



HASSENFELD
**CHILDREN'S
HOSPITAL**
AT NYU LANGONE

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Department of Child and Adolescent Psychiatry
Child Study Center

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

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Background: organizational skills impairments

- Organizational, time management and planning deficits are frequent in children with neurodevelopmental disorders (such as ADHD) and contribute to school failure and conflicts at home.
- Unlike stimulant medication, evidence-based **instruction-focused interventions** can remediate such organizational dysfunction in elementary school students.

Background: quantification of organizational skills deficits

Children's Organizational Skills Scale (COSS)

- Age- and sex-normed scales capturing memory and materials management, organized actions, and task planning impairments
- Child, parent, teacher informants

e.g., COSS Parent questions:

	HARDLY EVER OR NEVER	SOMETIMES	MUCH OF THE TIME	JUST ABOUT ALL OF THE TIME
1. My child starts projects but doesn't complete them.	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄
2. Once my child gets ready to do schoolwork or projects, he/she has trouble knowing how to start.	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄
3. My child is organized.	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄
4. My child seems to run out of time before school assignments are finished.	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄
5. My child has to stay up late to finish school projects or homework.	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄
6. When my child has a big project to do, he/she doesn't know where to begin.	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄
7. When my child has to do something, she/he puts it off as long as possible.	<input type="checkbox"/> ₁	<input type="checkbox"/> ₂	<input type="checkbox"/> ₃	<input type="checkbox"/> ₄

Background: externalizing organizational struggles (glitches)

4 specific “glitch characters” can obstruct child’s calm completion of academic assignments:



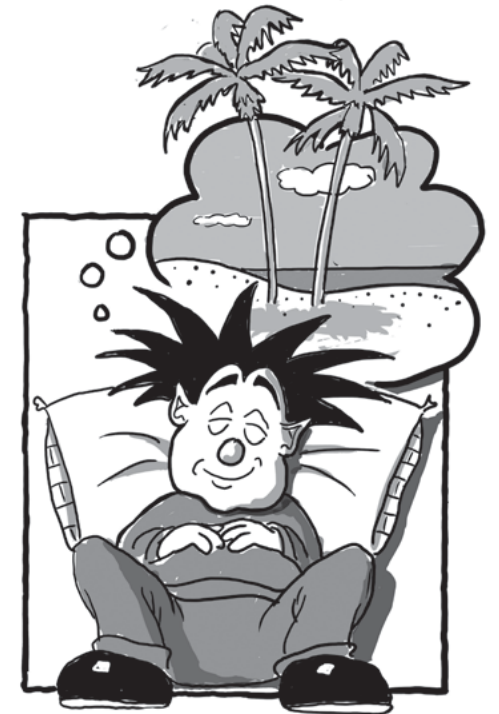
Go-Ahead-*Forget-It*
(track assignments)

Go-Ahead-*Lose-It*
(manage materials)



Time Bandit
(distract; delay)

Go-Ahead-*Don't-Plan*
(long-term planning)



Background: Organizational Skills Training (OST)

Organizational Skills Training for Children with ADHD

An Empirically Supported Treatment



Richard Gallagher,
Howard B. Abikoff, and Elana G. Spira

OST involves **individual sessions** with an OST therapist in which parents (and teachers remotely) receive training in behavior modification and children receive direct instruction and skills practice.

The child learns how to have the **Mastermind** control the glitches



Background: Promises & challenges of the original OST

- OST produces robust sustained remediation

[J Consult Clin Psychol](#). Author manuscript; available in PMC 2014 Feb 1.

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[J Consult Clin Psychol](#). 2013 Feb; **81**(1): 113–128.

