1.7 ML and Computer Vision for Developmental Disorders

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Challenges in disorders:

- Autism: 1:42
    - One every 50, 2% of population
- Sub Saharan/ Africa:
    - 0.5 billion of children, only handful of doctors trained for autism
- Lacks of autism specialists in US
    - Outside of cities
- Behavioral assessment – observation
    - Expensive
    - Time-consuming
        - Hours
    - Not enough clinicians
    - Current standard of care still challenging
        - Screening != diagnosis
            - M-CHAT-R
        - Screening: 50% of false positives
        - Diagnosis: not perfect

AWS Autism video:

- https://www.youtube.com/watch?v=YQpTlnWYAqE
- Clarification:
    - 17 points in IQ –
    - Between 18 to 24 months
        - US average age of diagnosis is 3 year
        - 3 times: Intervention opportunity missed

Encoded behaviors

- Events in the movie are deliberate
- Recording:
    - facial expression (emotions)
    - movement of children
        - Head (turn and pose) and hands movement
    - Audio
    - Clinical data
- Parents are not involved
- Also measuring: Clinician calling the name to tested child
    - Response to name calling
        - https://acamh.onlinelibrary.wiley.com/doi/abs/10.1111/jcpp.13381?campaign=wolearlyview

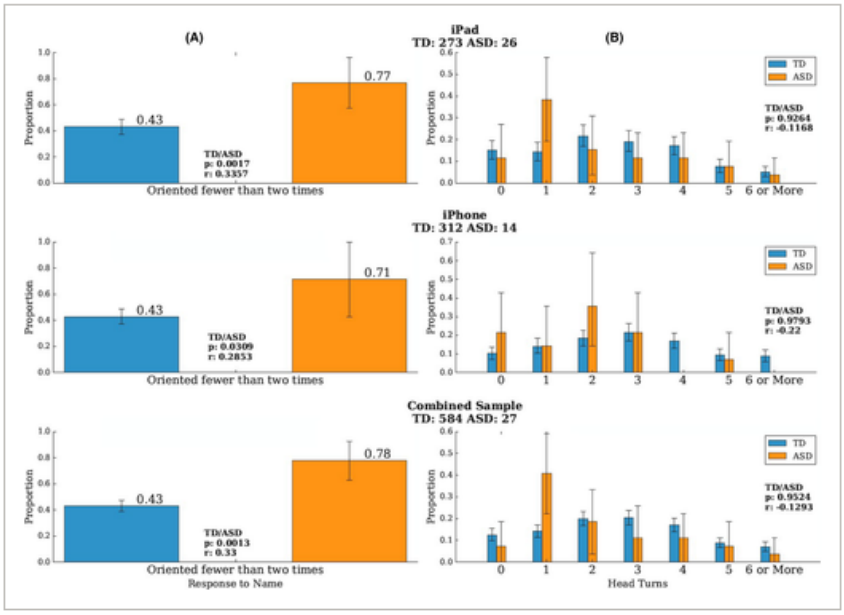

Figure 3 Open in figure viewer | PowerPoint

(A) The proportion of children who oriented fewer than two times versus twice or more to three name calls was significantly different for those with typical development (TD) versus those with ASD. (B) The proportion of children who spontaneously turned their heads 0, 1, 2, 3, 4, 5, and 6 or more times during the two movies during which the name calls occurred. The TD and ASD groups did not exhibit a significant difference in the cumulative number of spontaneous head turns. Effect sizes are denoted as '*r*'

