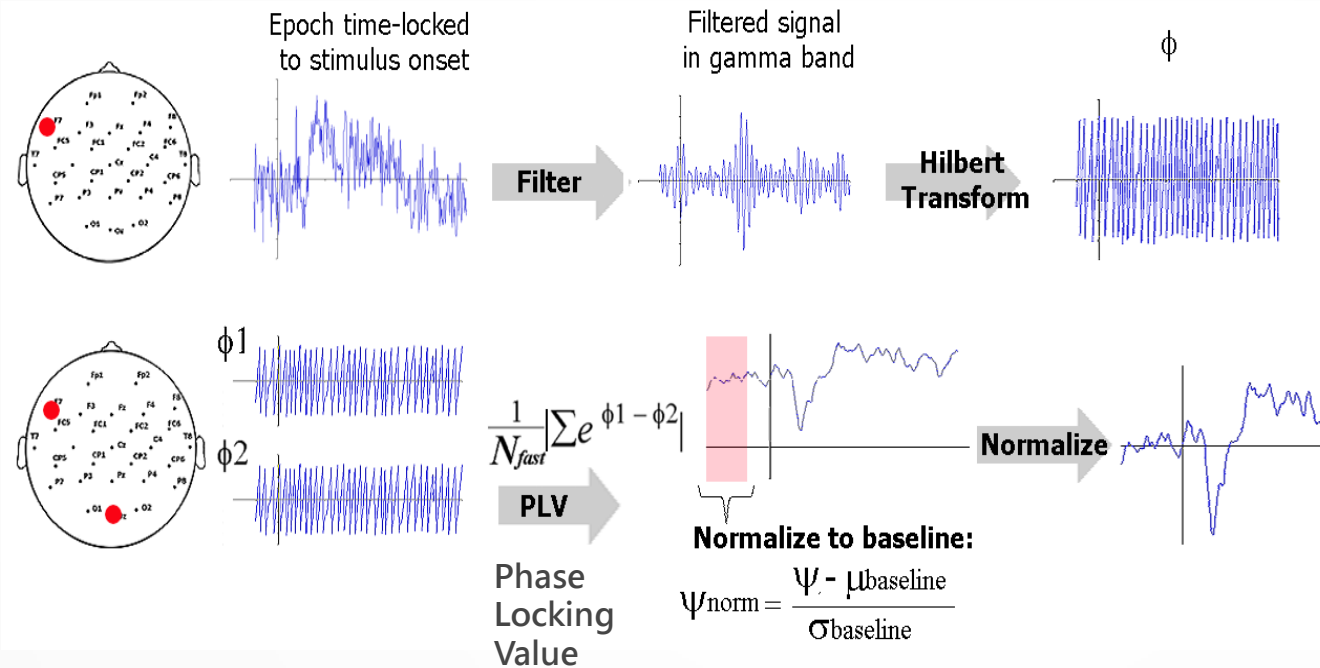
- A diet with **high fat** and **low carbohydrate** content
- Widely used for treating **drug-resistant epilepsy**
- Produced a $\geq 50\%$ reduction in seizure frequency in **33% of patients**, and **15.6% of patients were seizure free**
- Every patient responds to KDT differently
- to evaluate the capacity of EEG connectivity to determine/predict KDT effectiveness

Subject Enrollment

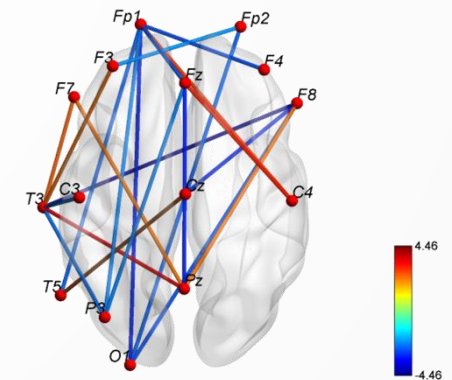
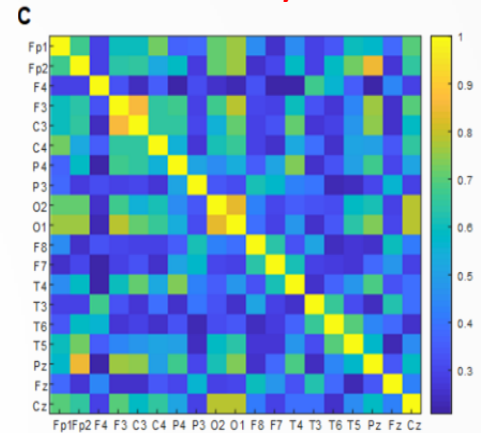
Screening for contraindications to KDT:
serum ammonia, lactate, cholesterol, triglyceride levels, urinary organic acids, and amino acids via blood spot testing, porphyria



