Tailoring and Validating DOT-Virtual Reality Methods for Use with Neurodiverse Children

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Introduction: Recent advances in diffuse optical tomography (DOT) and virtual reality (VR) offer powerful tools for studying cognitive development in controlled yet ecologically valid settings. However, their application in neurodivergent populations has been limited, raising concerns around inclusivity, compliance, and data reliability, defined as the degree to which a measure yields consistent results over time. In collaboration with caregivers, researchers, and our industry partner (Gowerlabs Ltd.), we developed a protocol to adapt DOT-VR setups to the needs of neurodiverse children and systematically assess their reproducibility. This project addressed two key gaps: (1) how to tailor DOT-VR setups for neurodiverse children aged 3–7, including autistic children, those with attention deficit hyperactivity disorder (ADHD) or at higher likelihood of ADHD, and children with low-empathy traits; and (2) whether these tools can produce reliable data in this population.

Methods: Children aged 3–7 completed a Go/No-Go inhibition task within the ToddlerLab Cave, a child-friendly VR environment (Figure). Frontal brain activity was recorded using the LUMO DOT system (Gowerlabs Ltd.). Each child participated in two sessions, spaced 1–2 weeks apart, to evaluate test–retest reliability and assess children's compliance. Caregivers completed pre- and post-session questionnaires to inform adaptations aimed at improving comfort, compliance, and overall data quality.

Results: Data from 51 children revealed variability in compliance. Children with ADHD, low-empathy traits, and neurotypical profiles generally adapted well to the DOT-VR setup. In contrast, autistic children—particularly those with heightened sensory sensitivity or more severe autistic traits—experienced greater difficulty tolerating the equipment. However, compliance and engagement improved significantly in the second session following tailored adaptations. Effective strategies included the use of breaks, preparatory videos of the testing session, tailored rewards, adjustments to the cap for comfort, and building rapport between the child and researchers, especially important when working with non-verbal children. Ongoing analyses are examining the consistency of neural activation between Go and No-Go trials across sessions, at both group and individual levels, to assess test–retest reliability.

Figure: Participant wearing the LUMO cap while playing in the ToddlerLab Cave.

Conclusion: This study presents the first systematic evaluation of DOT-VR methods in neurodiverse children. The findings underscore the importance of both technological adaptation and child-centred practices in ensuring inclusivity and data integrity. With appropriate adjustments, DOT-VR can serve as a reliable and ecologically valid tool for investigating developmental cognition including in neurodivergent children, advancing more inclusive and reproducible approaches in developmental neuroscience.