Disentangling Tourette syndrome and ADHD using electroencephalography and functional connectivity

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• Tourette syndrome (TS) and attention deficit hyperactivity disorder (ADHD) frequently co-occur.
• Children with TS who also have a diagnosis of ADHD are more likely to have impairments in cognitive function and more psychosocial and behavioral difficulties.
• It remains unclear how the neurobiological underpinnings of TS and ADHD may be similar or different.

• Different models (Rothenberger & Heinrich, 2022, Biomedicines):
  • Additive effects?
  • Interactive effects?
  • Different phenotype?
• One way of tackling this question is through the study of functional connectivity.
  • Functional connectivity relates to how different brain regions are co-activated
  • This may inform on neural communication may differ across different disorders or conditions.
• Previous work suggest mostly additive effects of TS and ADHD (Jurgiel et al., 2022, Biol Psychiatry CNNI)
OBJECTIVES

• Assess the separate and joint impacts of TS and ADHD on functional brain connectivity
  • Across several frequency bands
PARTICIPANTS

• 137 children
  • TS: 51
  • ADHD: 24
  • TS+ADHD: 29
  • Typically developing controls: 33
• Aged between 7 and 16 years old (mean = 11.1; SD = 1.9)
• High-density electroencephalography (hdEEG) recording during a 7-minute resting-state session.
• EEG preprocessing (filtering, artifact removal, interpolation of bad channels, segmentation in 2-second epochs, re-referencing)
Brain sources were reconstructed from sensor-level EEG data using weighted minimum norm estimation (wMNE) in Brainstorm software.

Source activity projected onto the Desikan-Killiany atlas (68 cortical regions)

Connectivity between these regions was computed with the phase locking value (PLV) in 5 frequency bands

- Delta (1-4 Hz)
- Theta (4-8Hz)
- Alpha (8-13 Hz)
- Beta (13-30 Hz)
- Gamma (30-50 Hz)
• Network-based statistics (NBS)
  • Allow the identification of functional connectivity subnetworks that differ between groups or that are associated with continuous measures.
  • While controlling for multiple comparisons (t-test performed for each connection) using permutation testing.
  • All analyses conducted with 2 (TS: present/not present) by 2 (ADHD: present/not present)
RESULTS

- ADHD main effect (delta: $p = 0.042$, theta: $p = 0.018$, alpha, $p = 0.029$)
RESULTS

- No significant ADHD*TS interaction
These results suggest that TS and ADHD are associated with different patterns of decreased connectivity in resting-state networks.

• Additive but not interactive effects.

• It is possible that more complex cognitive demands may result in interactive effects.
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  • Any questions?
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