Digital Assessment for Diagnosis & Treatment Outcome Measurement

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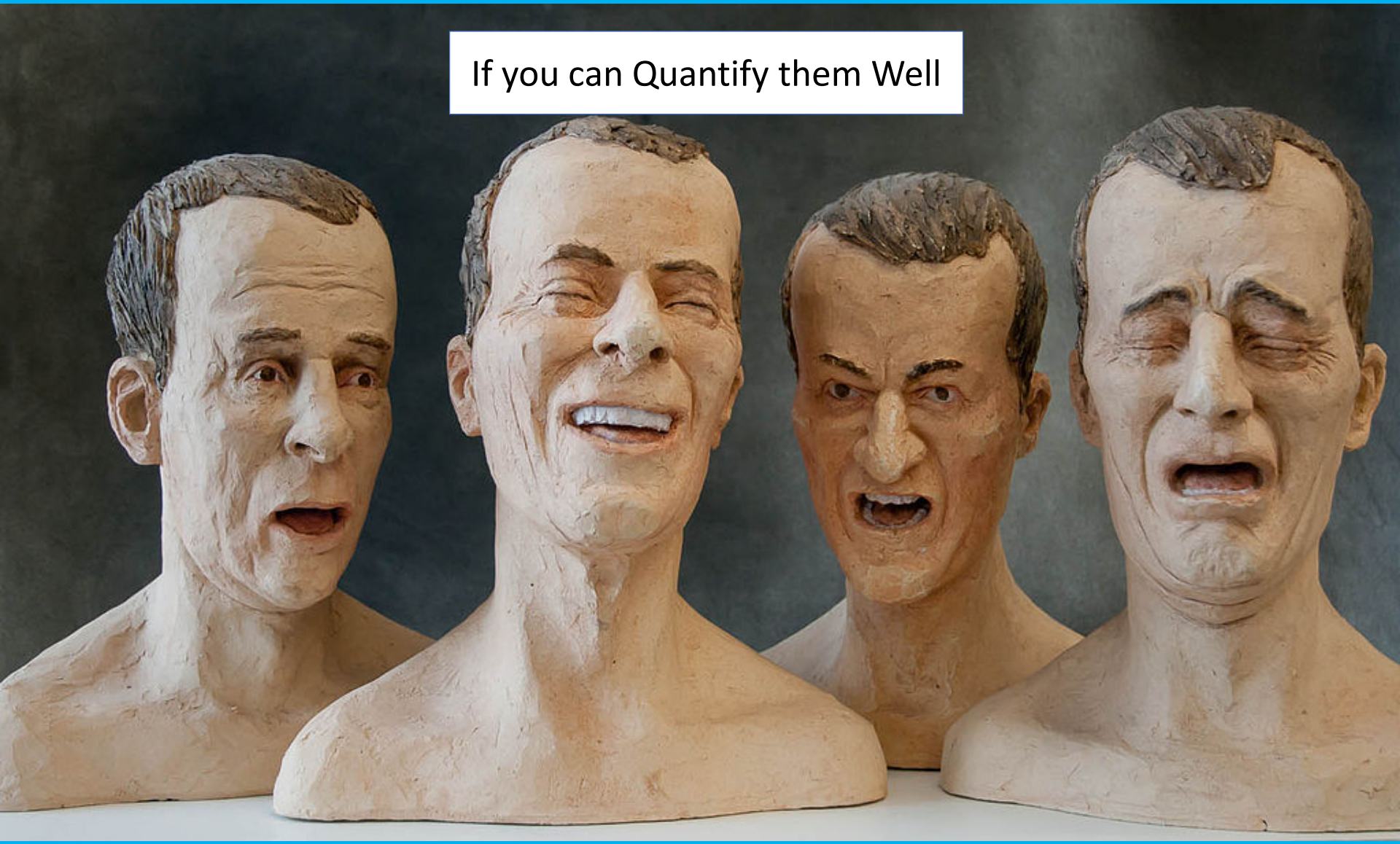
No disclosures related to this research

Behaviors are exquisitely organized representations of neural circuitry activity, i.e. Biomarkers



Autism is a Behaviorally Defined Condition

Perceptual Computing:

All behaviors observable by an autism expert can be digitally captured and analyzed to make predictions (e.g. diagnosis, treatment response, biological substrate)