PMID: [22889336](#)

Published online 2012 Aug 13. doi: [10.1037/a0029648](#)

Remediating Organizational Functioning in Children with ADHD:
Immediate and Long-Term Effects from a Randomized Controlled Trial

[Howard Abikoff](#), [Richard Gallagher](#), [Karen C. Wells](#), [Desiree W. Murray](#), [Lei Huang](#), [Feihan Lu](#), and [Eva Petkova](#)

- Challenges to wider OST adoption: time + travel

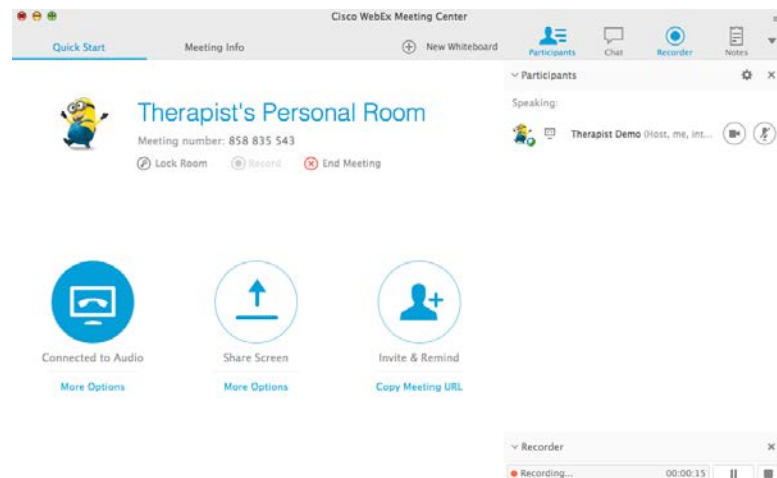
20 in-person visits (twice a week) over 10 weeks
during the school year

Current study: OST-modified (OSTm) to expand accessibility

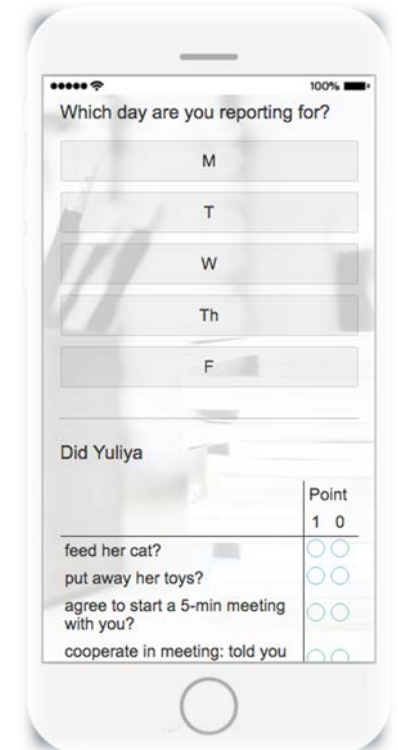
12 in-person weekly sessions (school year) +
new **remote** means to increase frequency of contacts with the
OSTm therapist

telepsychiatry

1. weekly 30-minute **video** session
with parent & child at home



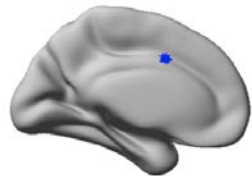
2. electronic
Behavior Record:
the therapist
receives child's
daily points logs



Prior imaging study: OST produces resting-state Δ iFC

Seed-based dACC iFC

[MNI: 8, 7, 38]



Paired pre vs. post whole-brain t-test
 $p < 0.05$ corrected

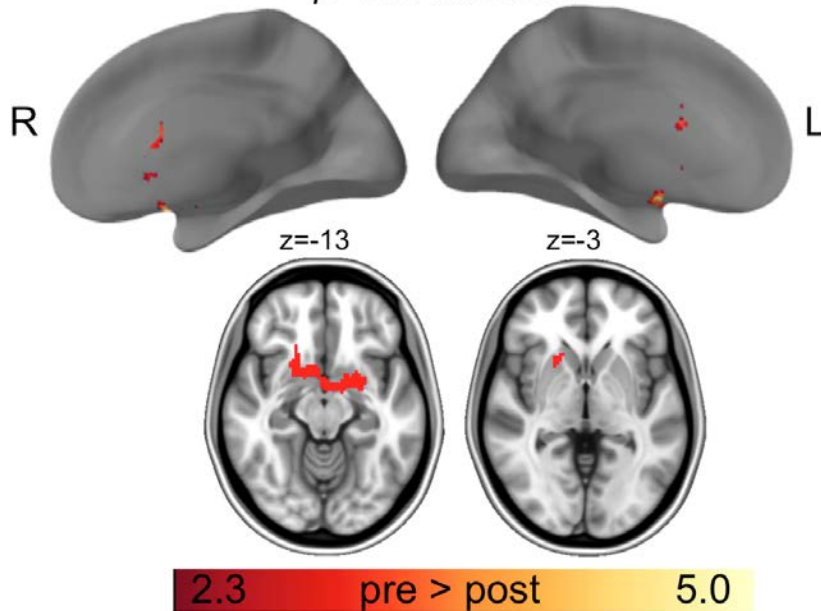


Fig. Resting-state fMRI data from open-label OST intervention in children with ADHD (n=15).

