



Brain plasticity following Organizational Skills Training in elementary school students: A pilot resting-state study



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BACKGROUND

- Organizational, time management and planning deficits in children with neurodevelopmental disorders (such as ADHD) contribute to school failure and conflicts at home.
- Unlike stimulant medication, evidence-based instruction-focused interventions (e.g., **OST**)¹ can remediate such organizational dysfunction in elementary school students.
- Pilot fMRI work (n=15) has shown intervention-related changes in resting-state intrinsic Functional Connectivity (iFC) between dorsal anterior cingulate & striatal areas.

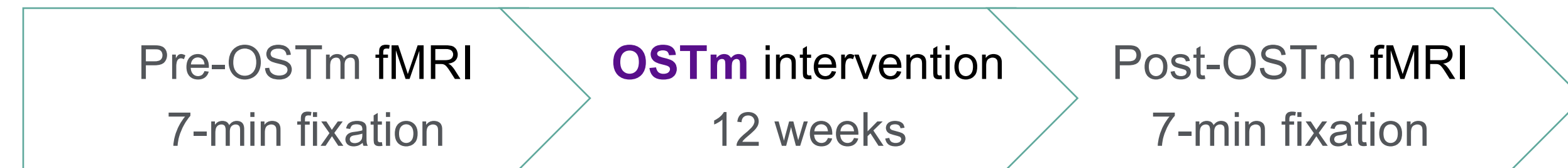
QUESTION

What is the involvement of our **pre-registered** neural target (Δ iFC dACC–ventral striatum) in the behavioral improvement following **modified Organizational Skills Training (OSTm)** in 3rd–5th grade students with organizational impairments?

DESIGN

Participants: n=29 students in 3rd, 4th or 5th grade

- Mean age: 9.1 years, girls n=9 (31%)
- Elevated (≥ 1 SD) and impairing organizational deficits: Children's Organizational Skills Scales² (COSS) ratings
- IQ > 85; non-impaired language skills
- No paraprofessional help, no self-contained special ed.



OST-modified intervention: time- and travel-demanding OST revised to expand treatment accessibility to a wider range of organizationally impaired elementary school kids

- replaced one of the 2 in-person weekly sessions with one **telepsychiatry** video-session
- introduced daily web-based progress (point) logging
- meeting DSM-5 criteria for ADHD not required

