

# Do temporal trajectories of human brain activities support visual decision-making?

*Group: Dinners (Pod: 154)*

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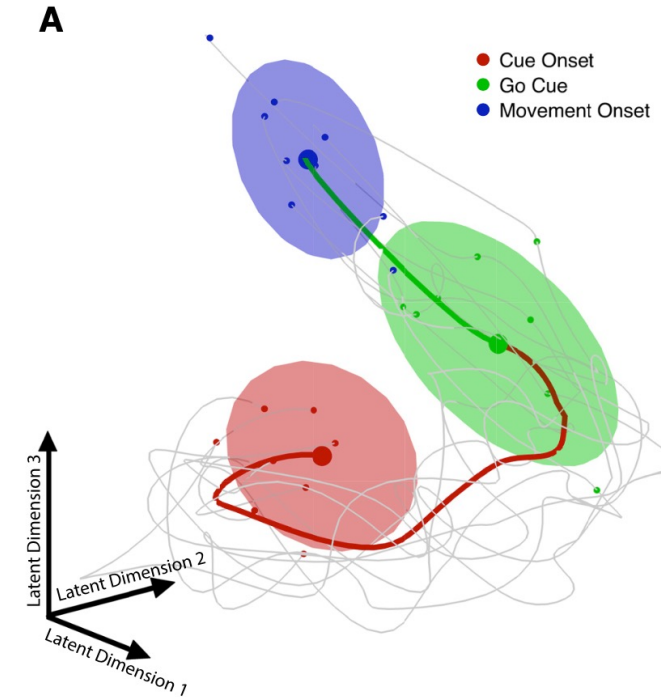
*Mentor: Ruyuan Zhang*



# Background

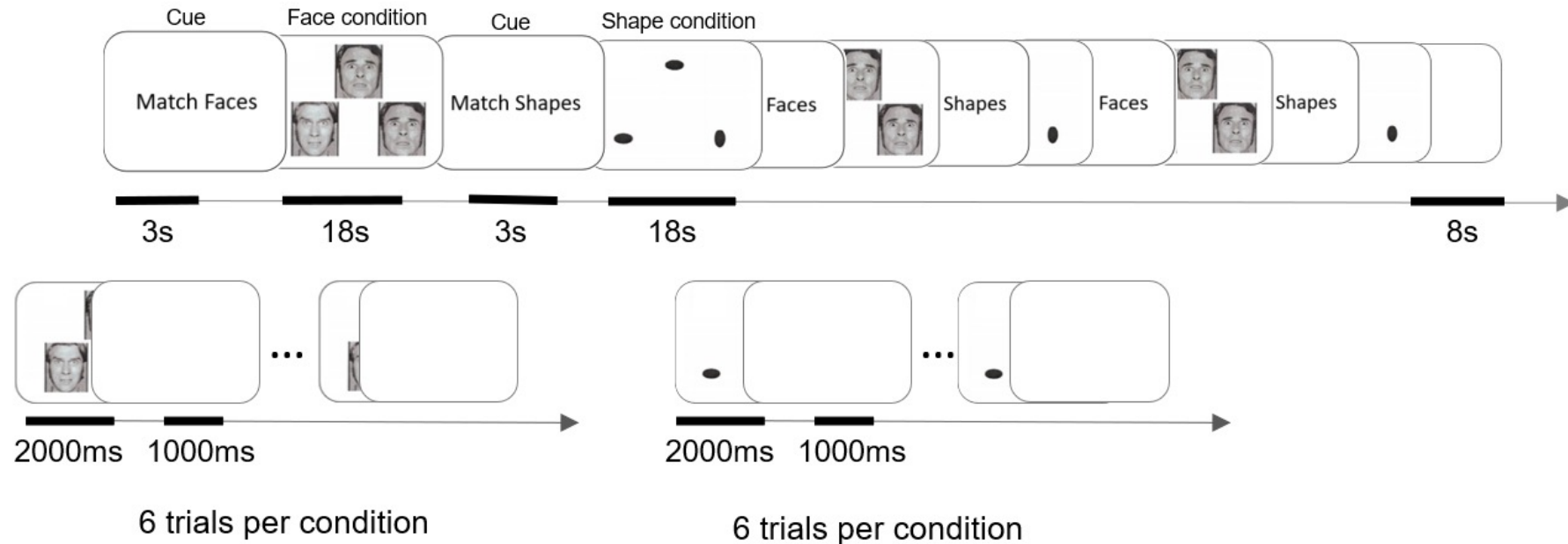
Previous animal studies have shown that neural population activities fluctuate in a low-dimensional manifold and the low-dimensional temporal trajectories contribute to decisional processes (Michaels, J. A., et al., 2015).