Network reconstruction



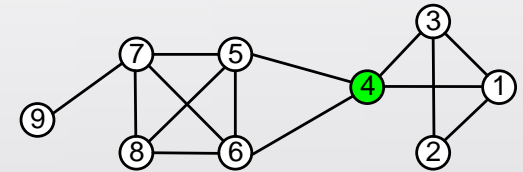
19x19 weighted connectivity matrix



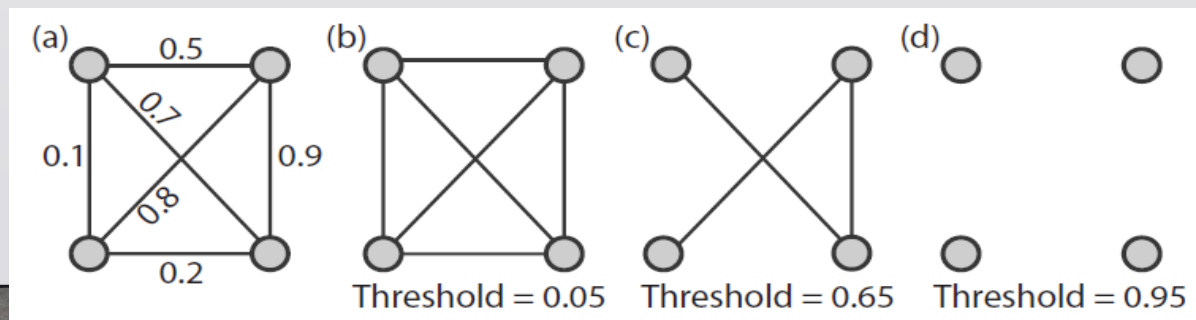
Graph Theoretical Analysis

For each of the obtained graphs, the following indices were calculated:

- (1) **basic measures** (nodal strength)
- (2) measures of **integration** (global efficiency)
- (3) measures of **segregation** (clustering coefficient)
- (4) measure of **centrality** (**betweenness centrality**)

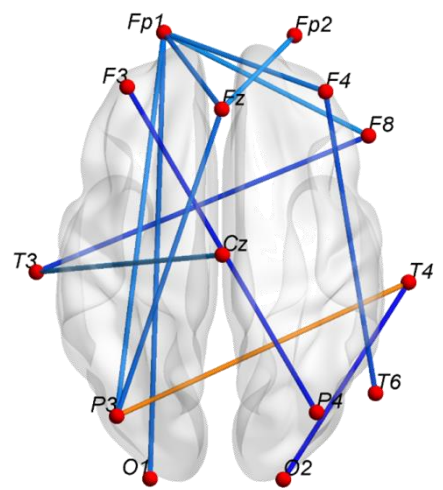


Proportional threshold

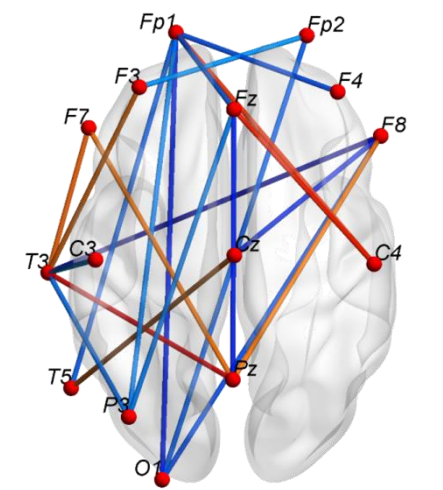


delta

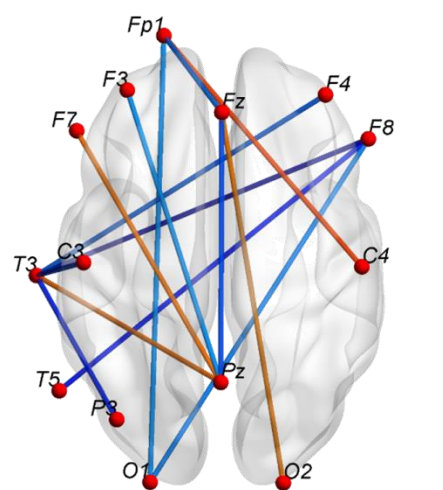
Responder (6MTH)
vs
Responder (0MTH)