RESULTS

Remediation of organizational skills deficits following **modified OST**

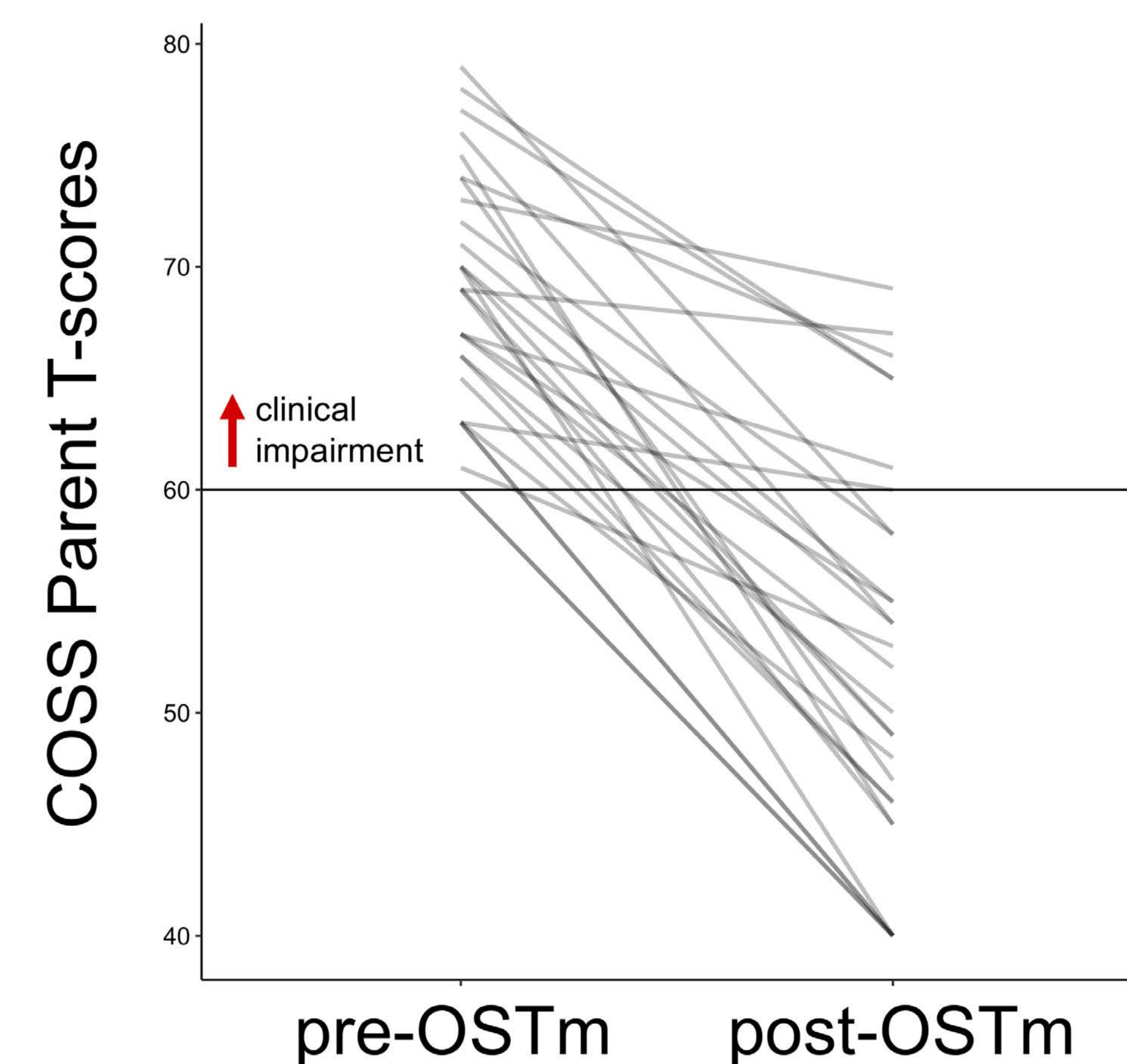


Fig 1. Each child's organizational skills improved after OSTm completion ($t_{28}=11.8$, $p<0.01$, Cohen's $d=2.2$) based on parent reported COSS total scores.

