Towards an automated analysis of social-communication behaviors in ASD

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Introduction

Objective behavioral assessment is a mainstay of behavioral science tools. Recent advances adapting human-AI interaction technology has promise to streamline analysis of core social-communication behaviors for treatment research. [1]

Procedures

We have developed a protocol to evaluate and refine machine learning algorithms to detect social communication behaviors in typically developing (TD) children and children with neurodevelopmental disorders (NDD) such as ASD. See Table 1 for sample characteristics & Fig 1. for data collection methods.

Figure 1. Protocol Development

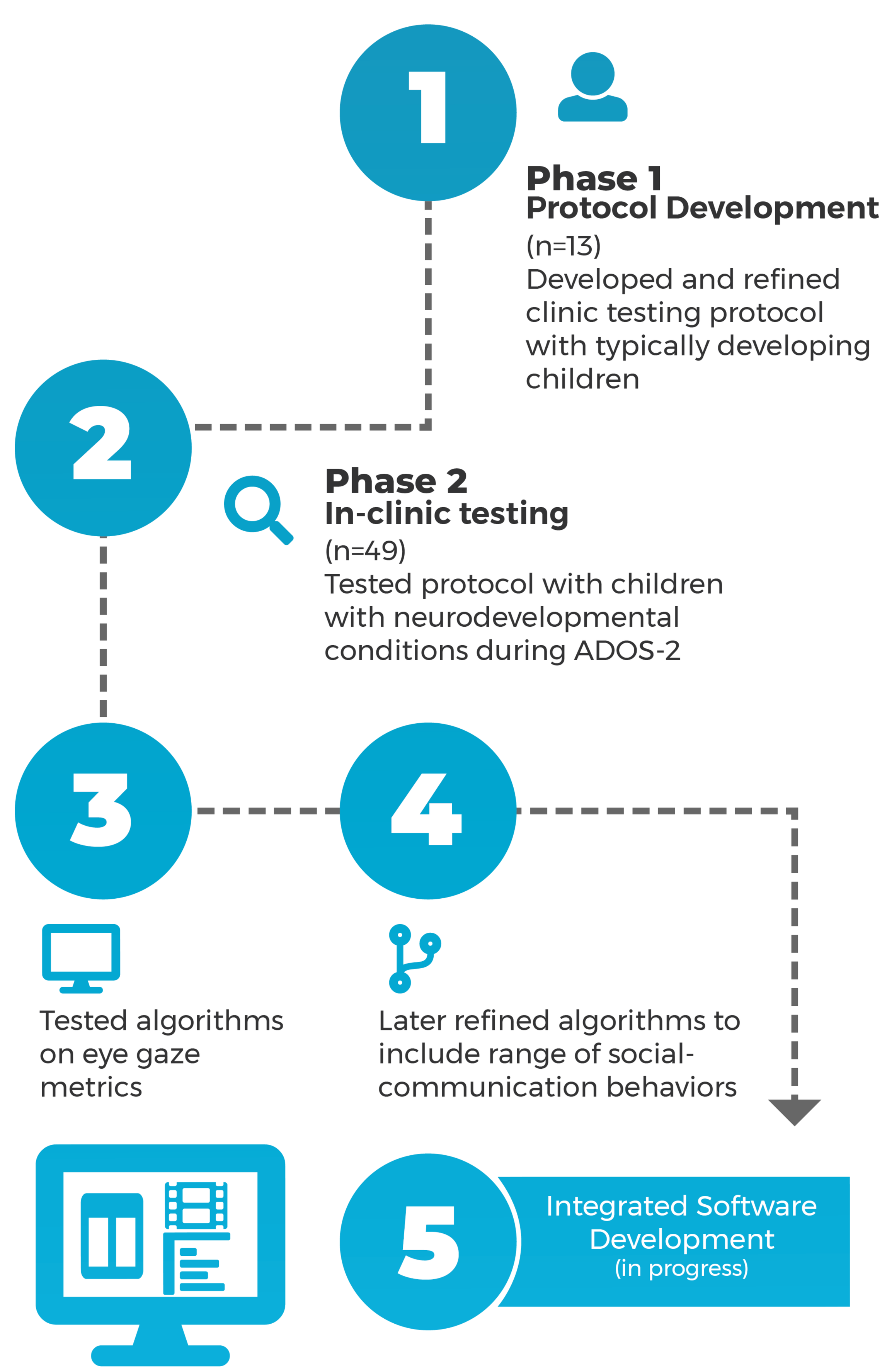


