



Disentangling Behavioral Signatures of ADHD and Autism through Digital Phenotyping

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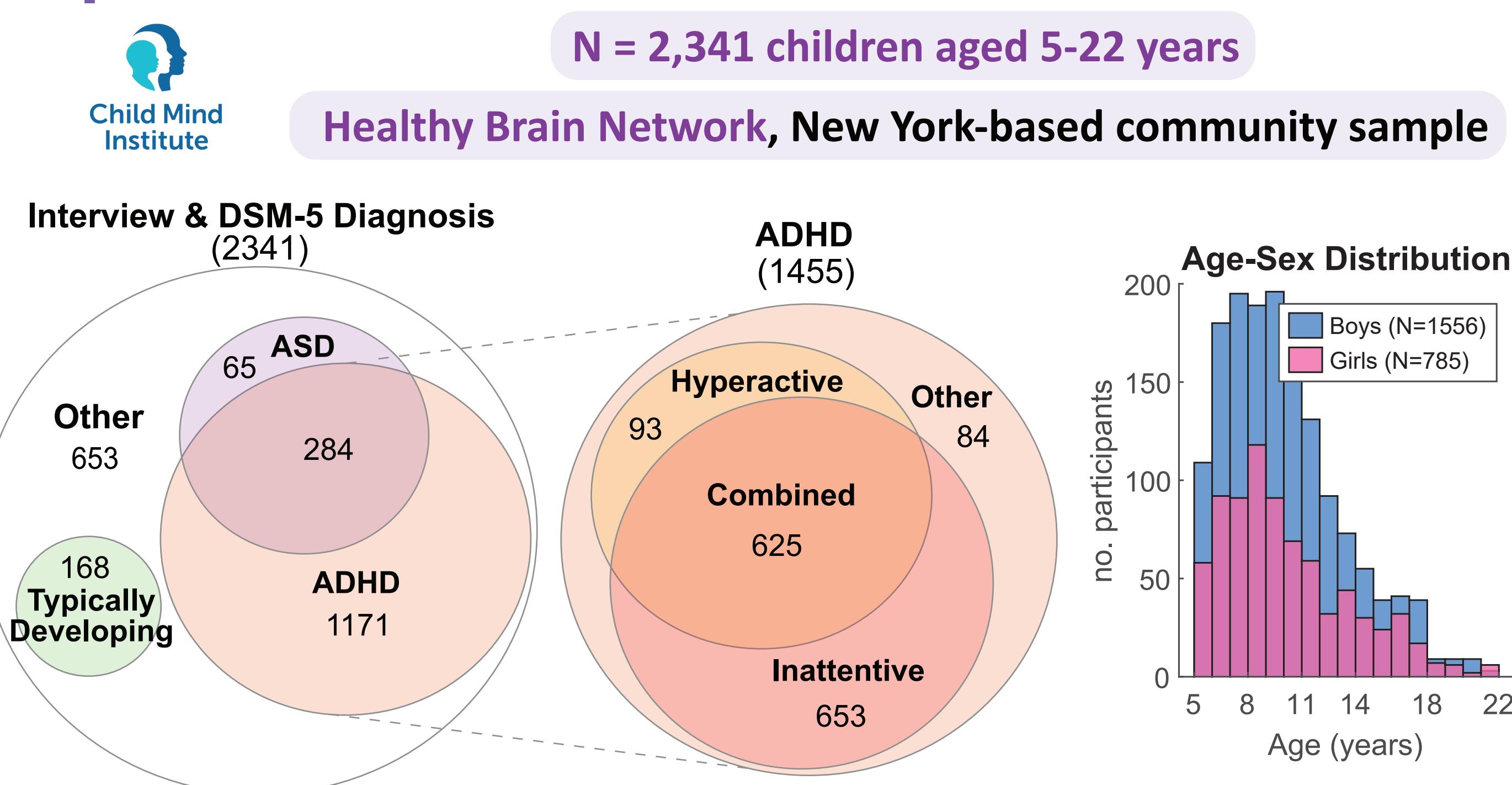
Background

- Attention-Deficit/Hyperactivity Disorder (ADHD) and Autism Spectrum Disorder (ASD) frequently co-occur, complicating diagnosis.
- Current clinical assessments are subjective and limited in scale.
- Digital phenotyping offers objective, scalable behavioral markers.