OSTm-driven behavioral improvement linked to Δ iFC in target neural circuitry

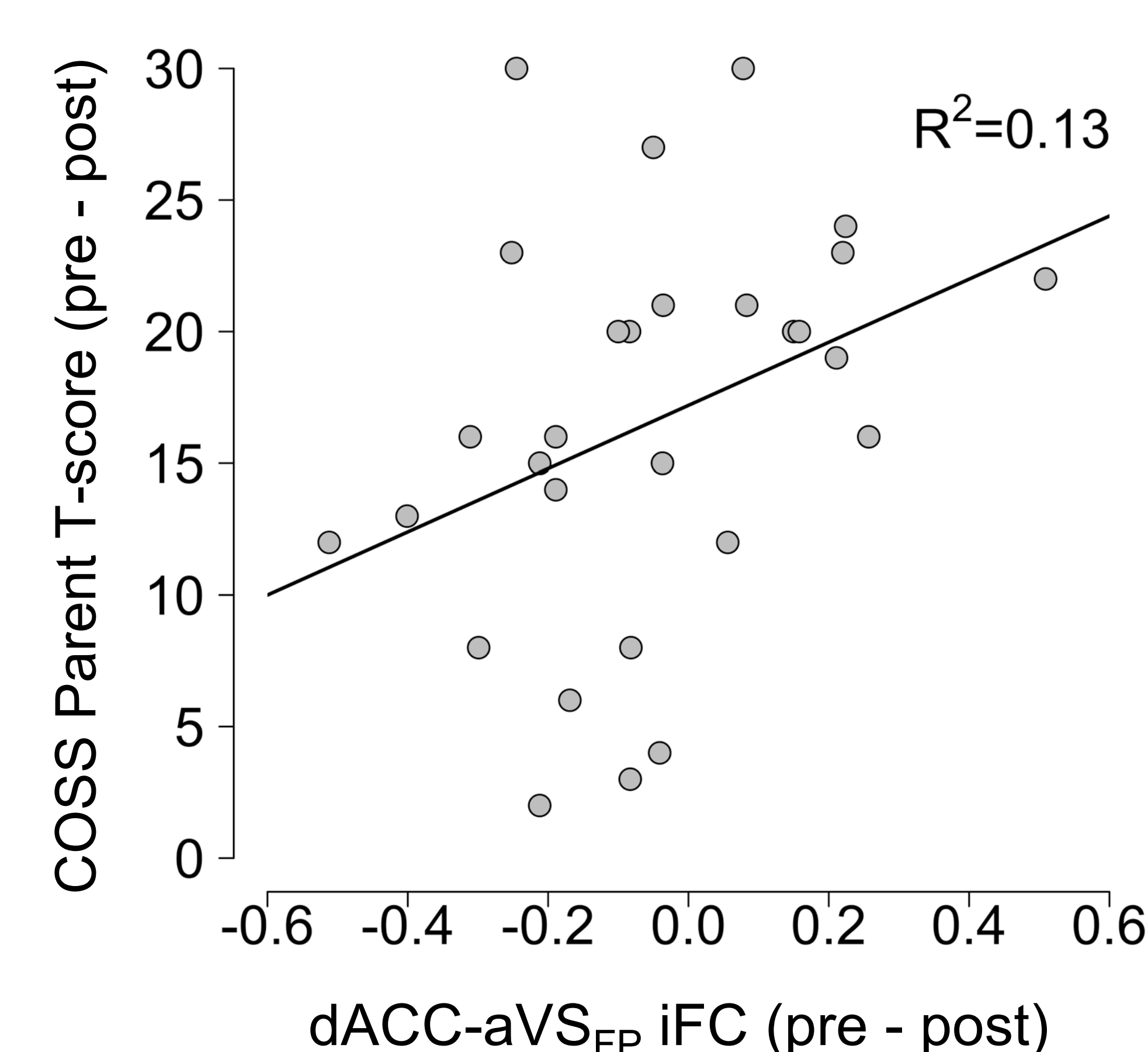


Fig 2. The change in dACC-aVS_{FP} iFC accounts for 13% of the variance of the improvement in children's organizational skills after the OSTm intervention.

Converging robust behavioral normalization following **OSTm**



Following OSTm, dysfunction in each domain (Memory & Materials Management; Organized Actions and Task Planning) significantly improved (COSS-Parent: Cohen's $d>1.64$). Teacher-rated and self-rated skills based on COSS total scores were also superior post-OSTm (both $p<0.01$, Cohen's $d=0.88$; $d=0.67$).

Neural target engagement

Pre-OSTm vs post-OSTm dACC-aVS iFC changed with effect size Cohen's $d=0.40$ ($n=29$) or Cohen's $d=0.49$ ($n=28$ without an outlier).