It remains unclear whether large-scale whole-brain activities also exhibit temporal trajectories that are linked to visual decision-making (Cunningham, J. P., & Yu, B. M., 2014).



# Dataset: Human Connectome Project (HCP)

One run of 6 blocks of 36 trials



**Figure 1. Experimental design**

## Subject

- 339 subjects were recruited (age: from 22 to 35, Geminus)

## fMRI data acquisition

- TR = 720 ms, TE = 33.1 ms, flip angle = 52°, BW = 2290 Hz/Px, in-plane FOV = 208 × 180 mm, 72 slices, 2.0 mm isotropic voxels, multi-band acceleration factor = 8.
- Two runs of each task were acquired.



# Data Analysis (1)- background connectivity

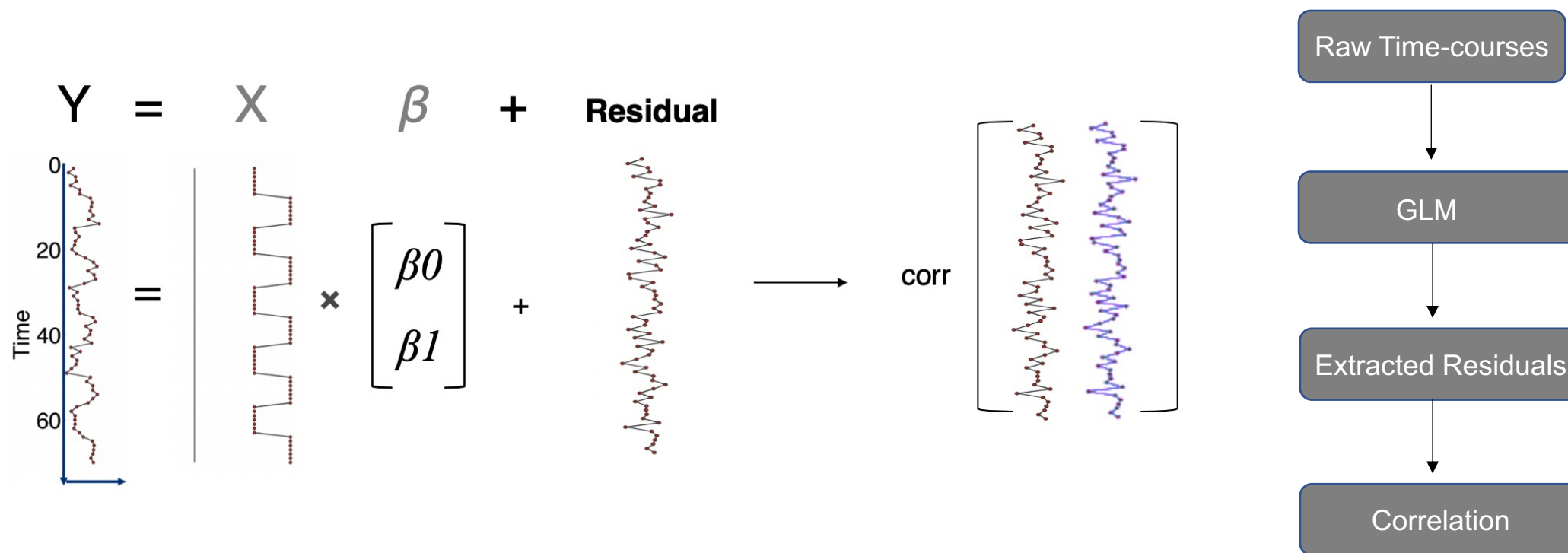


Figure 2. Background Connectivity Analysis pipeline.

