## ABSTRACT

There is a growing research interest to extract the temporal dependency between brain networks. Among several existing methods, functional network connectivity (FNC) is one of the widely used approaches to capture the intrinsic functional relationships among brain networks. In this study, we introduced a novel approach that uses FNC matrices of Adolescent Brain and Cognitive Development (ABCD) data to evaluate multiple overlapping brain functional change patterns (FCPs). Results show several highly structured FCPs that have a significant change over a two-year period and become stronger with age including brain functional connectivity between visual (VS) and sensorimotor (SM) domains. Our approach is a powerful tool to visualize and evaluate patterns of whole brain functional changes in longitudinal data.


## METHODS

In our experiment, we used subject-wise FNC values from ABCD data computed from a fully automated spatially constrained ICA approach using the Neuromark templates [1]. We use FNC from the baseline and two-year scans data. We computed the difference FNC matrices (ΔFNCs) by taking the cell-wise difference between the baseline and two-year FNC data. Next, we decompose the ΔFNC matrices with a group level ICA using the infomax algorithm to capture the covarying patterns of change (FCPs). This resulted in FNC sources and subject-wise loading parameters. We also identified FCPs which show a significant longitudinal change relative to zero by computing a one sample t-test on the loading parameters and evaluating the statistical significance with 95% significance level corrected for multiple comparisons.

## RESULTS

The present work used the dataset from the release 2.01 of the Adolescent Brain Cognitive Development (ABCD) study (https://abcdstudy.org/). In this study we used 3,489 subjects who had been scanned both at baseline and at a two-year follow-up visit.

Experimental results for the FCPs are shown in Figure 1. We have computed 5 components from the ICA estimate. In the figure, we plot all components and the associated T values. From the figure, we see the evidence of considerable modularity in the results, suggesting structured changes with age. We observe that the FCPs for components 2 and 4 have the highest positive (component 2) and negative (component 4) T-values. Here the T-value tells us the degree to which each FCP is expressed in the data (either positively or negatively). A high negative (positive) value of T represents increased (decreased) expression of the given FCP with age.

In the figure, we see that component 4 has the largest negative T value of -14.02 meaning this FCP is strongly (negatively) expressed in the data. In the plot, visual domain (VSN)-sensorimotor domain (SMN) and cerebellar domain (CBN)-sub cortical domain (SCN) exhibit the largest negative values, which implies increasing brain functional coupling over the two-year period. In addition, VSN-CBN and SMN-SCN domains show decreasing change patterns with age.

For component 2, we observe decreasing functional connectivity coupling between default mode domain (DMN) and SMN with age. The associated T-value (of 11.47) is positive for component 2 meaning this

FCP is strongly (positively) expressed in the data. We also see increased functional coupling between the CBN and DMN regions over the two-year period.

## CONCLUSION

In our work we have used delta FNC matrix to investigate brain functional connectivity change with age. Our results identified several FCPs showing a significant change over a two-year period. With increased age there is a stronger functional connectivity coupling between the VSN and SMN domains and decreasing anticorrelation between sensorimotor and cognitive/default mode network domains. In future work we will evaluate their relationship with cognitive and behavioral measures. This study was funded in part by NSF 2112455.

References:

[1] Y. Du, Z. Fu, J. Sui, S. Gao, Y. Xing, D. Lin, M. Salman, A. Abrol, M. A. Rahaman, J. Chen, L. E. Hong, P. Kochunov, E. A. Osuch, V. D. Calhoun, and I. Alzheimer's Disease Neuroimaging, "NeuroMark: An automated and adaptive ICA based pipeline to identify reproducible fMRI markers of brain disorders," Neuroimage Clin, vol. 28, p. 102375, 2020, PMC7509081

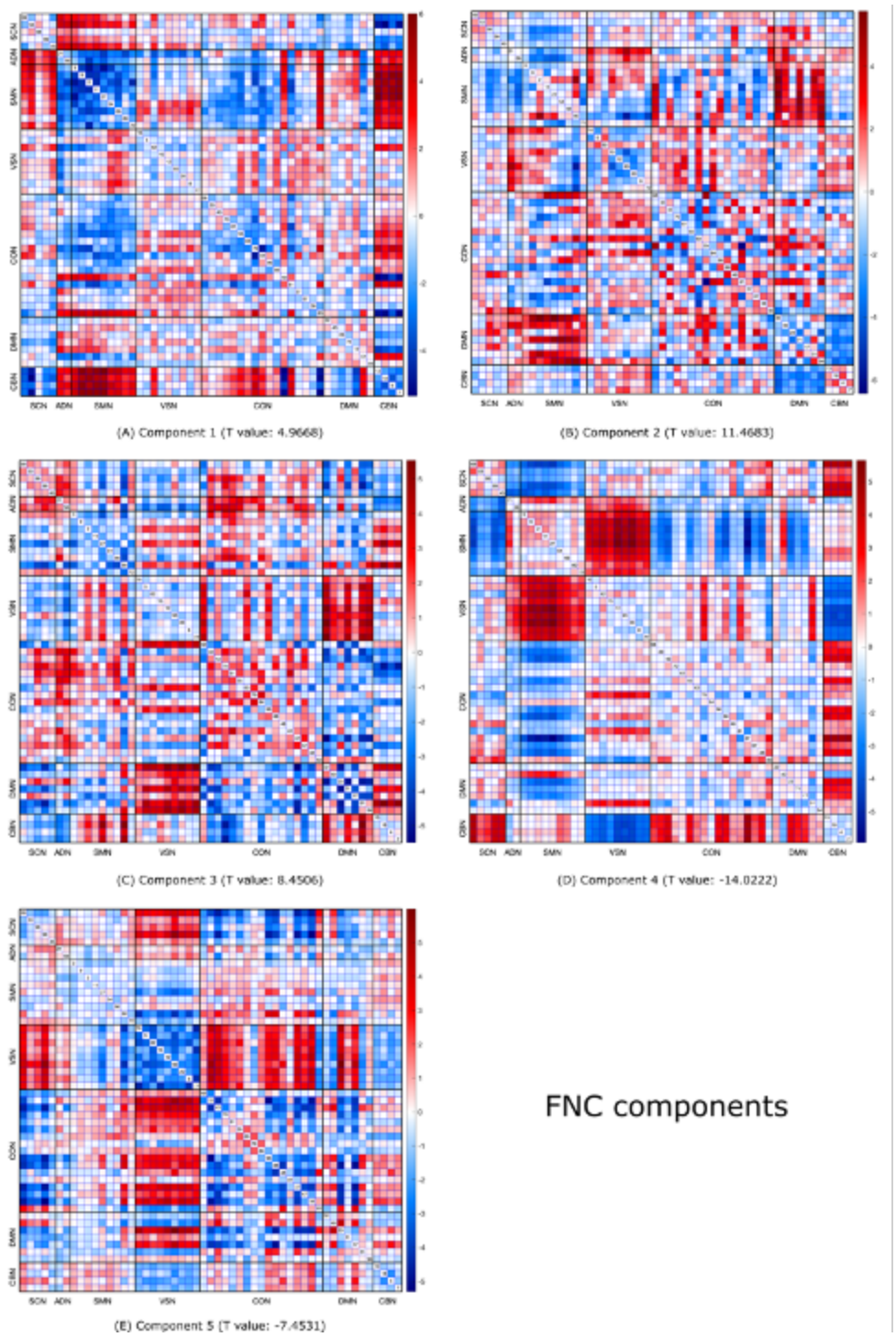


Figure 1: FNC component plot. In the figure, we observe the FCPs for components 2 and 4 have the highest positive (component 2) and negative (component 4) T-values.