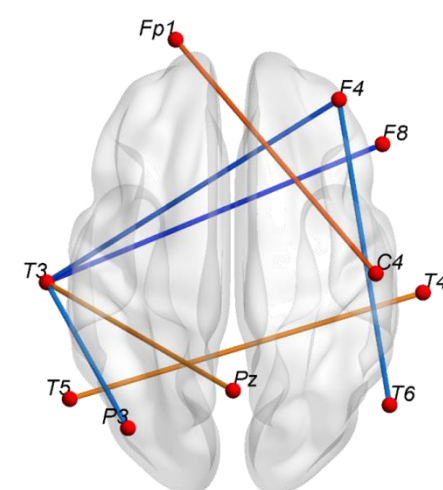
theta



alpha

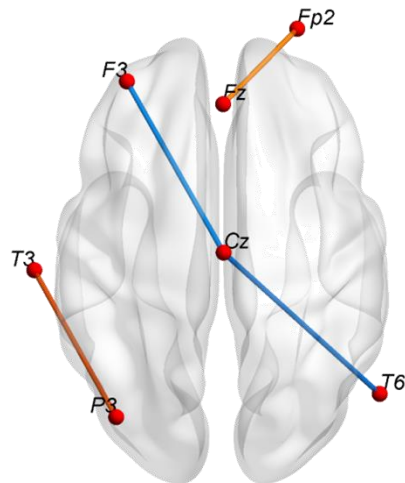


beta

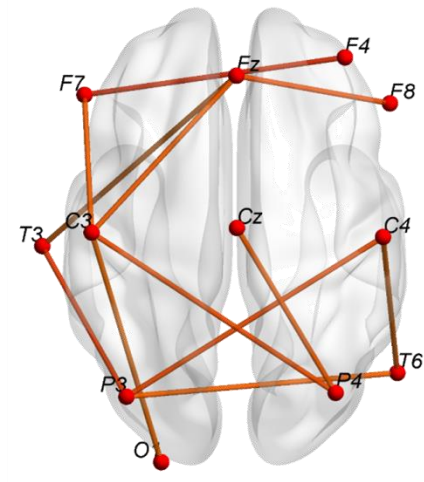


delta

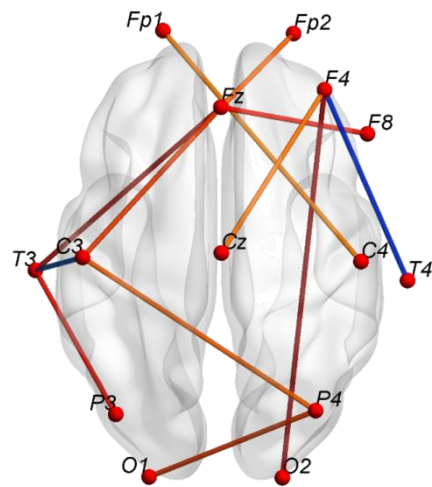
Nonresponder (6MTH)
vs
Nonresponder (0MTH)