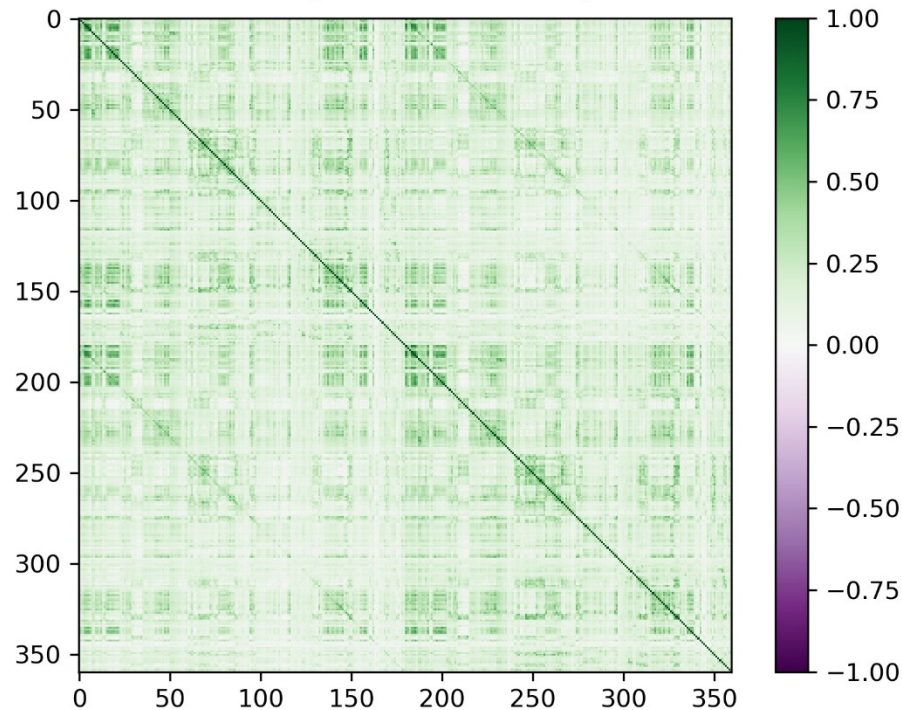


# Results (1)

## Background Connectivity of different task conditions(360 parcels)

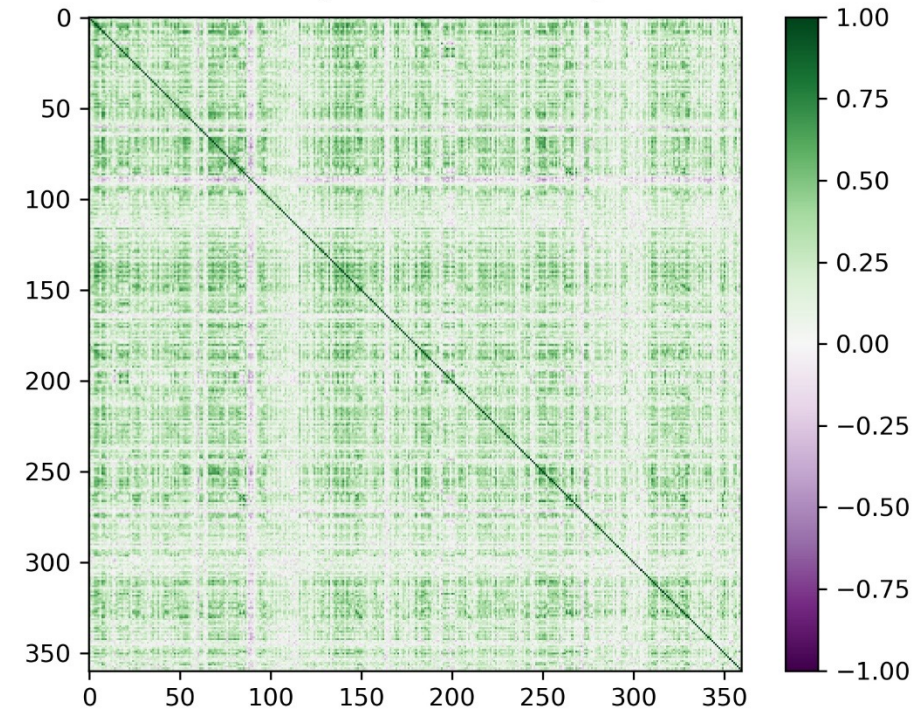
Face

