Towards Autism Screening through Emotion-guided Eye Gaze Response

Surjya Ghosh[*], Tanaya Guha[#]

[*]Centrum Wiskunde and Informatica, The Netherlands
[#]University of Warwick, UK

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Background

- **Autism Spectrum Disorder (ASD)**
  - Neurodevelopmental disorder [1, 2]
  - Significantly impaired social interaction [3, 4]
  - Limits communication abilities

- **ASD symptom manifestations**
  - Facial expression [5]
  - Atypical gaze response → fixate less [6]

- **Automated approaches for screening ASD**
  - Pupil diameter correlates with ASD

Require expert involvement, computationally-complex, and often time-consuming

Research Question

- **Emotion → integral component in communication**
    - Influence facial expression [7]
    - Influence eye gaze responses [8]

- **Possibility to explore the role of emotion**
    - For ASD subjects

Can we leverage **eye gaze responses based on the emotional stimuli** to screen ASD?

Field Study & Dataset

- **Experiment Apparatus**
  - VR-based social interaction platform
    - Avatar narrates story related to social situations
    - Avatar expresses 3 types of emotions (angry, happy, neutral)
    - Avatar asks questions after the story
      - **Participants respond with menu-driven interface**
    - During interaction participant's eye gaze data collected

- **Dataset details**

Data collection setup in a VR-based social interaction platform

TABLE I: Details of the eye gaze dataset used

|	
Number of subjects	16 (8 ASD, 8 TD)
Total (short) sessions	1,305
Average session duration	16.2 seconds
ASD sessions	625 (218 Angry, 208 Happy, 199 Neutral)
TD sessions	680 (235 Angry, 231 Happy, 214 Neutral)

4

Data Analysis

- **Pupil diameter, fixation duration, and fixation location**
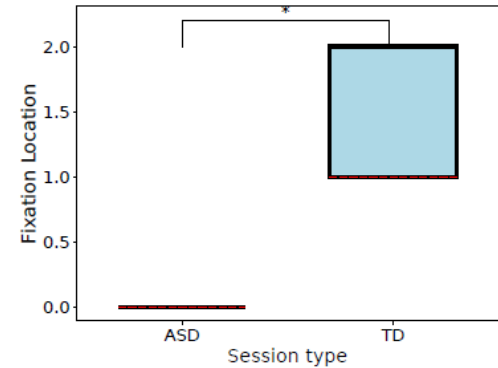   - Vary significantly (p<0.001) between two types of sessions

- Not normal distribution
- Unpaired Mann-Whitney Test
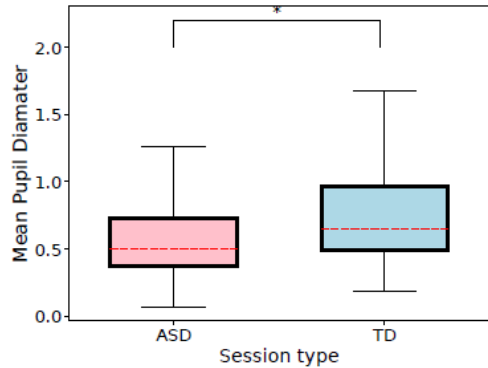
(a) Pupil diameter comparison
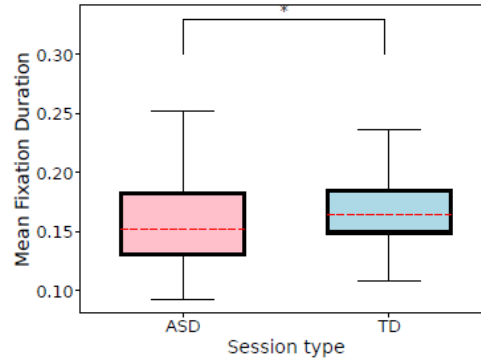
(b) Fixation duration comparison