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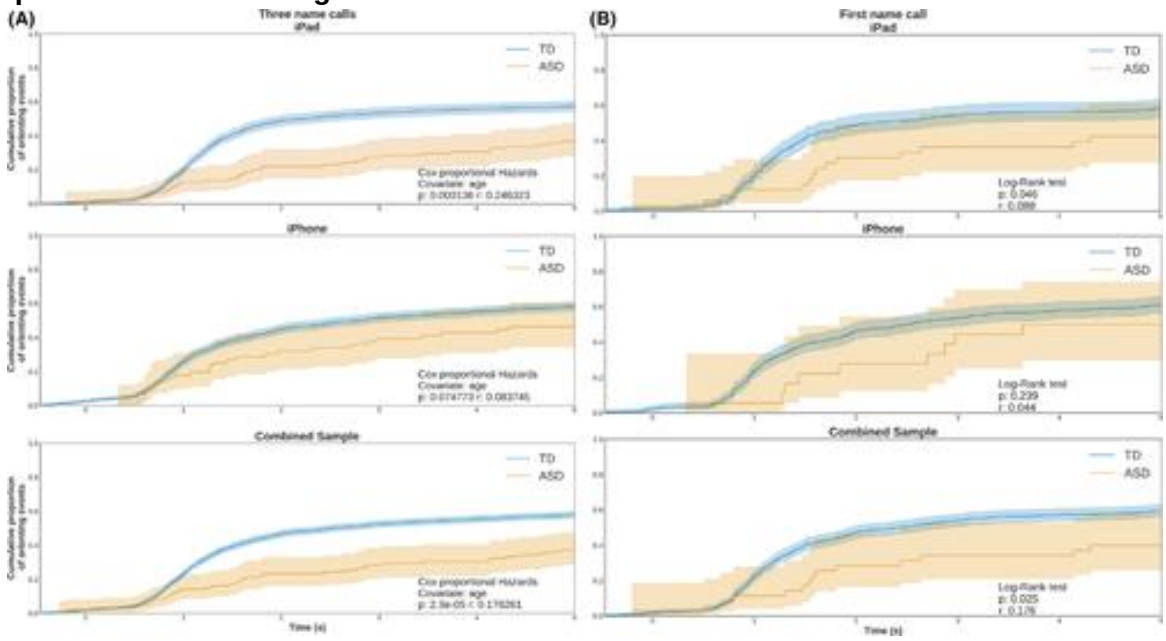
        - Children with autism will have slower response to name calling
        - Language delay without autism with no significant differences to non-autistic children
- Not easily compliant subjects
- Two categories of biomarkers:
    - Labsetting Biomarkers: reported in literatures, not done in domestic settings but at clinical settings
        - In regular settings
    - Discovery biomarkers:
        - Expert opinion: Distracted child will response to name calling from their parents
            - Thus including at part of the model

Response to Name Calling



- Face position:
    - Autistic children typically turn at 1 second later than non-autistic children
    - Never observed before in previous studies
    - New Biomarker
- Potential hypothesis:
    - Neural science behind autism: motor effort affecting autism?

Scalable Gaze Analysis

- https://jamanetwork.com/journals/jamapediatrics/fullarticle/2779395

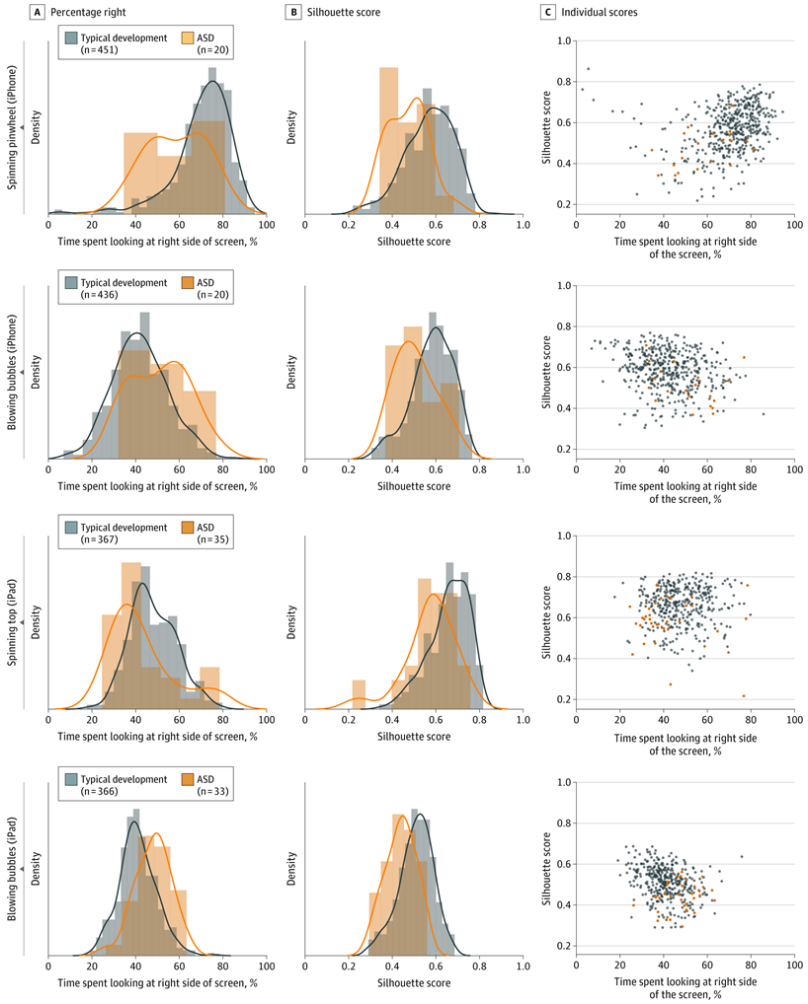
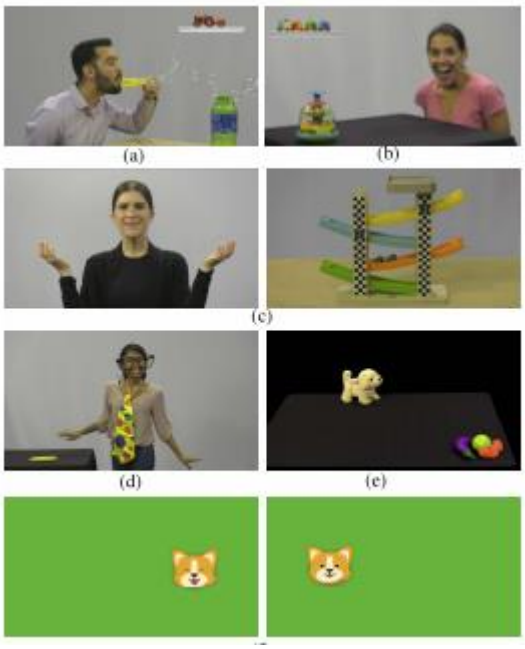