Background Conectivity



Shape

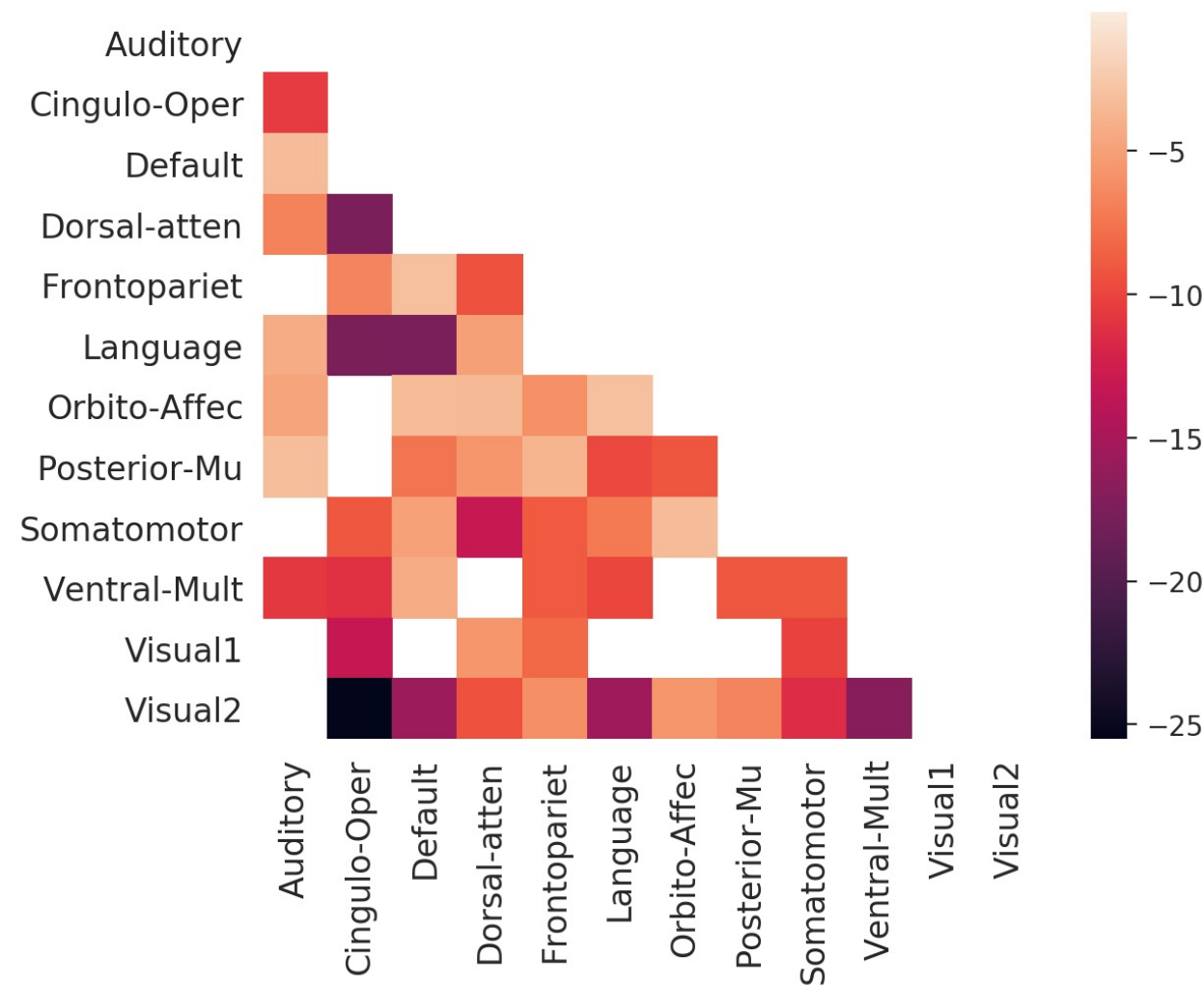
Background Conectivity



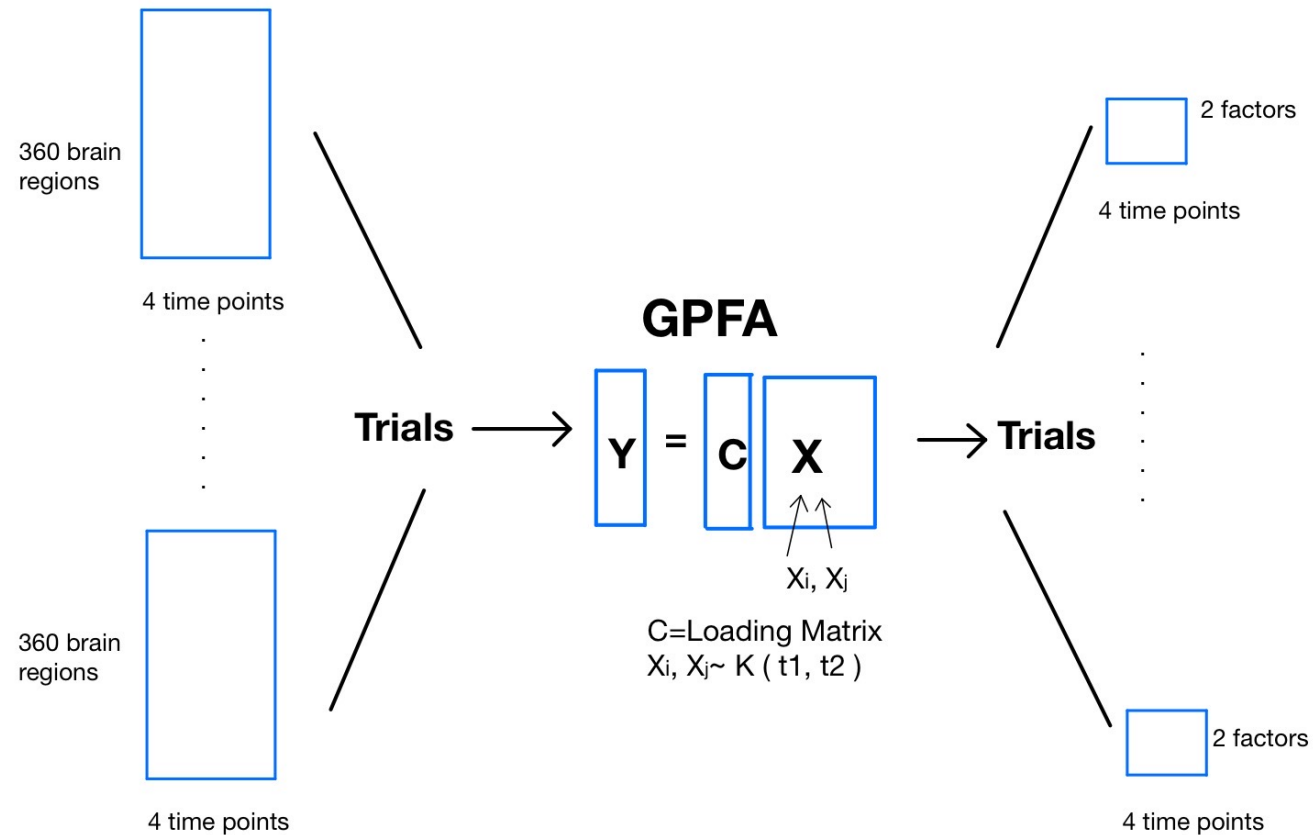


# Results (1)

Z-value of