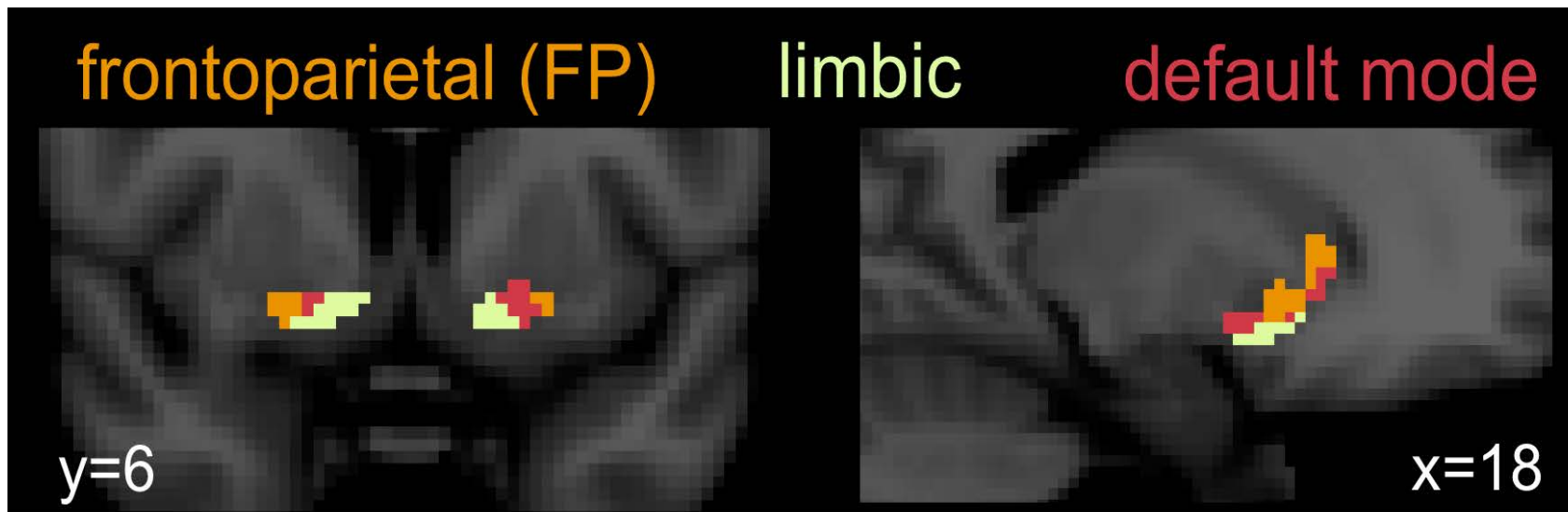
Significant post-OST changes in intrinsic functional connectivity (iFC) between dorsal Anterior Cingulate Cortex (dACC) and areas including ventral striatum.

Data not shown: improvement in parent-rated organizational skills (COSS-P scores) post-OST correlates with this Δ iFC ($r_{13}=0.57$, $p < 0.05$).