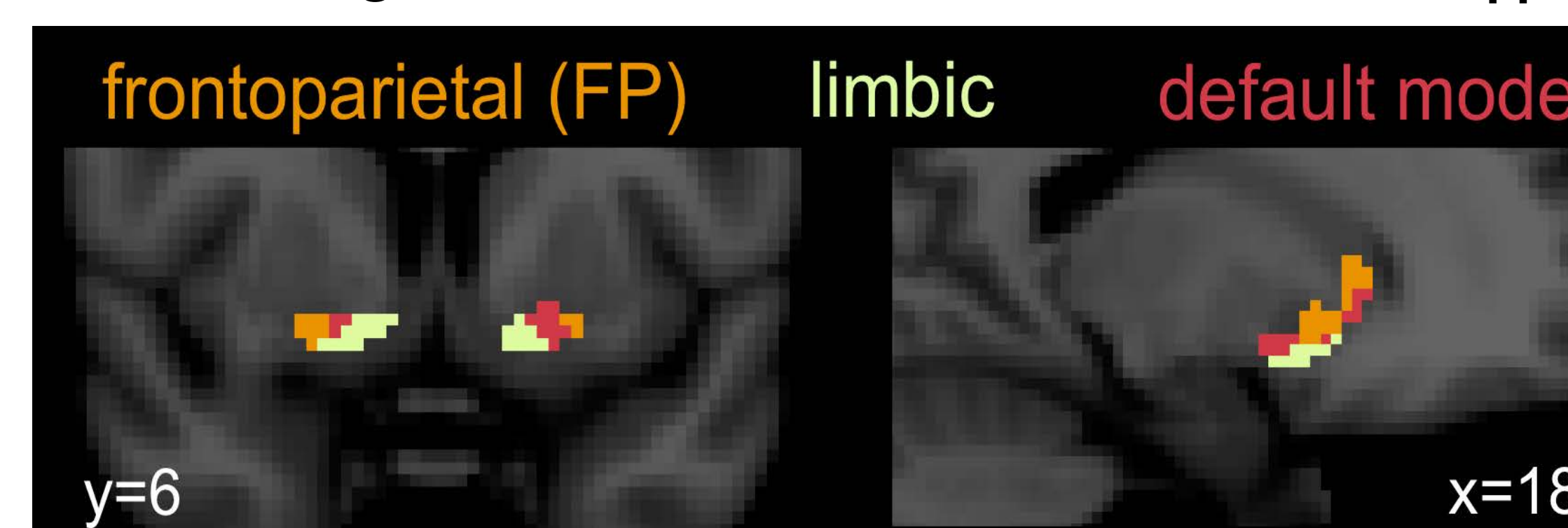
METHODS

Detailed methods at osf.io/rsx36/

- 3 Tesla Siemens Prisma
- Adolescent Brain Cognitive Development study sequences: T1 MPRAGE (0.8x0.8x0.8mm) EPI: 7-min fixation (TR=0.8s, 2.4x2.4x2.4mm)
- C-PAC v1.4.1 used for image pre-processing and Seed-based Correlation Analysis
- Seed: dorsal Anterior Cingulate Cortex (dACC) = MNI [8, 7, 38]

	Pre-OSTm	Post-OSTm
Mean FD_J	0.068 mm	0.070 mm
Min FD_J	0.039 mm	0.037 mm
Max FD_J	0.103 mm	0.123 mm

Hypothesized **OSTm** treatment target: Δ resting-state iFC between dACC & aVS_{FP}



pre-registered at osf.io/5m5sx

Masks centered on our pilot OST results spanning 3 network-defined subregions of anterior ventral striatum (aVS), corresponding to frontoparietal (FP), limbic & default mode networks [7 Yeo³ iFC striatal parcellations]

Head micro-motion index = Jenkinson Framework Displacement (FD_J)
Equivalent mean FD_J for pre- vs. post-OSTm scans (two-one-sided tests procedure: $d_z=0.1$ significantly within $d_z\pm 0.5$ equivalence bounds, $t_{28}=-2.2$, $p<0.02$)

CONCLUSIONS

- Successful modification of the evidenced-based OST intervention: **OSTm** is feasible, acceptable to parents and effective (80% of treated students falling below the clinical impairment cut-off after OSTm completion).
- Convergent pilot results and current findings with pre-registered brain masks suggest that the circuitry linking dACC and aVS may mediate OSTm improvement.
- If replicated, this association between robust OSTm-driven boosts in organizational, time management and planning skills & alterations in resting-state connectivity may enable the exploration of the neural mechanisms of organizational dysfunction and its remediation.

[1] Abikoff H, Gallagher R, Wells KC, Murray DW, Huang L, Lu F, Petkova E. (2013) Remediating organizational functioning in children with ADHD: Immediate and long-term effects from a randomized controlled trial. *J. Consult. Clin. Psychol.* 81(1):113
 [2] Abikoff H, Gallagher R. (2009) The Children's Organizational Skills Scales: North Tonawanda, NY: Multi-Health Systems
 [3] Choi E, Yeo B, Buckner RL (2012) The organization of the human striatum estimated by intrinsic functional connectivity. *J Neurophysiol.* 108(8):2242.
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