background connectivity comparison (face v.s. shape)

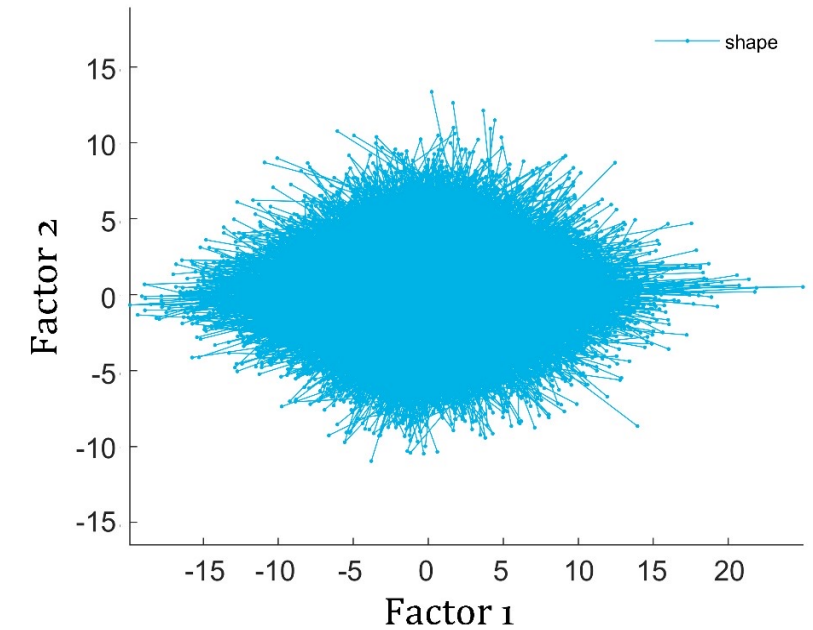
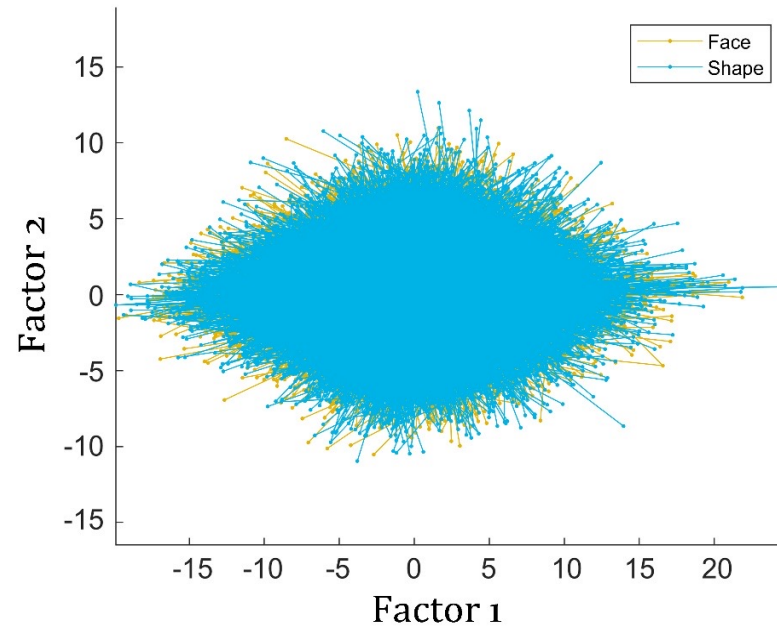
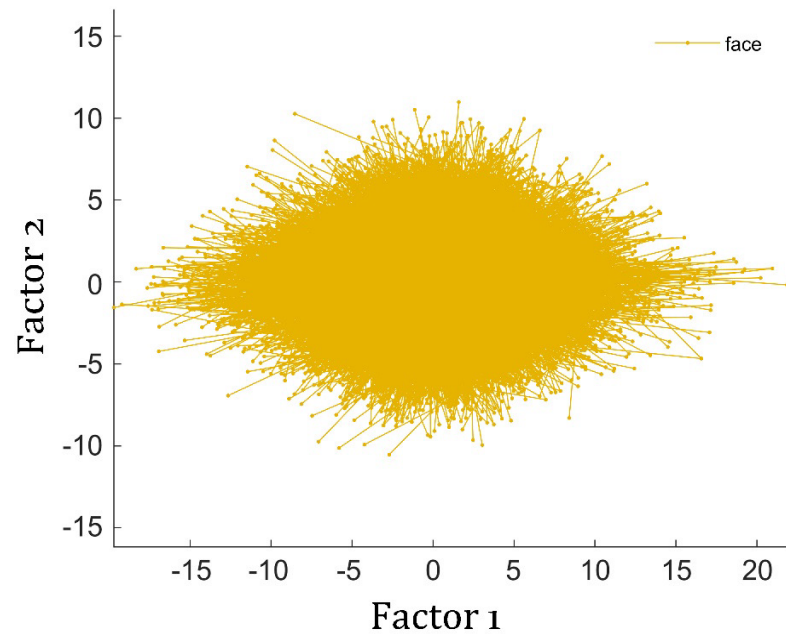


