Painting Dynamic Cartograms of the Striatum with Resting State fMRI from the Adolescent Development Study

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Introduction. The ontogeny of human cognition is highlighted in adolescence by a burst of exploratory behavior preceding the integration of rewarded actions into persistent habits influencing future social and health outcomes. This developmental period coincides with measurable changes in metabolism, myelination and circuit structure of the striatal-cortical system. Blood-oxygen-level dependent (BOLD) signals measured longitudinally with resting state functional magnetic resonance imaging (rsfMRI) in 140 youth from ages 11-17 revealed a hierarchical and age-dynamic topography of neural activity in the striatum corresponding to cortical efferents carrying signals from sensory, motor and cognitive areas. Masked group Independent Component Analysis (mICA) of the striatum with split half sampling for validation of model order (SHS) was applied to identify large-scale intrinsic networks and their subdivisions. Striatal mICA cartograms were covariant throughout adolescence, suggesting post-pubertal cognitive maturation is reflected by dynamic multi-scale functional reorganization of the striatum in developing adolescents. **Methods.** 143 right-handed youths (11-14 yo) from the Washington, D.C. area participated in a longitudinal brain imaging study on the precursors and effects of early substance use. MRI data were collected three times at ~18 month intervals. 312 sessions from 140 subjects were retained for analysis (N=126/91/95 @ 0/18/36 mos). Participants had no history of mental disorders, serious head injury, or substance use at baseline. A 3T Siemens Tim Trio with a 12-channel head coil was used to acquire whole-brain rsfMRIs & structural MRIs (sMRIs). Subjects kept their eyes open and allowed their minds to wander during rsfMRIs (TR=2280, 3mm^3 voxels, 5:49m). Data was preprocessed in CONN v17.f. A study-specific mask (SSM) of the striatum was obtained by thresholding the group gray matter tissue probability map and masking with a generic striatum atlas of the striatum. Individual fMRIs were intersected with the striatal SSM, aCompCorr denoised, filtered (0.008-0.22Hz) then smoothed (4mm). Intrinsic striatal connectivity was estimated with mICA using FSL MELODIC. Split-half sampling (300 iterations) was implemented to identify stable clustering solutions and assess the stability of these maps with age. **Results & Discussion**. SHS revealed reliable solutions for 2 & 3 parcels (r>0.95) in bilateral striatum, 5 (r=0.87) & 9 (r=0.91) for left and 10 (r=0.92) for right only. Reproducibility varied by age group. Youth aged 14-16 had lower reliability of model order estimates (r>0.80) compared to 11-13 and 16-18yos (r>0.90). The order of stable solutions in right striatum decreased with age, suggesting striatal development is accompanied by integration of small subunits into larger temporally coherent clusters. Our findings stress the importance of developmentally accurate parcellations of the striatum for models of adolescent brain development.