Data: 3T Siemens Allegra, EPI: TR=2s, voxel: 3x3x4mm

OSTm imaging study: pre-registered neural target =

Δ resting-state iFC between **dACC** & **aVS_{FP}**



pre-registered at osf.io/5m5sx

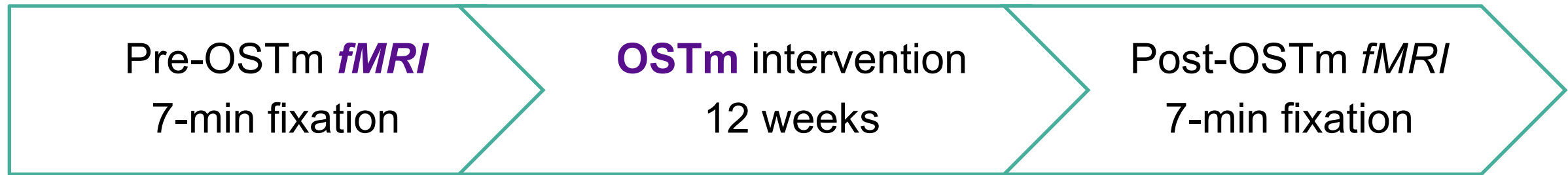
Masks centered on pilot OST results spanning 3 network-defined subregions of anterior ventral striatum (**aVS**), corresponding to frontoparietal (**FP**), limbic & default mode networks [based on Yeo* 7-network functional striatal **parcellations**]

*Choi E, Yeo B, Buckner RL (2012) The organization of the human striatum estimated by intrinsic functional connectivity. *J Neurophysiol.* 108(8):2242-2263.

OSTm imaging study: question

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

OSTm imaging study: procedures



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 Scales (**COSS**) Parent total T-scores
 - meeting DSM-5 criteria for ADHD not required
- IQ > 85; non-impaired language skills
- No paraprofessional help, no self-contained special ed. classroom
- Must provide **high-quality** pre-OSTm *fMRI* imaging data ($FD_j < 0.13$ mm, i.e., lower than clinical pediatric neuroimaging standards)

OSTm study: low head micro-motion (FD_J) during fixation scans

Jenkinson Framewise Displacement (FD_J)

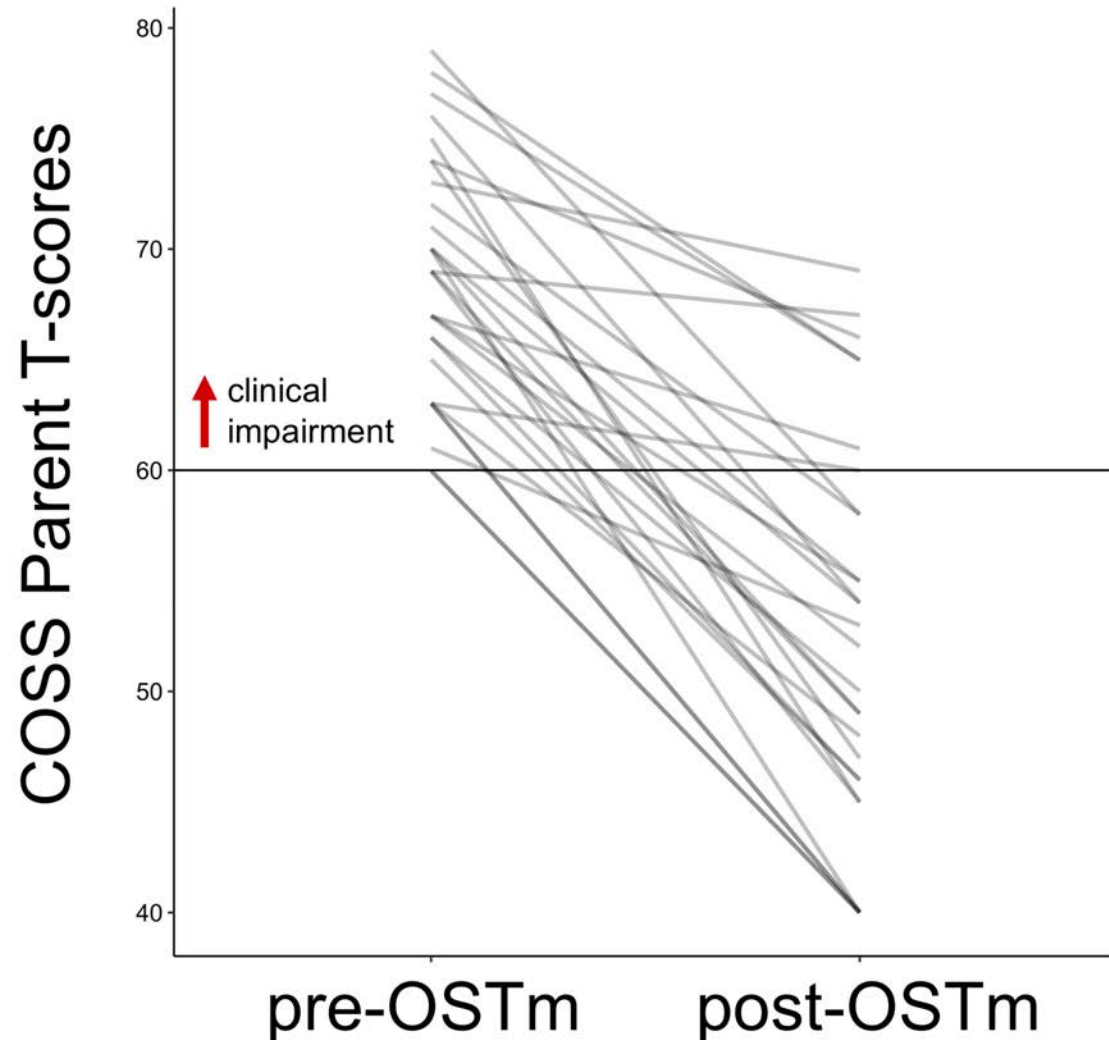
	Pre-OSTm	Post-OSTm
Mean FD_J	0.068 mm	0.070 mm
Min FD_J	0.039 mm	0.037 mm
Max FD_J	0.103 mm	0.123 mm