Objectives

- Identify unique vs. overlapping behavioral signatures of ADHD and ASD.
- Quantify effects of age, sex, and IQ.
- Validate AI-derived markers for naturalistic behavior.

Population



Results

Narrative & Theory of Mind

Text Embeddings Capture Answer Meaning

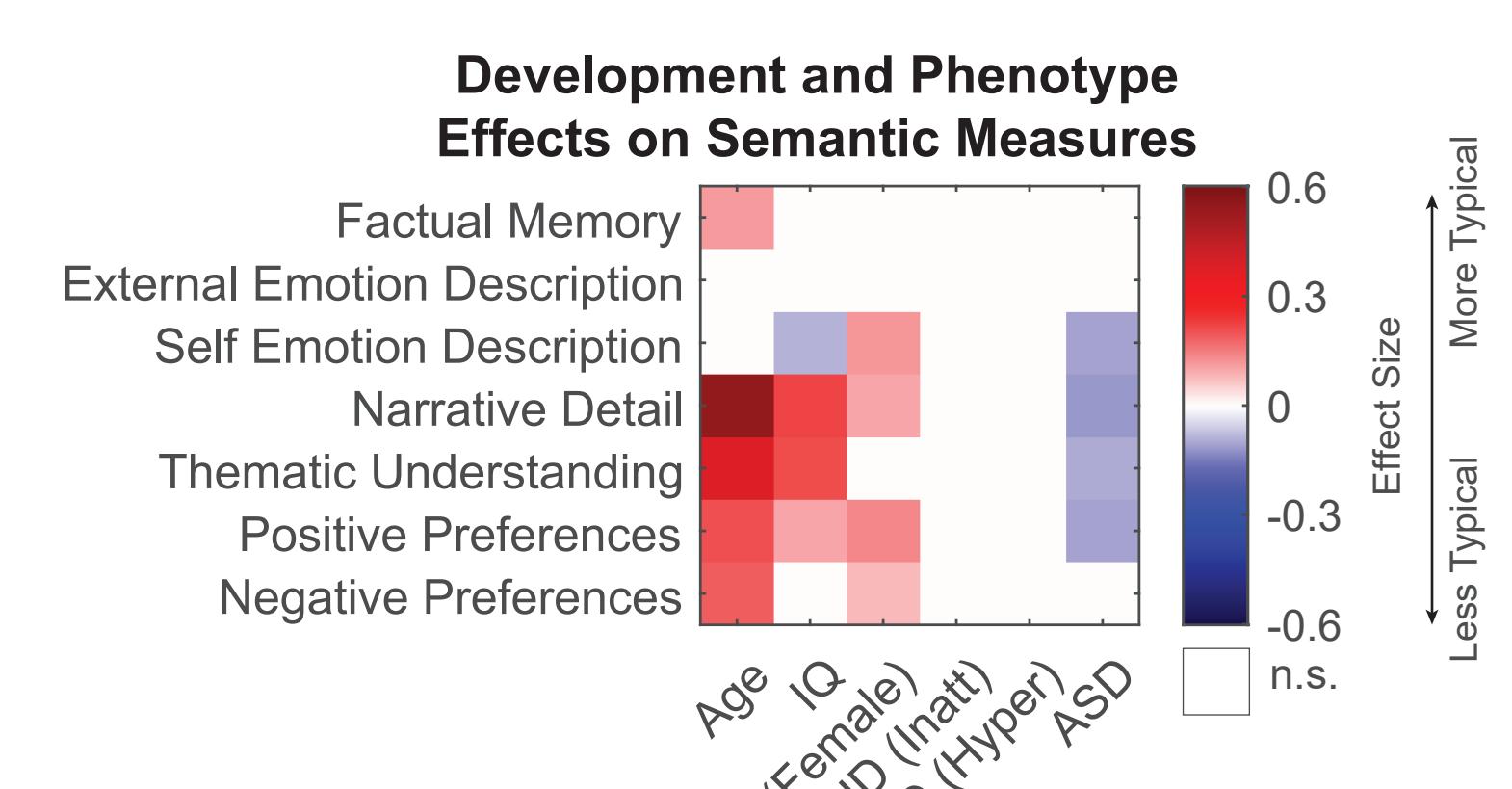
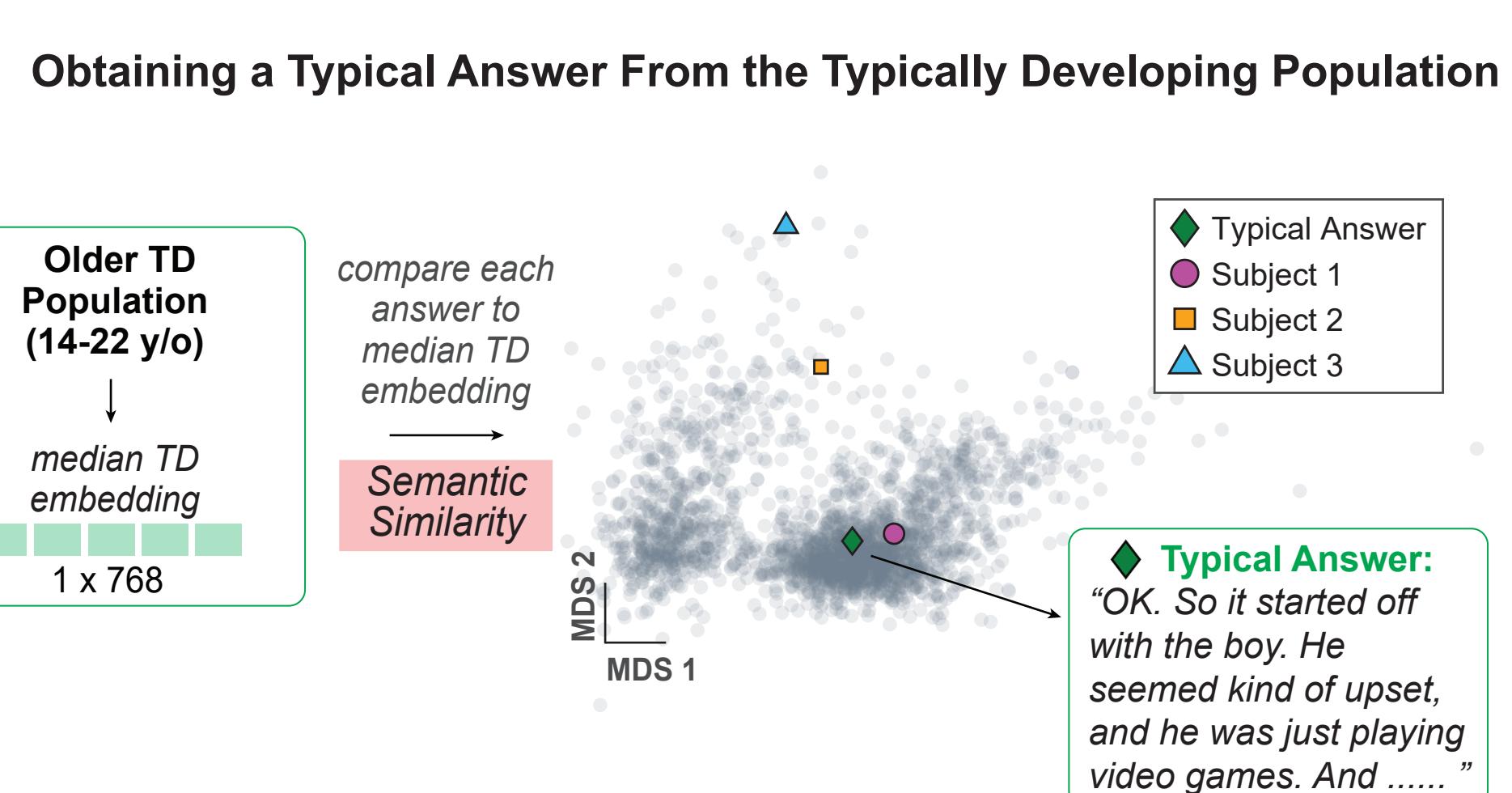