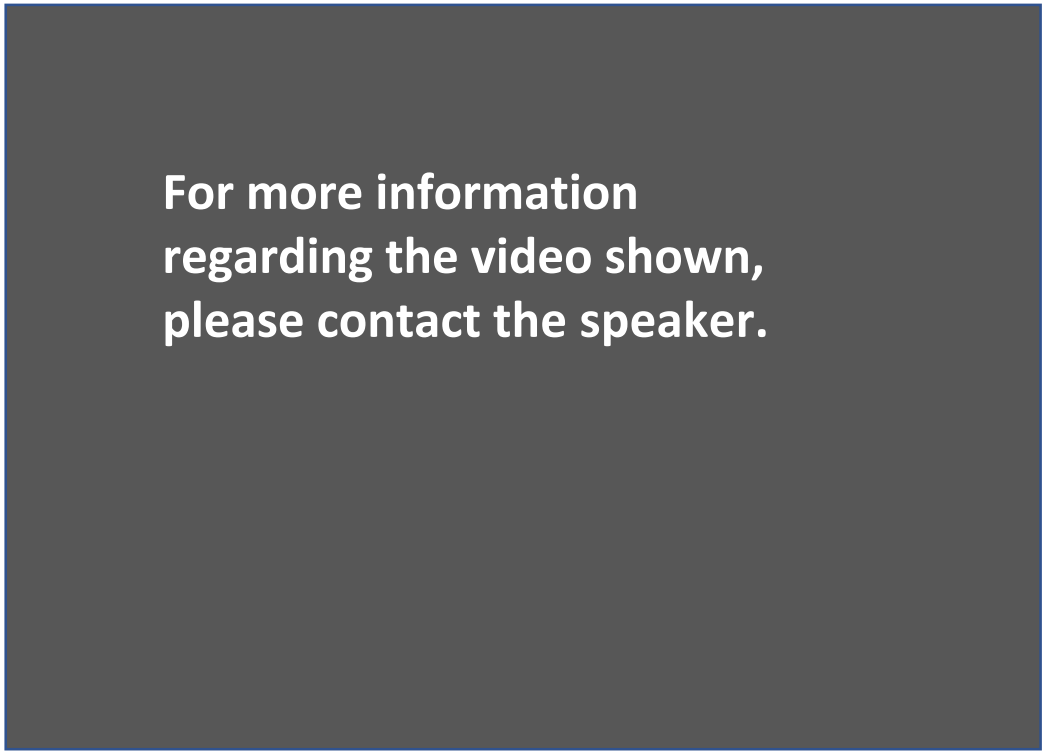
- In the lab, as well as natural everyday contexts
- Perfect attention and memory

These can all be digitally captured with very high accuracy

- Repetitive Behaviors, Imitation: Gross Motor
- Facial expression, gesture, eye contact: Nonverbal Communication
- Acoustic properties of speech – rate, volume, prosody
- Language (reflects inner life, restricted interests)
- Autonomic nervous system activity (anxiety, arousal)

- For **Precise Measurement & Prediction**
  - dx, granular characterization, intervention planning for core and other features of ASD (or any condition), intervention response, side effect monitoring, natural history description, genetic variants, brain imaging …

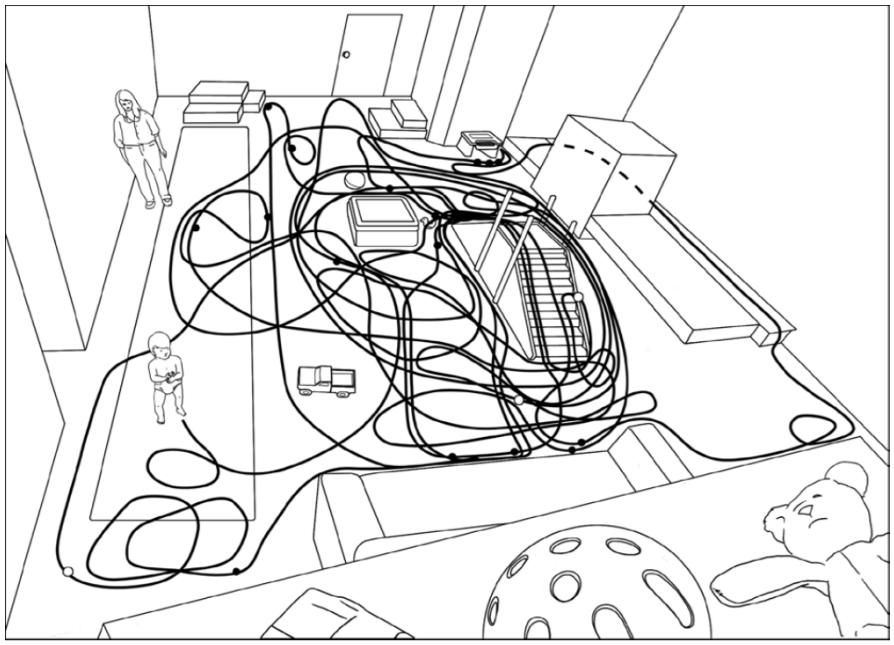
Measuring Gross Motor Behavior



- **Motor Coordination**
- **Balance/Postural stability**
- **Repetitive Behaviors, Stereotypies**

Gross Motor delay one of the earliest signs of autism risk

Exploration, Social Approach, Motor Learning



Adolph et al. 2012. Learning to walk. Thousands of Steps and Dozens of Falls Per Day

For more information regarding the video shown, please contact the speaker.