Equivalent mean FD_J for pre- vs. post-OSTm fixation (resting-state) scans (two-one-sided tests procedure: $d_z=0.1$ significantly within $d_z \pm 0.5$ equivalence bounds, $t_{28}=-2.2$, $p<0.02$)

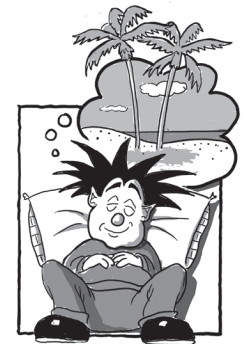
OSTm study: neuroimaging methods <https://osf.io/rsx36/>

- Acquisition
 - 3 Tesla Siemens Prisma
 - *Adolescent Brain Cognitive Development* study imaging protocol:
T1 MPRAGE (0.8x0.8x0.8mm) EPI: 7-min fixation (TR=0.8s, 2.4x2.4x2.4mm)
- Image pre-processing and Seed-based Correlation Analysis
 - C-PAC v1.4.1 <https://fcp-indi.github.io/docs/user/index>
 - seed: **dACC** = MNI [8, 7, 38]
 - masks: [OST pilot clusters] \cap [Yeo 7-network functional striatal parcellations] = aVS_{FP} & aVS_{ALL} ([pre-registered](#) prior to R61MH113663 submission)
 - z-scored iFC between dACC and aVS_{FP} reported
 - Pearson's correlation between *pre- minus post-OSTm* COSS-Parent Total T-scores (i.e., behavioral outcome) and *pre- minus post-OSTm* z-scored iFC dACC-aVS_{FP} (i.e., neural target circuitry)