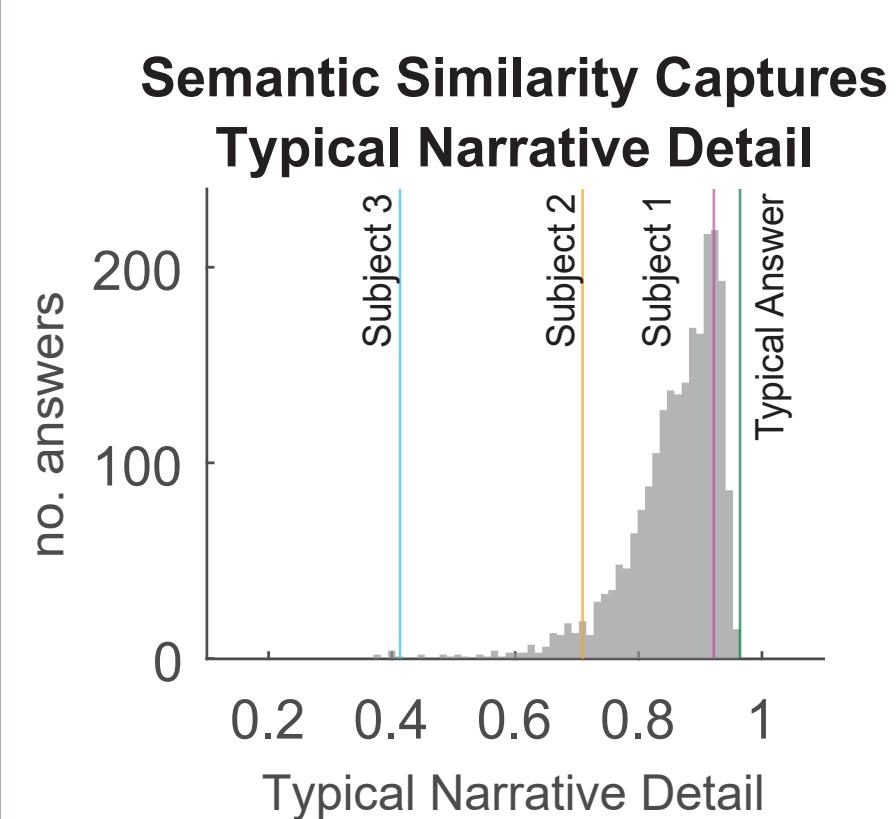
Interviewer: "Can you tell me what happened in the movie? Try to tell the whole story. Remember that stories have a beginning, things that happen, and an ending."

