Study reveals relationship of gut microbiome on children's brain development and function

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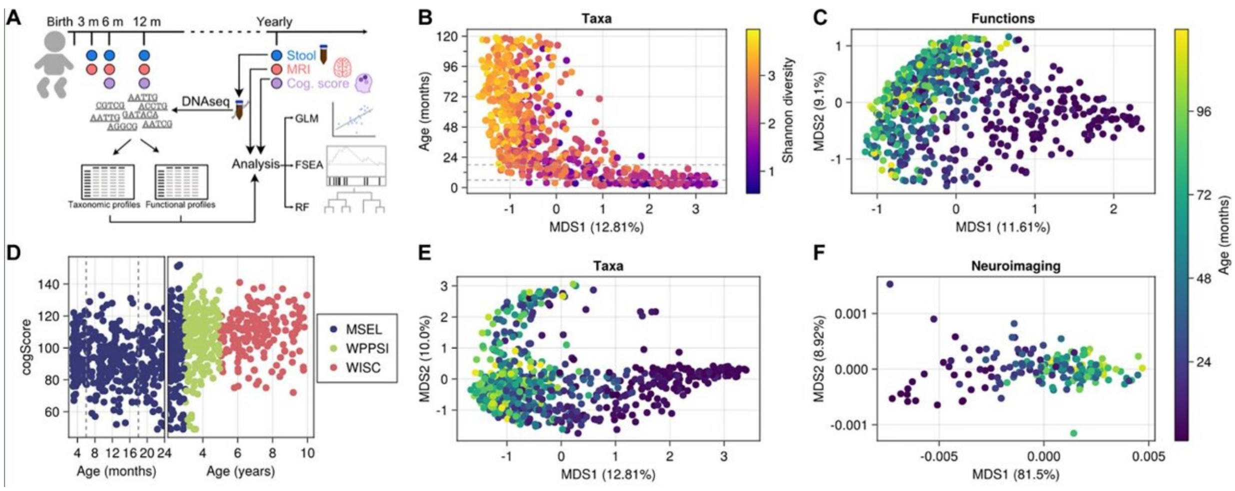

The RESONANCE cohort is a diverse cohort with accelerated longitudinal sampling. (A) Stool samples, cognitive assessments, and neuroimaging were collected from participants at different ages throughout the first years of life. (B) Cognitive function scores are assessed by different tests, but may be normalized using full-scale composite scores. (C and D) Principal coordinates analysis using Bray-Curtis dissimilarity on taxonomic profiles demonstrates high beta diversity, with much of the first axis of variation explained by increasing age and alpha diversity. MSEL, Mullen Scales of Early Learning; WPPSI, Wechsler Preschool & Primary Scale of Intelligence; WISC, Wechsler Intelligence Scale for Children. Differences in gene function profiles (E) and neuroimaging [principal components analysis (PCA) based on the Euclidean distance of brain region volumes] (F) are likewise dominated by changes as children age. Credit: *Science Advances* (2023). DOI: 10.1126/sciadv.adi0497

Emerging evidence implicates the gut microbiome in cognitive outcomes and neurodevelopmental disorders, but the influence of gut microbial metabolism on typical neurodevelopment has not been explored in detail. Researchers from Wellesley College, in collaboration with other institutions, have demonstrated that differences in the gut microbiome are associated with overall cognitive function and brain structure in healthy children.

This study—published Dec. 22 in *Science Advances*—is a part of the Environmental Influences on Child Health Outcome (ECHO) Program. This study investigates this relationship in 381 healthy children, all part of The RESONANCE cohort in Providence, Rhode Island, offering novel insights into early childhood development.

The research reveals a connection between the gut microbiome and cognitive function in children. Specific gut microbial species, such as Alistipes obesi and Blautia wexlerae, are associated with higher cognitive functions. Conversely, species like Ruminococcus gnavus are more prevalent in children with lower cognitive scores. The study emphasizes the role of microbial genes, particularly those involved in the metabolism of neuroactive compounds like short-chain fatty acids, in influencing cognitive abilities.

Advanced machine learning models demonstrated the capability of gut microbial profiles to predict variations in brain structure and cognitive performance, highlighting the potential for early detection and intervention strategies in neurodevelopment. This study represents an important first step in the understanding of the relationship between the gut biome and cognitive function in children.

The corresponding author Vanja Klepac-Ceraj notes, "This research on a single cohort offers exciting hypotheses that we now want to test in additional settings."

This research is the first to examine the gut-brain-microbiome axis in normal neurocognitive development among healthy children. The integration of multivariable linear and machine learning models to analyze the complex relationship between gut microbiome profiles and neurodevelopment is innovative. These models not only established the association of gut microbiota with cognitive function but also predicted future cognitive performance based on early-life microbial profiles.

The findings pave the way for developing biomarkers for neurocognition and brain development. This research could lead to early detection of developmental issues and interventions, potentially mitigating long-term cognitive challenges. It highlights the importance of gut health in early childhood, suggesting dietary and lifestyle considerations for parents and health care providers. Furthermore, this study marks the first step in formulating hypotheses that can be tested experimentally and in animal models.

More information: Kevin S. Bonham et al, Gut-resident microorganisms and their genes are associated with cognition and neuroanatomy in children, *Science Advances* (2023). DOI: 10.1126/sciadv.adi0497

Provided by Wellesley College

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