# Data Analysis (2)- GPFA



# Results (2)

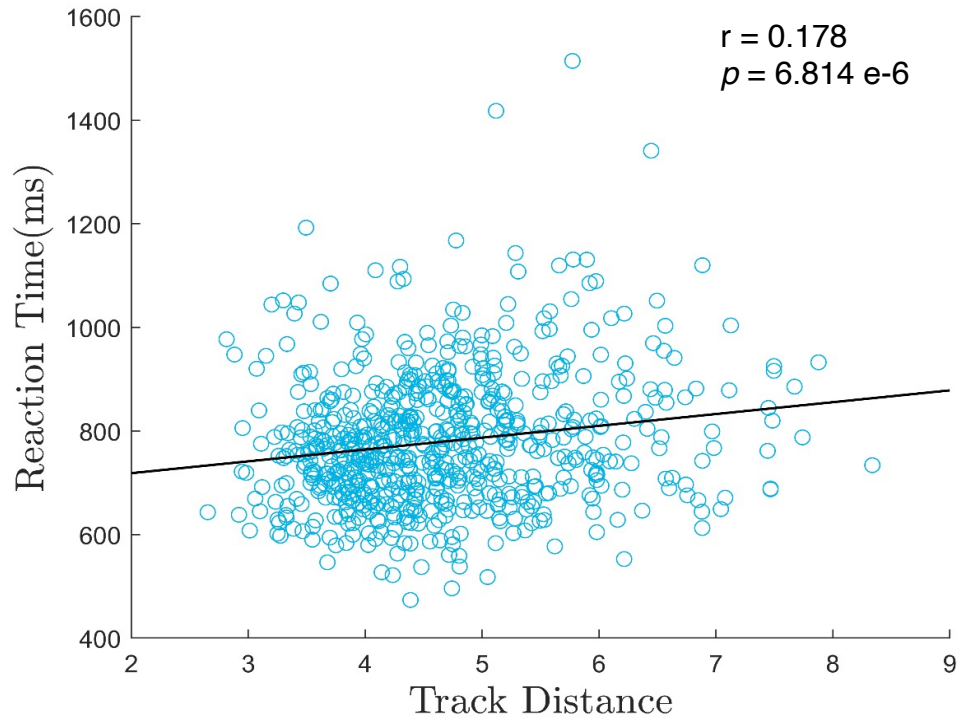
## Trial-based trajectory of different visual stimulus types