Results: Remediation of organizational deficits post-OSTm



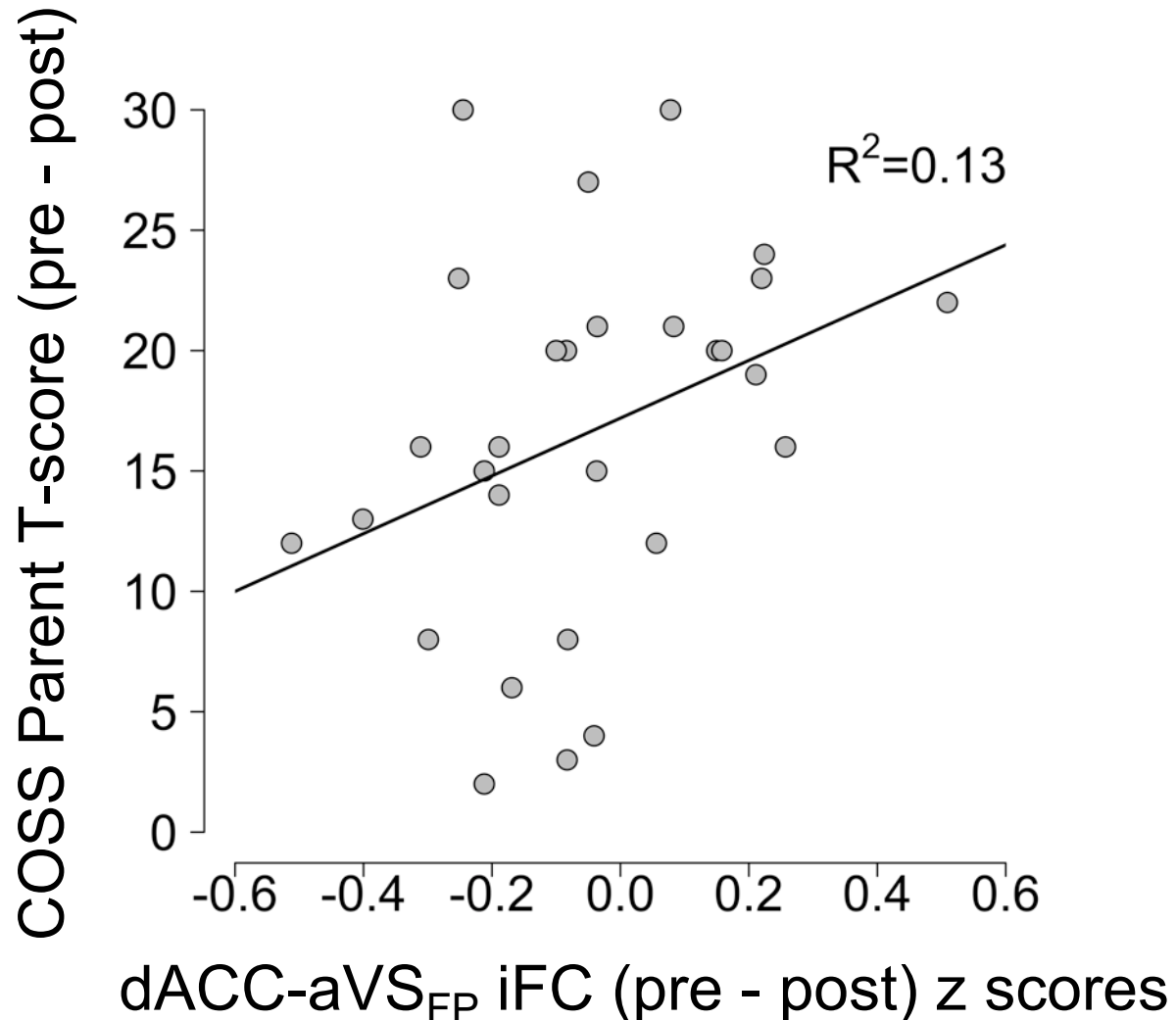
- Each child's parent-rated organizational dysfunction improved after OSTm ($t_{28}=11.8$, $p<0.01$; Cohen's $d=2.2$)



- Consistent robust behavioral effects: teachers and children also reported superior org. skills post-OSTm (both $p<0.01$, Cohen's $d=0.88$; $d=0.67$; data not shown).

