Progressing or Regressing?
Using Neurobiological Tools to Reveal the Mechanisms Underlying Screen and Technology Use in Children

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Introduction: Digital media exposure has become ubiquitous from infancy to adolescence, yet its impact on the developing brain—particularly on neural circuits supporting language, executive functions, and learning—remains insufficiently understood. To move the field beyond behavioral correlations, this keynote highlights the unique contribution of neuroimaging tools in uncovering the neural mechanisms linking screen use with children's cognitive and academic trajectories.

Methods: Across several studies involving preschool- and school-age children, we employed a multimodal neuroimaging approach including functional MRI, structural MRI, diffusion tensor imaging (DTI), and EEG. These tools were used to probe neural networks involved in reading development, executive functions, visual processing, and attention, in relation to children's screen exposure patterns and digital media use.

Results: Converging findings demonstrate the sensitivity of neurobiological measures to early differences in media exposure. In 3–5-year-old children, increased screen use was associated with reduced executive functions and language abilities, alongside lower white-matter organization in tracts supporting cognitive control, language, and visual processing. Reduced cortical thickness was also observed in nearby regions.
EEG studies showed diminished inhibitory ERP components in 4–5-year-olds with higher screen time. Among 6–8-year-olds, the mere presence of a smartphone during a simple reaction-time task reduced frontal theta–beta ratios, indicating increased cognitive load. Similar patterns emerged when reading from screens vs. paper, and during a novel fMRI paradigm where 6-year-olds interacted with ChatGPT inside the scanner, showing reduced recruitment of cognitive networks.
Functional connectivity analyses further revealed lower coupling between visual, language, and executive networks in children with higher screen exposure, with distinct patterns for children with and without reading difficulties.

Implications: Neuroimaging provides direct insight into *how* and *why* screen exposure may alter cognitive and learning-related processes—revealing changes in brain organization that are not detectable through behavioral measures alone. These findings underscore the importance of age-appropriate, context-sensitive decisions regarding digital media use in homes and schools, and highlight the need for thoughtful design of educational technologies that align with children's neurodevelopmental profiles.