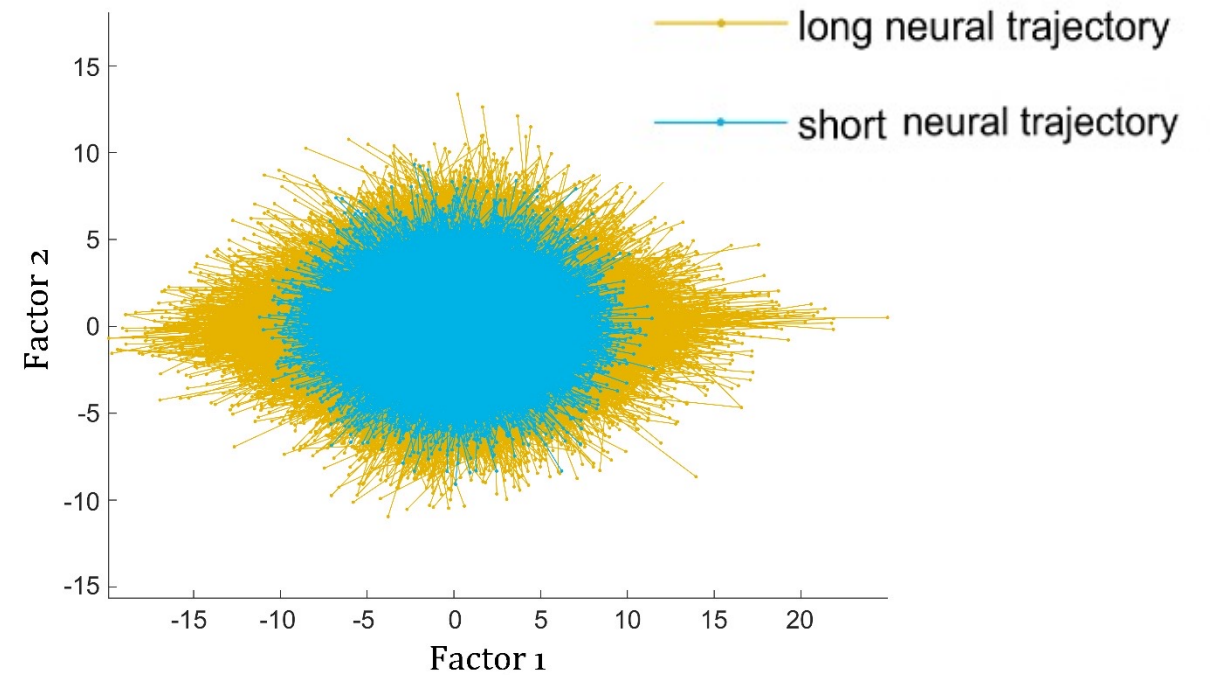


# Results (2)

## Correlation between average trial-based trajectory distance and reaction time

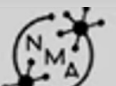
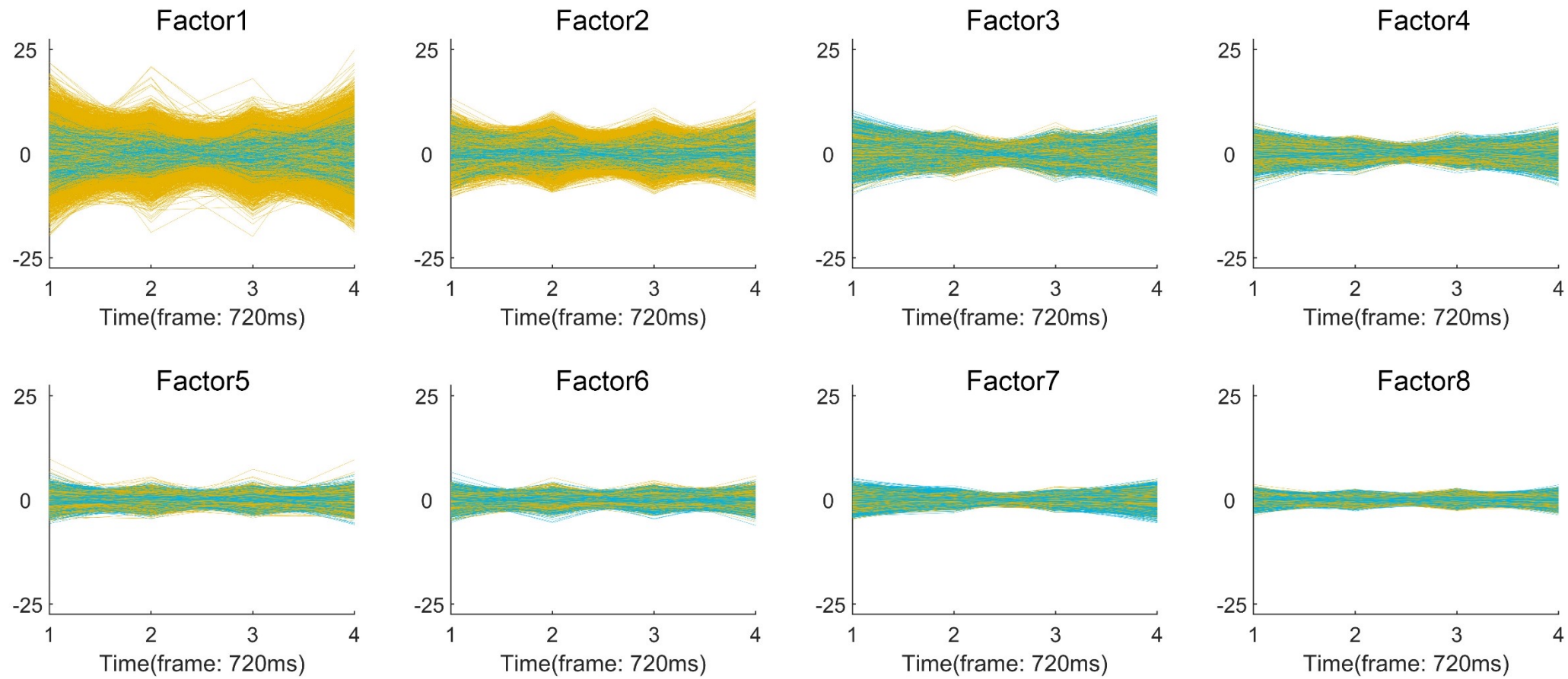