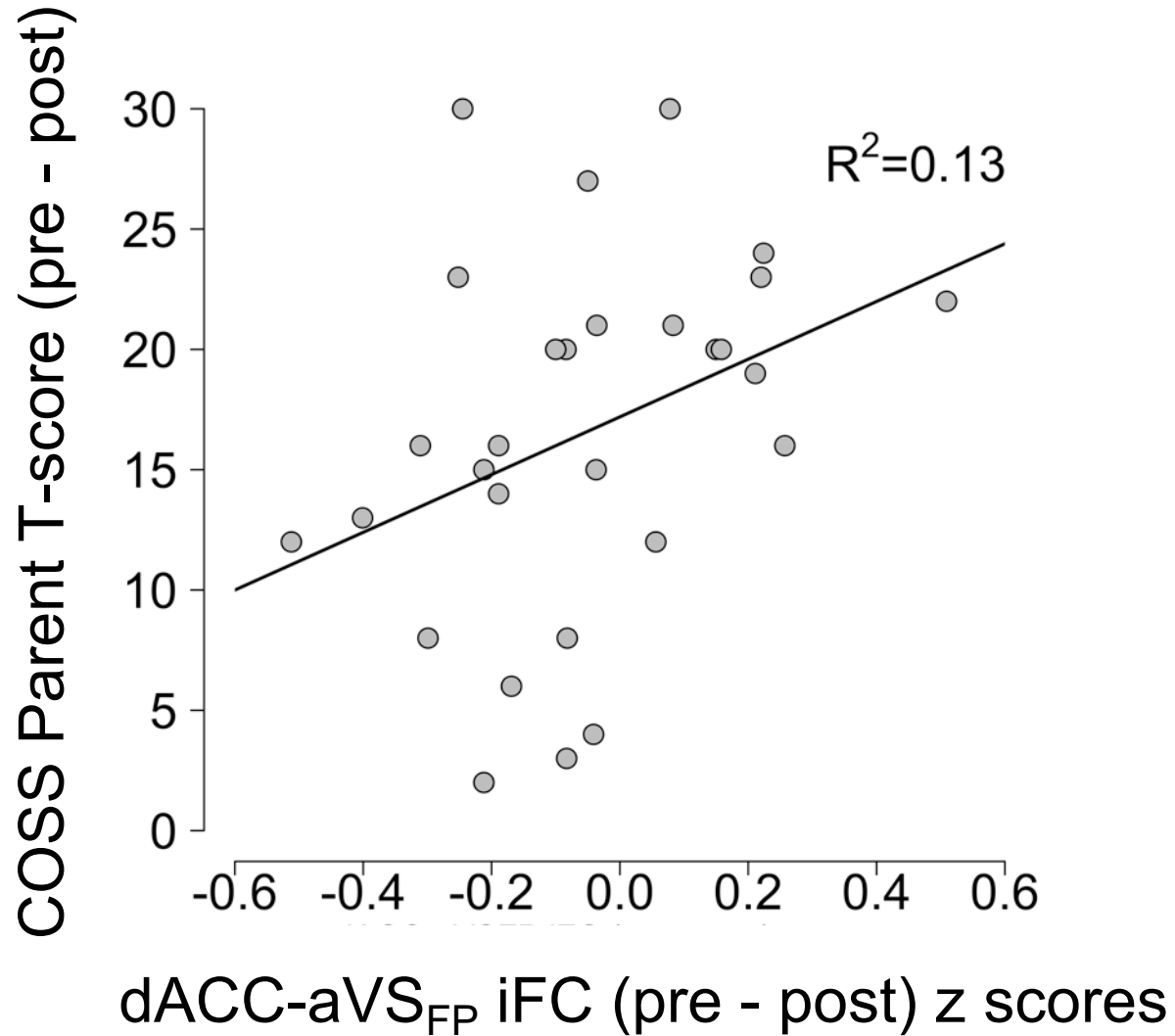
**Higher scores indicate more frequent organizational deficits*

Results: Δ iFC neural target linked to post-OSTm behavioral gains



Δ strength of functional connectivity at rest (fixation) between the dACC & the pre-registered ventral striatal mask (within the frontoparietal network parcellation) accounts for **13% of the variance** of the improvement in organizational skills after OSTm intervention.

Results: Δ iFC neural target linked to post-OSTm behavioral gains



Neural target engagement: Pre-OSTm vs post-OSTm changes in dACC-aVS_{ALL} iFC with effect size Cohen's $d=0.40$ ($n=29$) or Cohen's $d=0.49$ ($n=28$ without an outlier).



Summary

- Successful modification of evidence-based OST: **OSTm** is feasible, its **video-sessions** are acceptable to families and effective (80% of treated students fell below the clinical impairment cut-off after completing OSTm; self-report, parent and teacher ratings concur).
- 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, the association between robust OSTm-driven boosts in organizational, time management and planning skills & alterations in resting-state connectivity may enable exploration of the neural mechanisms of organizational dysfunction and its remediation.