Fig 1. Gaze data for 4 movies that depicted a person on one side of the screen playing with toys located on the opposite side of the screen. A, Distribution of percentage right scores (percentage of time spent looking at the right side of the screen) for each movie. B, Distribution of silhouette scores for each movie. C, Scatterplots displaying individual participant percentage right (horizontal axis) and silhouette scores (vertical axis). For “spinning pinwheel” (iPhone), the person is on the right side of the screen; for “blowing bubbles” (iPhone), the person is on the left side; for “spinning top” (iPad), the person is on the right side; and for “blowing bubbles” (iPad), the person is on the left side. ASD indicates autism spectrum disorder.

- Strong biomarker with glaze
- Potentially lead to motor efforts
- Traditionally under controlled settings
    - Three types of stimuli for left and right motions
        - Alternating conversation between two people at two ends of the screen
            - Ask if children engaged to the left-right pattern for the conversation
            - Autistic children not highly correlated to the conversation
        - Objects gazing

- Non-social objects gazing well-known as sign of diagnosis than social event
- Half of the screen containing only the toy
- Autistic children spend more time gazing at the toy

Facial Dynamics

- https://ieeexplore.ieee.org/document/7021907
- 

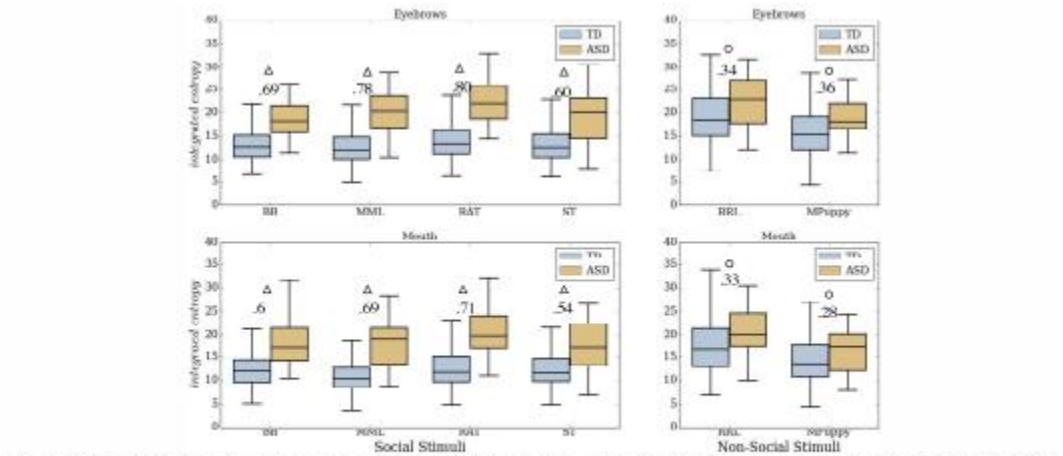
- Facial recognition and expression were originally trained for adult data
  - Not applicable to children data
- Multiscale entropy for dynamics of
  - Eyebrows
  - Mouth
- 