Imitation: A Core Difficulty

(large effect size)

Wearables – gyroscopy, accelerometer

For more information regarding the video shown, please contact the speaker.

Quantifying Imitation Performance

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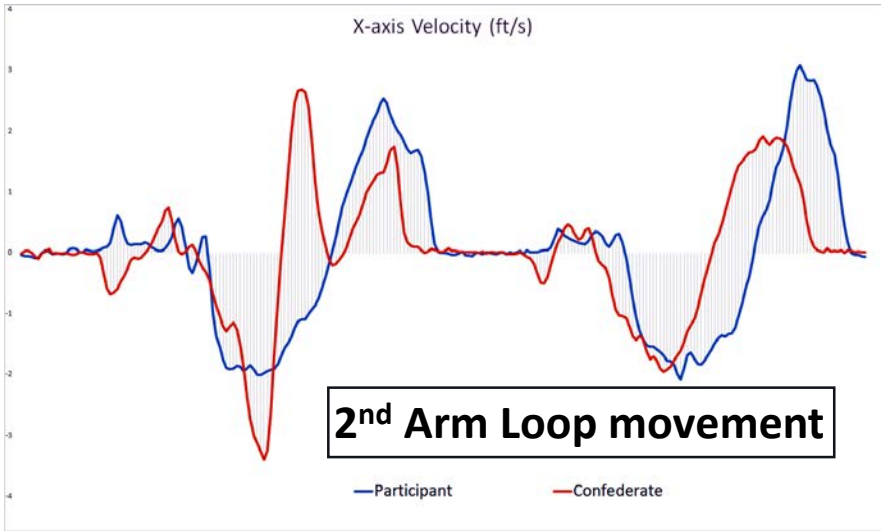
Quantifying & Analyzing Movements



Arm loop movement (Confederate – left, Participant – right). To give some insight into the level of tracking fidelity this system is capable of, here is just one of the movements from the Gross motor task. This is on the second circle of movement where the subject has started to adapt to mimicking the movement very well. However, you can see subtle differences in the execution of this movement, in both the spatial location of the execution, as well as in the delay in the changes in velocity along the x-axis. So we are not sacrificing signal by not having cords strapped to the patient's body. In other words, if an abnormality exists in motor ability, there is confidence that we will find it with this technology.

Synchronous Motor Learning: Dance

For more information regarding the video shown, please contact the speaker.

Gross Motor Assessment: “Portable”

For more information regarding the video shown, please contact the speaker.

Diagnosing Autism from a 3 Minute "Get to Know" Conversation

Proof of Concept Pilot Study

17 ASD, 27 TD

Age and IQ matched

For more information regarding the video shown, please contact the speaker.

Example of a Predictive Feature

17 ASD, 27 TD

Age and IQ matched

Analyses:

- Machine Learning
- 44 fold Nested Leave One Out Cross Validation

1st Study Results:

Preliminary/Unpublished

Accuracy: ~84%

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Limitations: Many. 1st Proof of Concept Study

Computational Linguistics

Two Parts to Speech

- **What we say**: morphemes->sentences (contractions, turn taking)
- **How we say it**: acoustics: rate, tone, rhythm, volume, stress, intensity (prosody, co-articulation: spacing between phonemes/words)

- Quantify both (natural language processing & acoustic analyses)
- Prediction – diagnosis, treatment response, brain scan result, genomic risk factors, etc.

Example pilot study findings (Parish-Morris et al, 2016)

- Use pedantic phrases/odd word choices: 85% AUC (n=65 ASD & 17 TDC)
- More dysfluencies (Um, Uh); Slower speech rate; Longer inter turn pauses, Differences in Pitch (fundamental frequency)
- Best prediction: Multivariate analyses combining speech features with nonverbal communications (facial expressions, eye gaze, gesture) and imitation

Perceptual Computing Promises

Improvements in Clinical Care (not autism specific)

- Reduction in clinic waitlists with remote Screening Assessment & Triage
- Earlier, more accurate diagnosis → earlier intervention → better outcomes
- Ongoing home and school based *monitoring* of response to interventions

Improved Scientific Reproducibility

- Characterize Heterogeneity → Control Heterogeneity
- Scalable to the real world assessment enabling larger samples

Accelerate biological discovery: genetics, brain imaging, etc.

- Impoverished characterization, e.g., "autism" vs. "no autism," handicaps biological studies
  - Statistical modeling imprecise and statistically underpowered

THANK YOU!

Center for Autism Research (CAR)