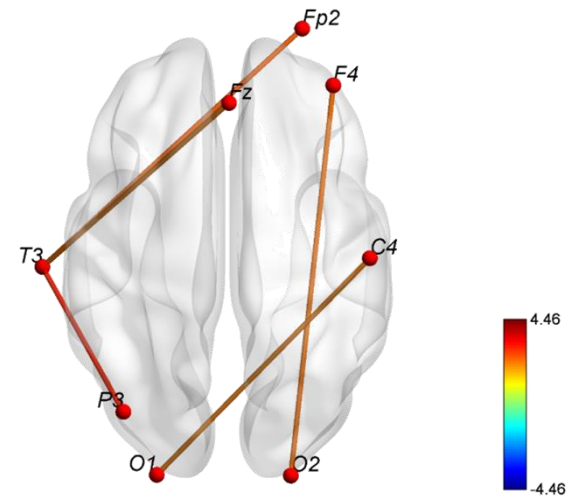
theta



alpha

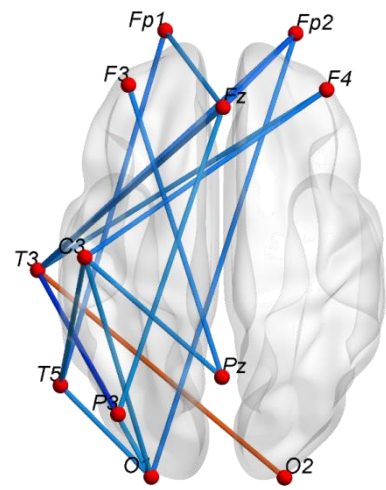


beta

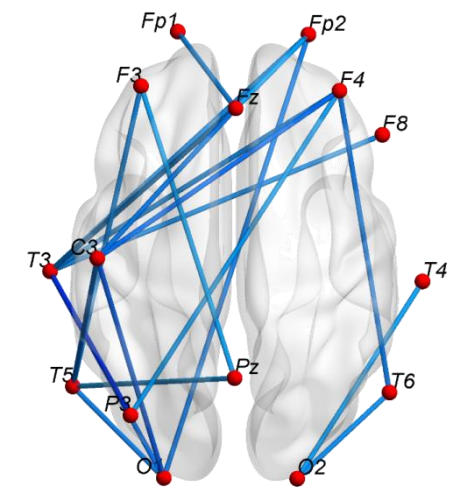


delta

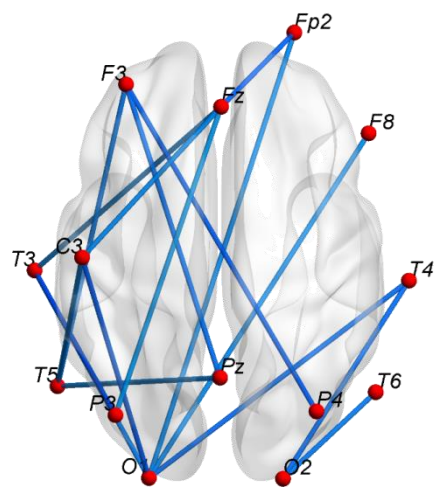
Responder (6MTH)
vs
Nonresponder (6MTH)



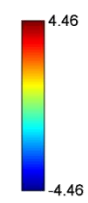
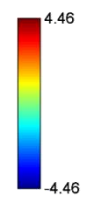
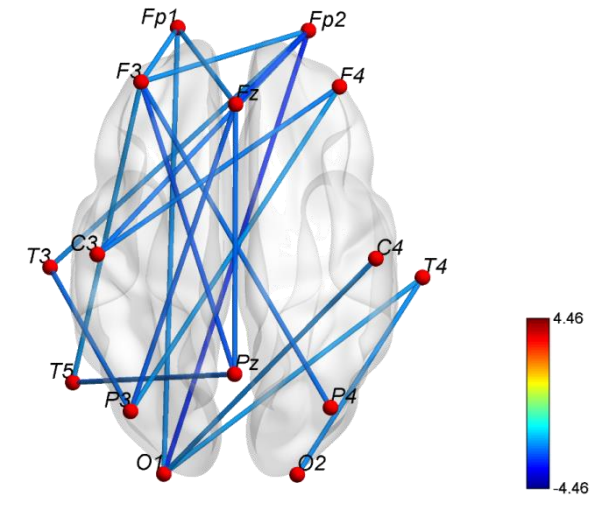
theta