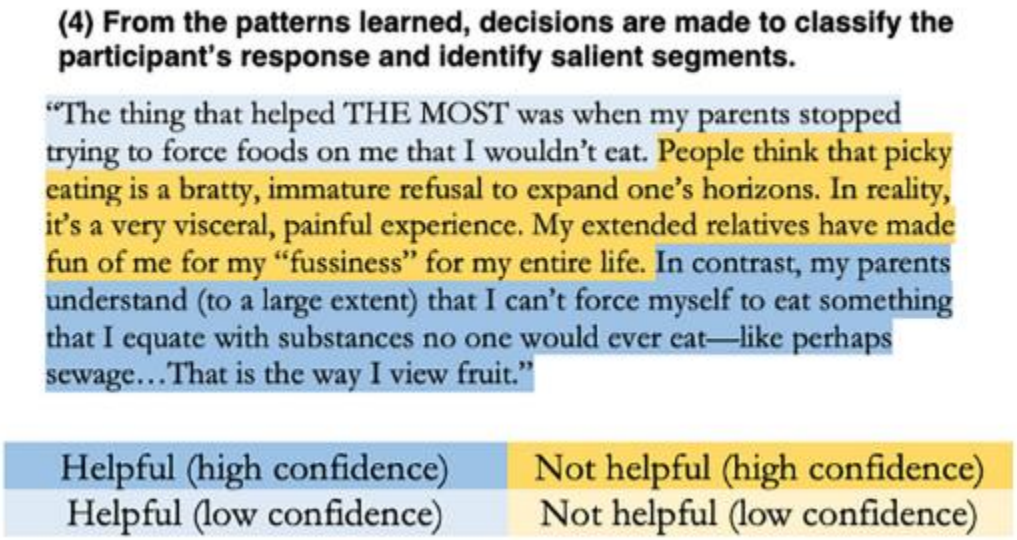
  Fig. 5. Comparative analysis of *integrated entropy* between the ASD and TD groups for all the social and non-social movies. Symbols: △→ p<.00001 and ○→ p<.01. The numbers inside the figure represent the effect size r. *BB = Blowing Bubbles, MML = Make Me Laugh, MML = Make Me Laugh, ST = Spinning Top, RAT = Rhymes and Toys, RRL = Dog in Grass RRL, and Mpuppy = Mechanical Puppy.* Refer to Fig. A6 in the supplementary for scatter plot distributions of the groups.
- Much more limited separation in non-social stimuli than social stimuli
  - Less predictable dynamics for autistic children in facial dynamics

Game: Fine Motor Control

- https://www.researchgate.net/publication/351351985_ASSESSMENT_OF_MOTOR_SKILLS_VIA_A_TABLET-BASED_GAME_IN_YOUNG_CHILDREN_WITH_AUTISM_SPECTRUM_DISORDER
- Carefully designed interactive game
- Bubbles rising from bottom to the top
    - Incentive (nice animal appearing) if popping bubble
    - Recording fine motor control
- Two groups:
    - Autism + ADHD
    - Autism
    - Separating Autism to Autism + ADHD children
        - Autistic children pop more than ADHD children
        - Autistic children with lower accuracy
            - Motor control
        - Number of touches with higher error with ADHD

Food Intake Disorders

- https://onlinelibrary.wiley.com/doi/epdf/10.1002/eat.23639



(4) From the patterns learned, decisions are made to classify the participant's response and identify salient segments.

"The thing that helped THE MOST was when my parents stopped trying to force foods on me that I wouldn't eat. People think that picky eating is a bratty, immature refusal to expand one's horizons. In reality, it's a very visceral, painful experience. My extended relatives have made fun of me for my "fussiness" for my entire life. In contrast, my parents understand (to a large extent) that I can't force myself to eat something that I equate with substances no one would ever eat—like perhaps sewage…That is the way I view fruit."

Helpful (high confidence)	Not helpful (high confidence)
Helpful (low confidence)	Not helpful (low confidence)

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- NLP analyzing responses
    - Positive and negative that may lead to FID
- No known-strategies for all cases
    - Intervention introduced

ML Challenges

- Fairness - ICML, FaaCT
    - Questions may not be addressed by ML community
    - Pareto mean mark fairness (possibly referring to Fairness With Minimal Harm)
        - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7912461/
        - https://par.nsf.gov/servlets/purl/10167731
        - Fair towards all demographics without hurting another demographics

- Privacy - ICML
- Multimodal missing data
    - Connecting all biomarkers
    - Large number of missing data
        - How to deal with that by ourselves?
- Unique population
- Hard working environment
    - Logistics and technical challenges
- Evaluated by clinicians
    - More publications on clinical journals, not ML journals