• Subject 1: "Yeah, so in the beginning... The kid, he like seems really into his video games. And his mom comes home...."

• Subject 2: "He kicked the dog. In the beginning, he hated the dog. In the middle, he liked the dog a little bit, and then he liked it."

• Subject 3: "I do not remember."

... Embedding Model Subjects x 768 dimensions



Language

Obtaining Objective Language Ability Metrics from Natural Conversations

Interview Audio

WhisperX

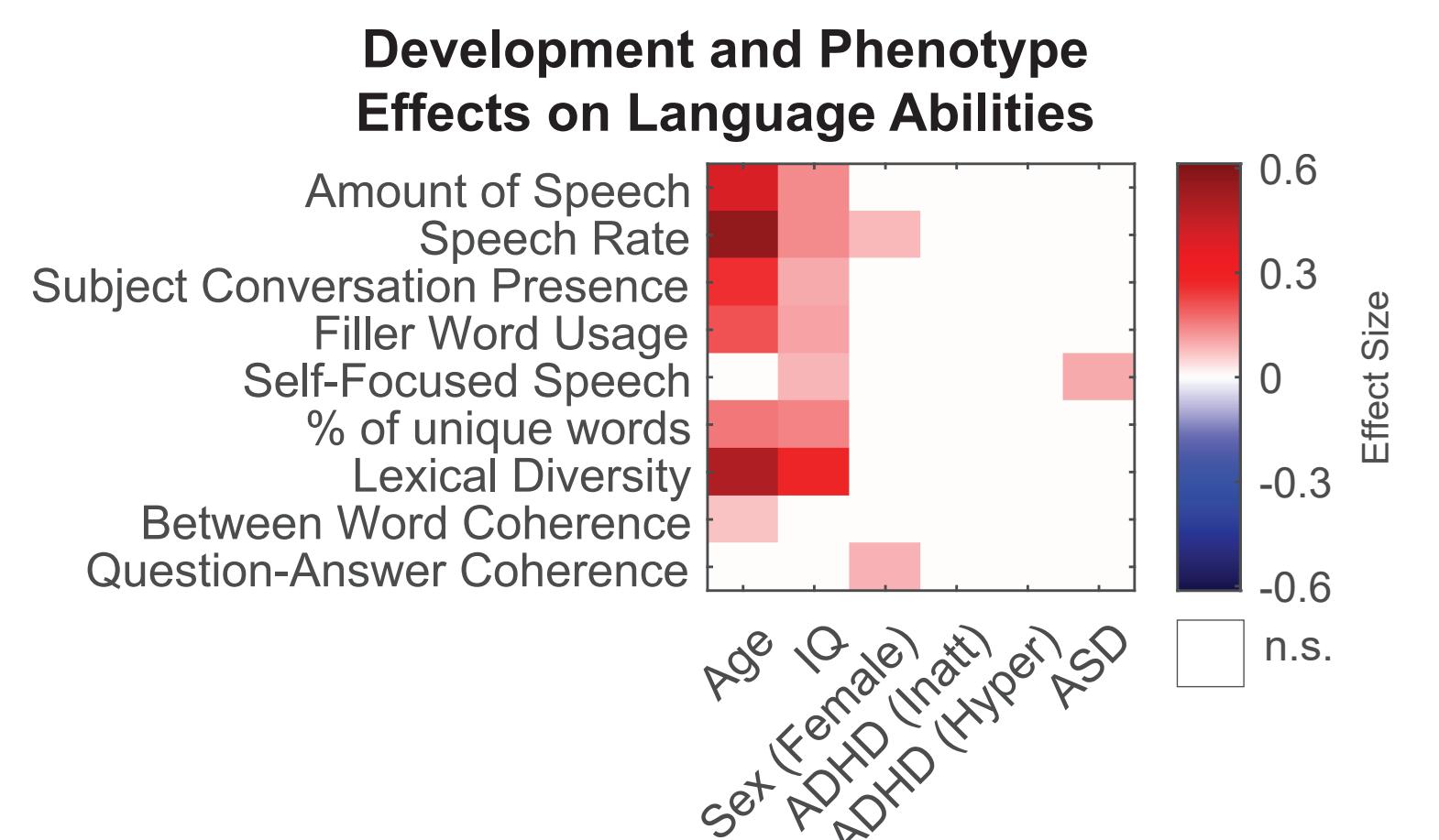
Transcript & word-level timestamps

Subject Speech

LLM Diarization

Natural Language Processing

Language Ability Metrics



Task

Describe the short film *The Present* during a semi-structured interview.



AI Tools

WhisperX + Large-Language Models

- Transcription & speaker diarization.

Google Text Embeddings

- Semantic analysis of responses.

OpenWillis

- Speech & prosody measures.