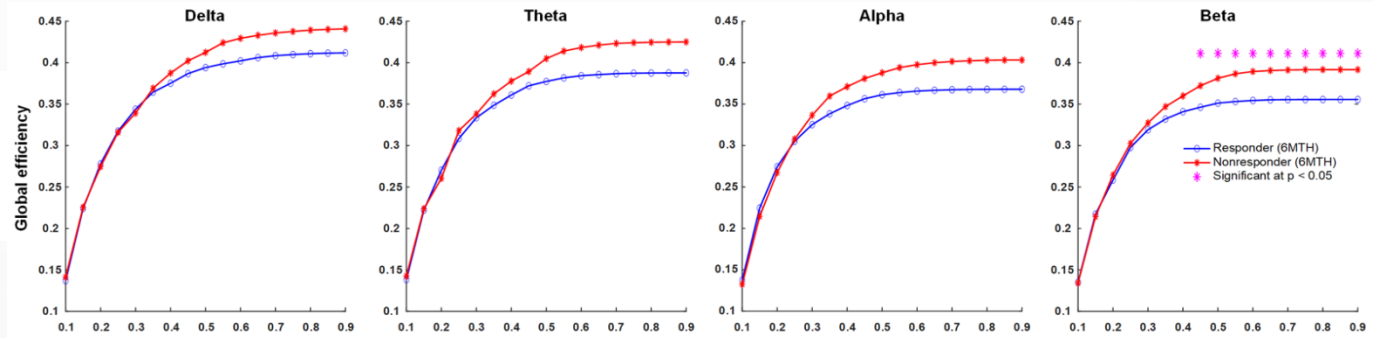
alpha



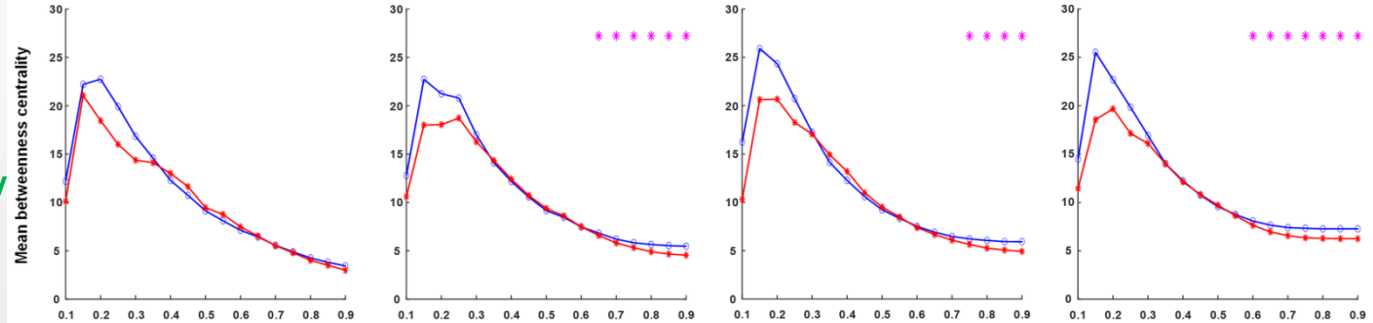
beta



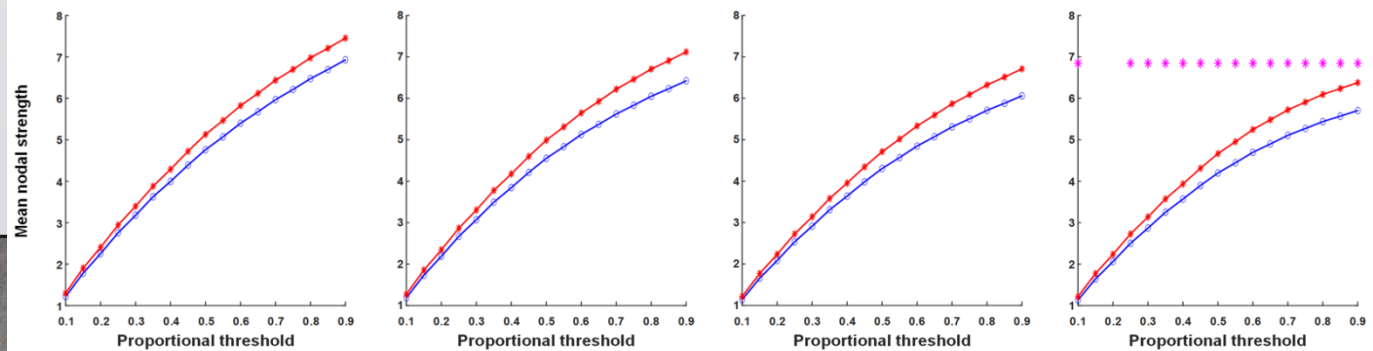
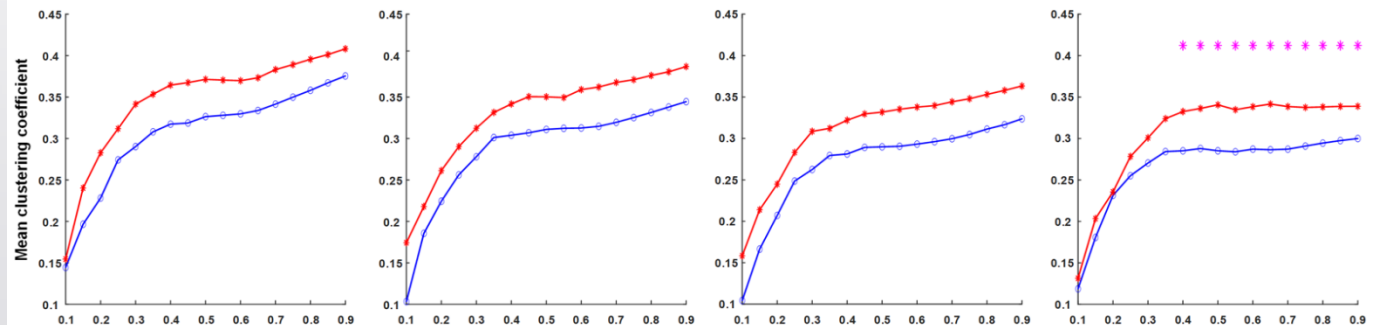
Integration
global efficiency