Figure 2. Non-obtrusive Data Collection Procedures

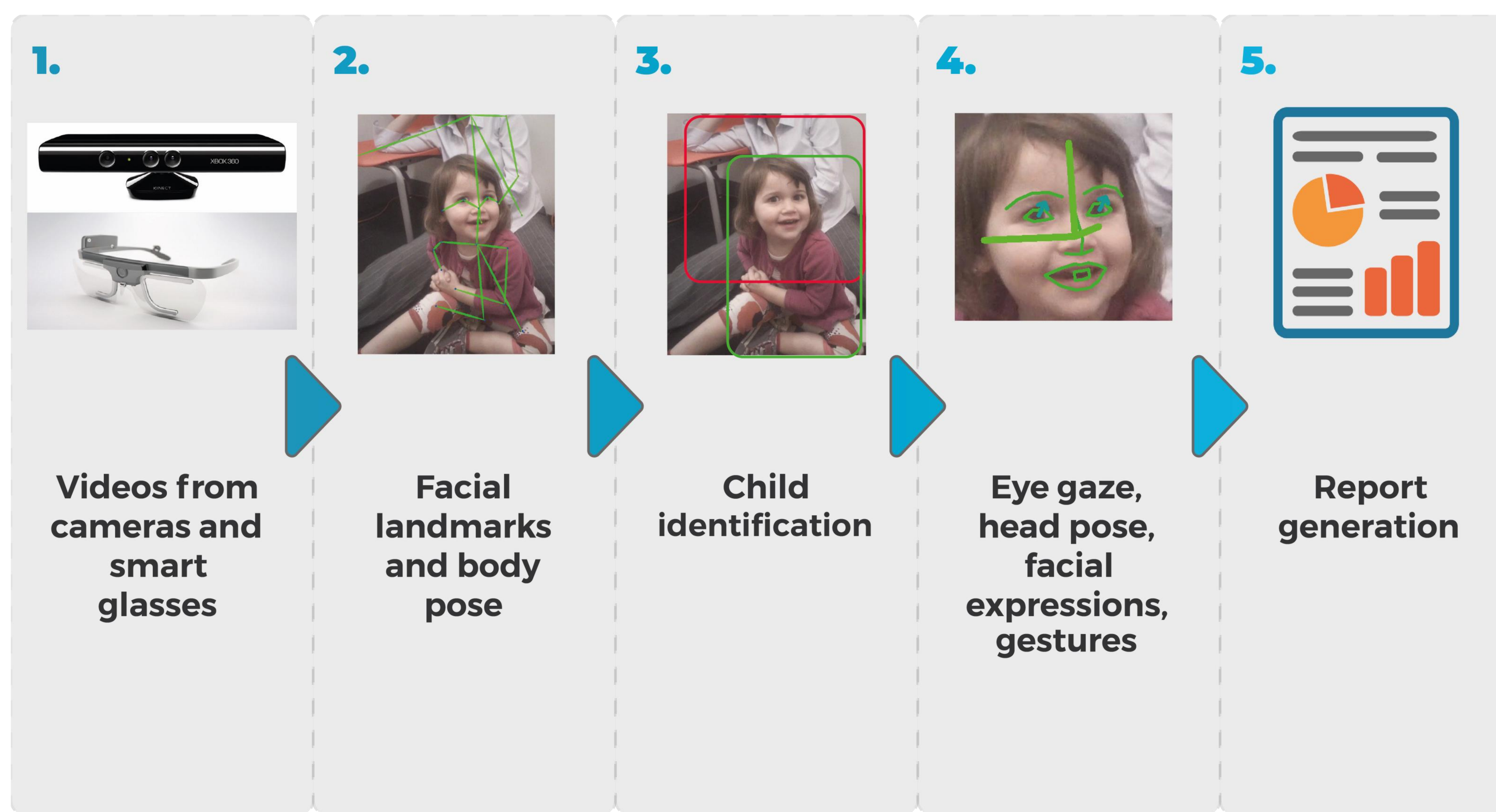


Table 1. Participant Demographics

	Full Sample		Age-matched Comparative Analysis	
	TD n=13	NDD n=49	TD n=8	ASD n=8
Age in Years	5.9 (2.6)	8.9 (3.6)	5.9 (3.0)	5.6 (3.4)
Sex (N, % male)	6, 46.2%	29, 59.2%	4, 50%	6, 75%
Full Scale IQ (mean, SD)	n/a	88.1 (24.1)	n/a	111 (16.7)
ADOS-2 CSS (mean, SD)	1.6 (1.8)	6.1 (2.8)	1.9 (2.1)	6.3 (3.1)

Table 2. Correlations between biometric data and corresponding ADOS-2 items

	Positive valence emotion	Negative valence emotions	Gaze Initiations (Child)	Gaze Responses (Child)	Synchronized Gaze
ADOS-2 unusual eye contact	-.33	-.07	**-.41**	**-.46**	**-.47**
ADOS-2 facial expressions	**-.52***	**-.35**	-.26	-.35	-.41