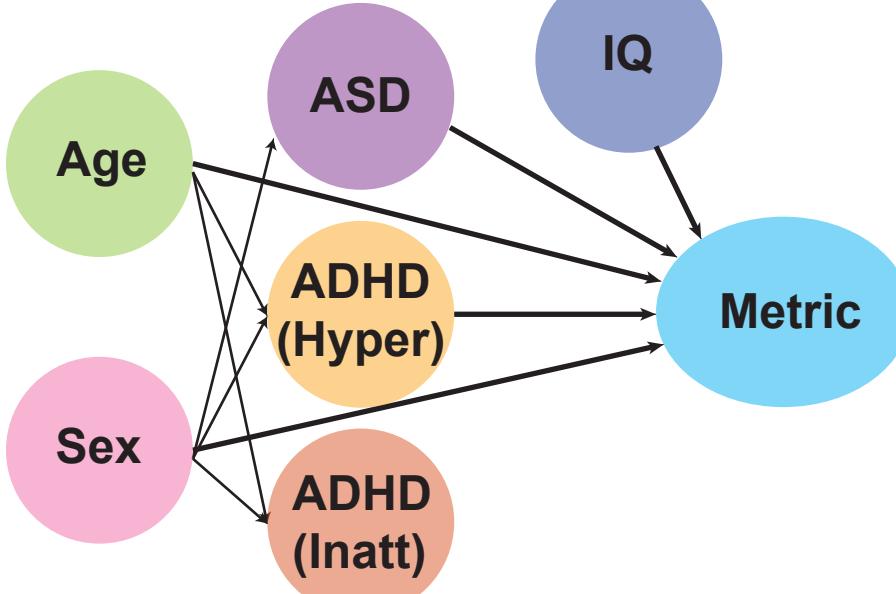
Mediapipe Holistic Model

- Body and Facial movement measures.

Analysis

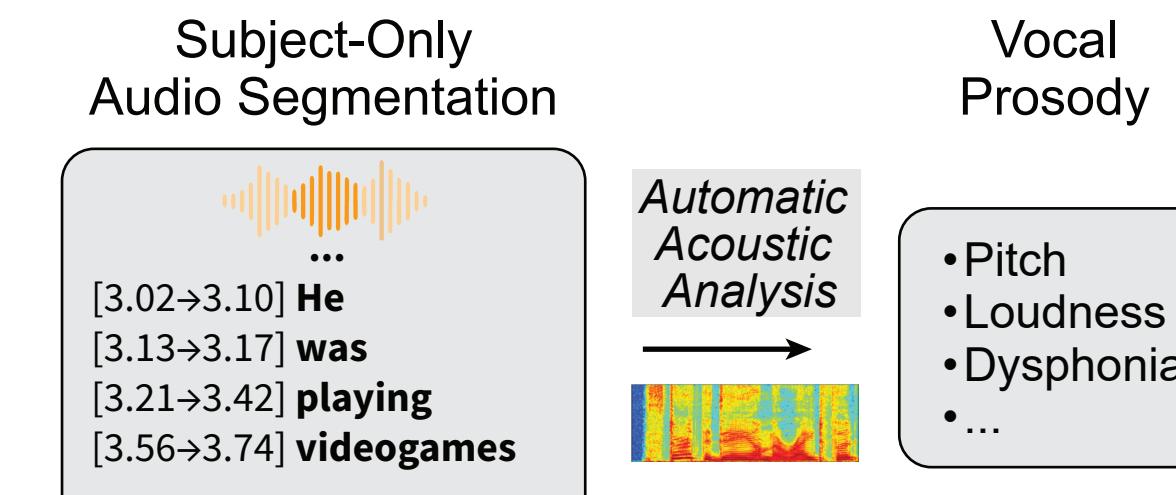
Multivariate regression controlling for age, sex, IQ, and comorbidity

$$\text{Metric} \sim \text{Age} + \text{IQ} + \text{Sex} + \text{ADHD-Inatt} + \text{ADHD-Hyper} + \text{ASD}$$