Centrality
betweenness centrality



Segregation
clustering coefficient

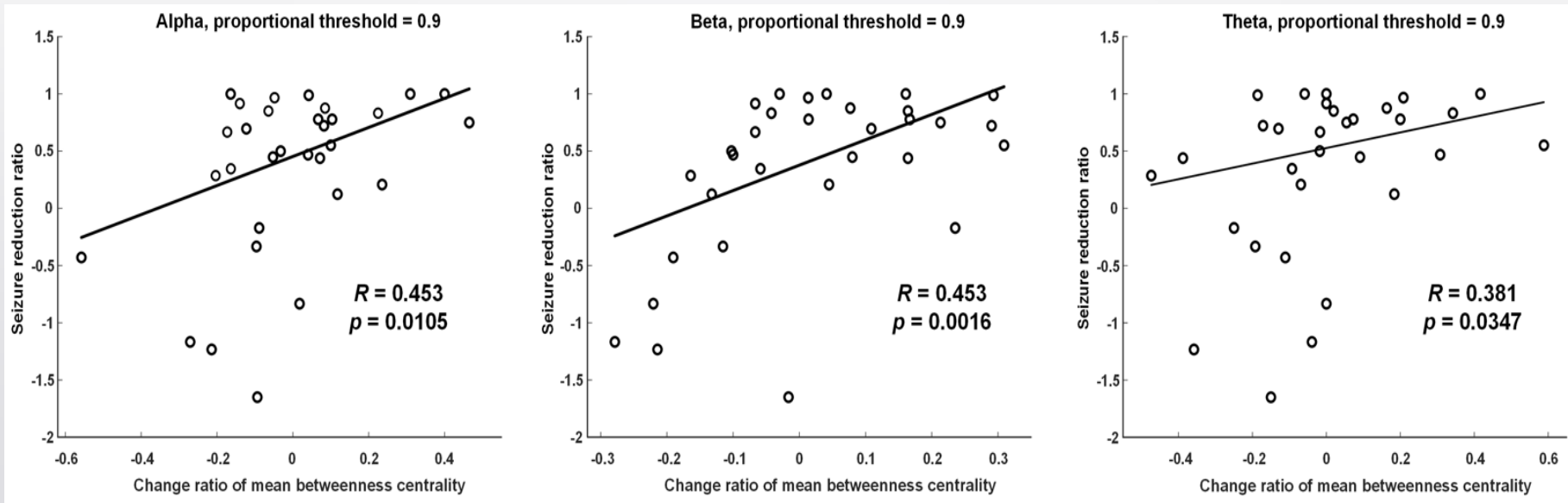


Responder (6MTH)
vs
Nonresponder (6MTH)



Linear regression analysis

X: alteration of **mean betweenness centrality** (90%) in alpha, beta, and theta band
Y: the **seizure reduction ratio**





Conclusion

- After 6th month's KDT, the general interictal **EEG connectivity reduced in KDT responders** (compared with itself or non-responders).
- **Betweenness centrality increased**; its alteration ratio positively correlated with seizure reduction rate.
- KDT tended to **modify the low- to moderate-intensity connections.**



Thanks for your
attention!