Figure 3. Gaze Behavior

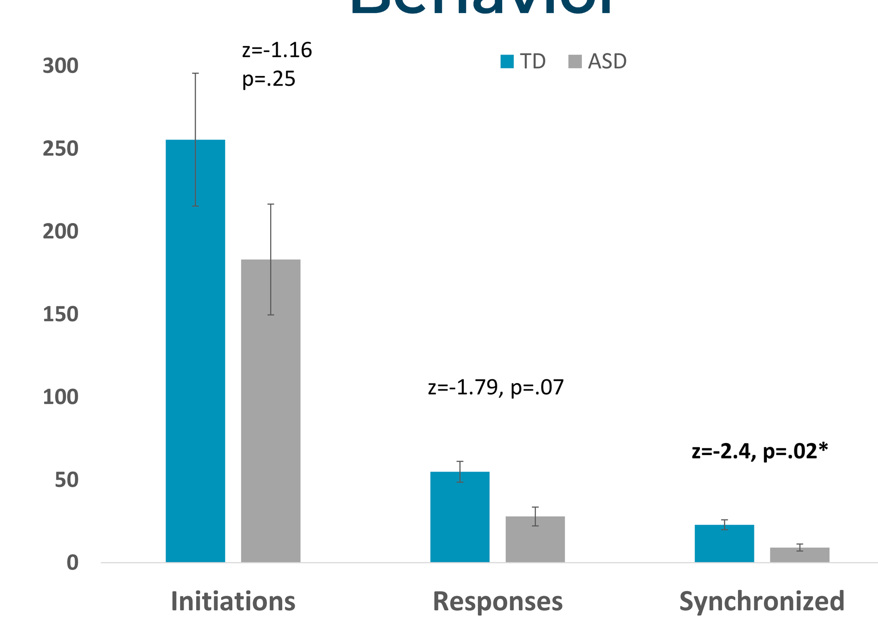
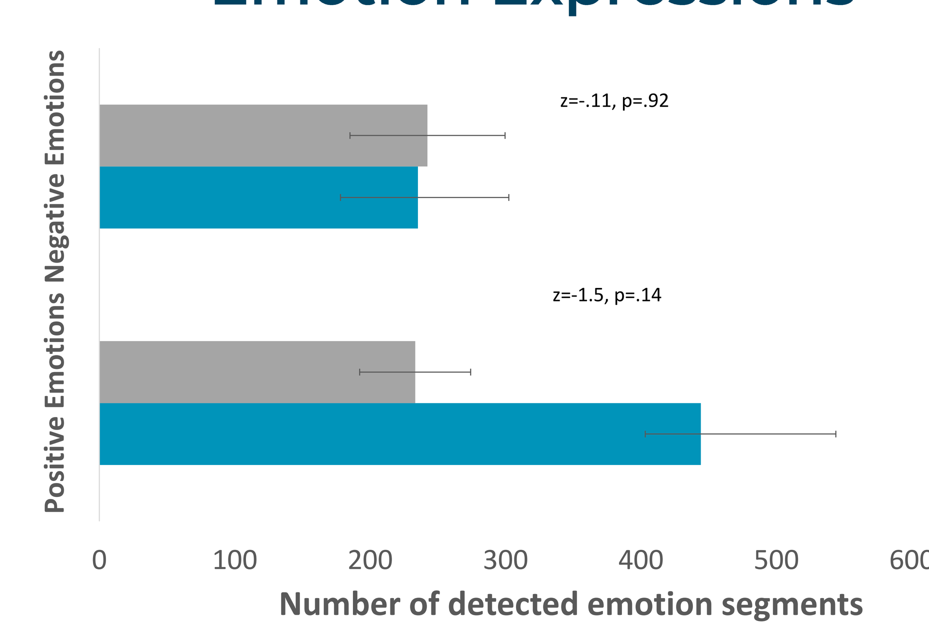


Figure 4. Frequency of Emotion Expressions



Data analysis

- We combined machine learning components into an algorithm that finds and analyzes the patient (Fig. 2)
- Quality assurance checks included testing on independent emotion and eye gaze data sets. We use a state-of-the-art deep learning system that reaches a 0.63 mean F1 score for facial action unit activity detection on a frame-by-frame level. [2]
- Our solution is a fully automated system, it does not suffer from reproducibility issues
- Spearman's rho used to estimate relationship between biometric data and clinician ratings of behavior on ADOS-2 items. Wilcoxon sign rank test used to evaluate group differences.

Results & Discussion

- Moderate, negative correlations found between frequency of gaze & facial expressions and clinician ratings of impairments on ADOS-2 items (Table 2)
- Gaze data suggest lower levels of initiations, responses, and synchronized gaze in ASD vs. TD with statistically significant differences found in synchronized gaze (Fig. 3)
- Emotion data indicate lower levels of positive emotions but equivalent levels of negative emotions in ASD vs. TD (Figure 4)

Conclusions & Future Directions

- System shows promise to identify digital biomarkers closely linked to disease phenotype in ASD
- Monitoring capacity includes behavioral classes as well as subtle behavioral markers of change
- Future directions will require training system in broader neurodevelopmental and psychiatric samples (e.g. at-risk schizophrenia, ADHD) & testing within behavioral and pharmacological intervention trials

References

[1] Lőrincz, András. "Revolution in health and wellbeing." *KI-Künstliche Intelligenz* 29.2 (2015): 219-222.

[2] Tősér, Zoltán, et al. "Deep learning for facial action unit detection under large head poses." *European Conference on Computer Vision*. Springer, Cham, 2016.

Funding: Boler Family Foundation