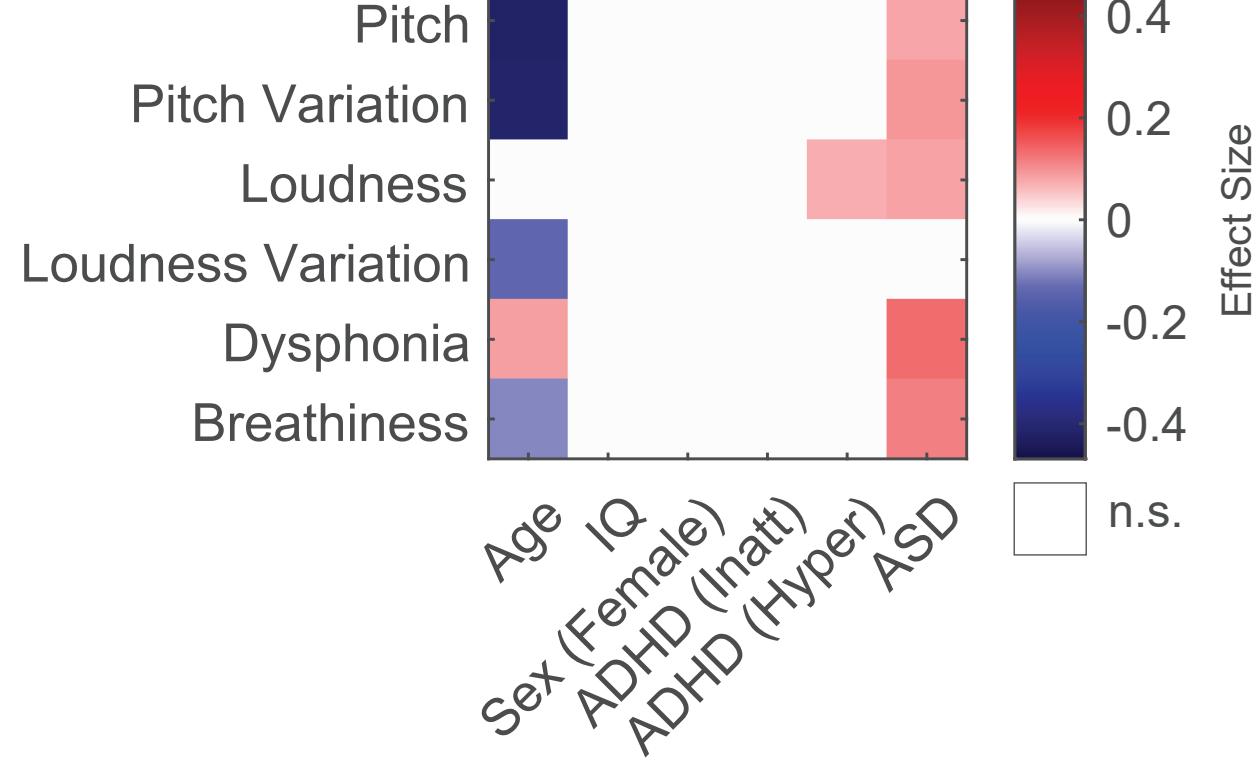


Vocal Prosody

Obtaining Objective Vocal Prosody Metrics from Natural Language

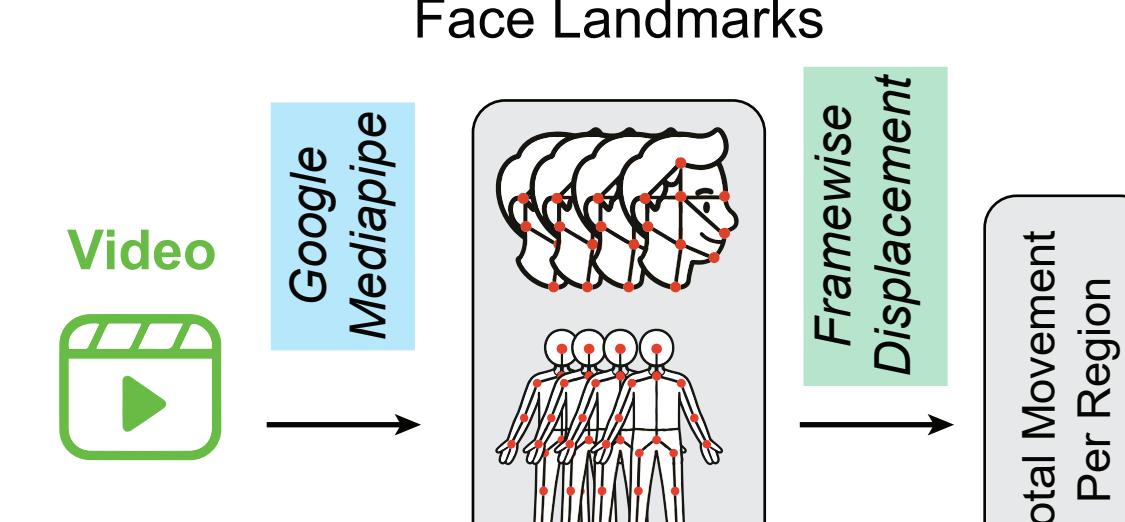


Development and Phenotype Effects on Vocal Prosody

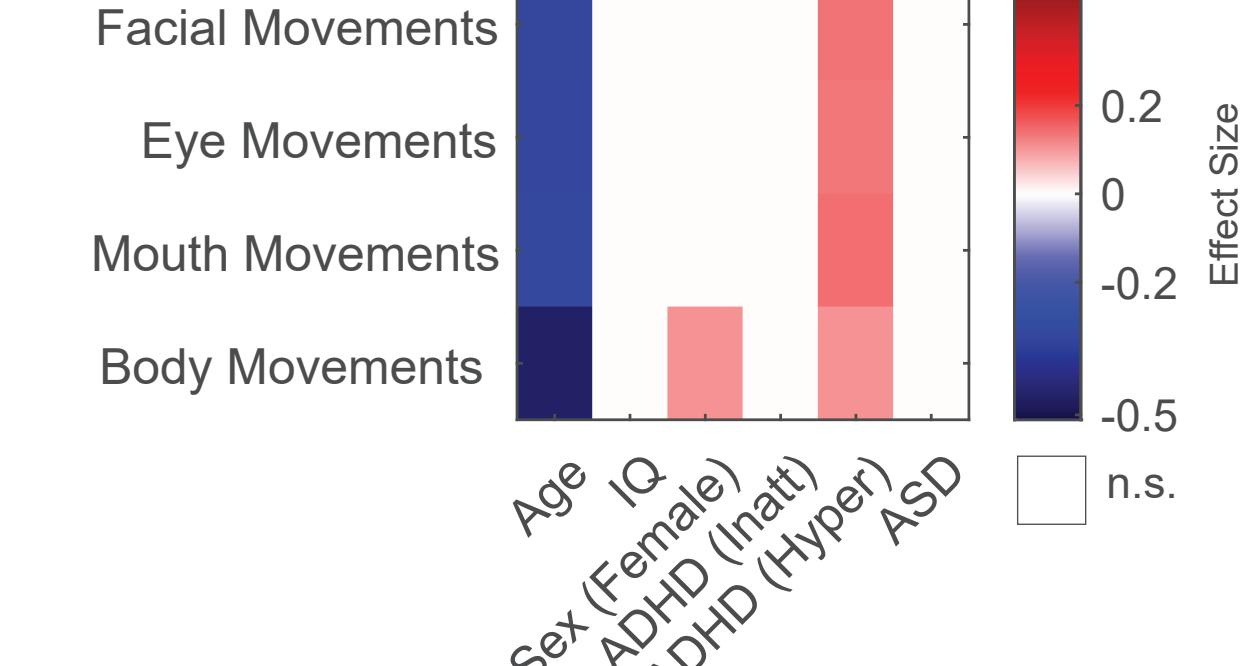


Movement

Measuring Movement from Video



Development and Phenotype Effects on Quantified Movement



Highlights

- Distinct, quantifiable signatures differentiate ASD and ADHD.
- **ASD:** intact language structure, but impaired narrative, Theory of Mind, and atypical prosody.
- **ADHD-Hyperactive:** increased movement as a specific marker.
- Developmental modeling is essential to separate pathology from maturation.
- Digital phenotyping offers data-driven complement to clinical assessments.
- Scalable, objective behavioral analysis may open path for developmental diagnostics using naturalistic data.