## Trial-based trajectories split by geometric length



# Results (2)

## Temporal trajectories in each dimension



# Conclusions

- Whole-brain functional connectivity analyses suggest that in both face and shape condition, brain regions are highly positively interconnected and the two condition differs a lot in the sense of neural network.
- GPFA suggests that the neural trajectories do not differ between the face and shape condition and that the major difference between long and short neural trajectories lies in factor 1.
- We found average trial-based trajectory positively correlated with and reaction time.



# Discussion

- Why do functional connectivity analyses suggest a significant face-shape difference but GPFA does not?

Functional connectivity reflects **static** response coupling between brain regions, while temporal trajectories revealed by GPFA reflect the **dynamic** coupling between brain regions. The functional connectivity maps differ though response amplitudes or dynamics revealed by GPFA do not differ between the two conditions.



# Experience

**Time backs to the first day, a hungry, drowsy and heavy-eyed man** turned off his iPad and rushed to the bathroom to take a shower. That's me, who had never imagined how intensive a day of NMA could be. The past four hours I suffered from catching up my group members' rapid discussions. As a freshman who majored in mathematics and has little experience, the words they used are beyond my vocabularies, such as Temporal Gyrus, or even trial. Actually, I had no idea of what the "trial" means in the structure of an experiment. Honestly, I felt somehow frustrated when the water fell onto my head from the shower handsets, which could be reviewed as a beginner's torturous self doubt.



**Time flying to the W1D5, a hungry, drowsy and heavy-eyed man** turned off his computer and rushed to the bathroom to take a shower. That's me, who had never imagined the dataset we found could not be downloaded successfully. We have discussed several days about our project based on this dataset and set our following plan, but the dataset prohibited us from all our anticipation. We, therefore, need to restarted our project from the very beginning. Everything seems to be misty so as my bathroom looks. Indeed, I had no idea of what I should do this weekend. However, my team members, who are indomitable and trustworthy, seemed to be confident about handling it, which really gave me a lot of strength and power.



# Experience

In my deep mind, I got a faith that all the difficulties could be conquered soon.

**At present, a hungry, drowsy and heavy-eyed man** was typing in front of his computer before he would rush to the bathroom to take a shower. That's me, who had spent nearly 3 weeks with my teammates who had already become my friends. Although we have some final steps remaining to be done, I am feeling a sense of completion. For me, the completion doesn't mean the finish of our project, but it is about the time we spent together, the questions we put forward and dealt in company with each other. I valued the time most. In this uncertain time, we meet online, and we will say goodbye online. Through each one's face and voice, I meet him or her synchronously, just like a neuron and another neuron. The connections between ourselves are mysterious, some form the network, some result in the outcome. Our venerable life is like the synaptic plasticity, sailing in the time of mist, searching for a light. I know when I finish my shower and take up my laptop again, the light will arise.





***Thank you for watching!***

*Thanks, and where are*



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