(c) Fixation location comparison

Methodology

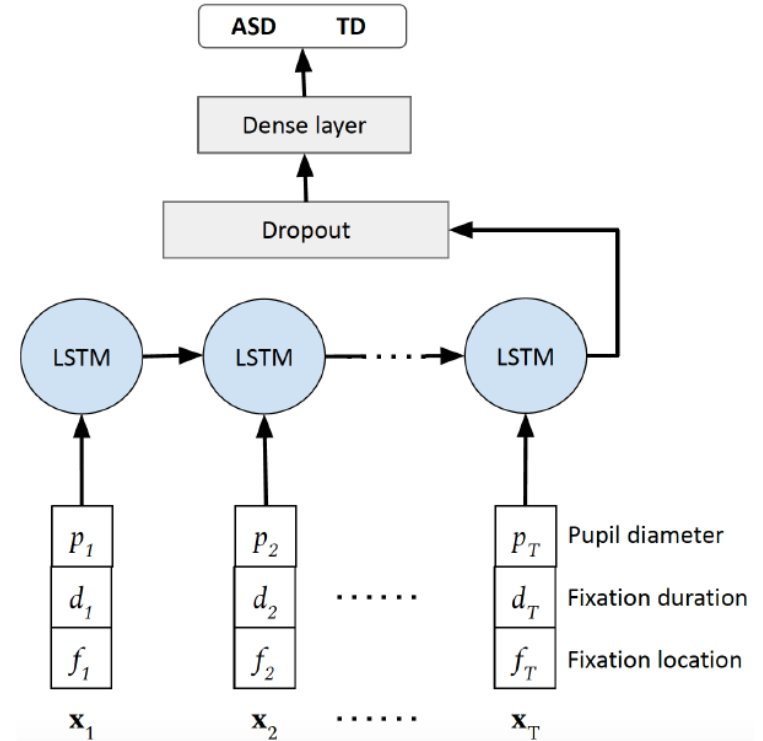- **Session Representation**
  - A set of eye gaze parameters
  - At every time step 't'
    - Pupil diameter
    - Fixation duration
    - Fixation location

- **LSTM cells**

- **Dropout layer**

- **Dense layer**
  - Sigmoid function
  - Binary classification (ASD / TD)

LSTM-based model for ASD screening

Evaluation

- **Baseline**
  - RF-based
  - Features extracted from sessions
    - {mean, median} of pupil diameter
    - {mean, median} of fixation duration
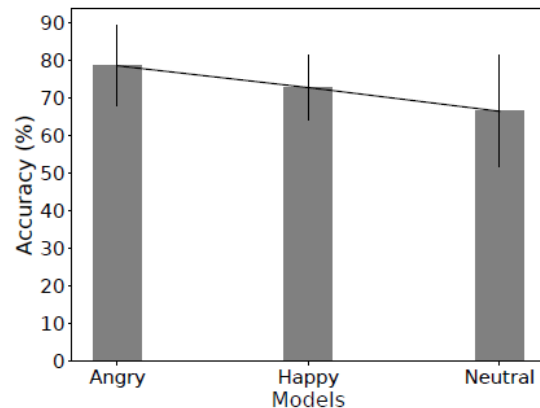   - mode of fixation location

- **Ablation Study**
  - Fixation location is the most discriminating

- **Emotion Stimuli's Influence**
  - Angry, happy stimuli are better

TABLE II: ASD screening results

Model	Accuracy (in %)
RF Baseline	67.8± 8.7
LSTM (proposed)	**77.3± 3.5**
Ablation	
LSTM-pupil dia	59.1± 6.3
LSTM-fix dur	54.8± 12.5
LSTM-fix loc	69.9± 7.9
LSTM w/o pupil dia	72.2± 6.5
LSTM w/o fix dur	76.4± 6.4
LSTM w/o fix loc	61.9± 9.7

Stimuli-wise ASD screening performance

Conclusion

- **Emotion-guided eye gaze response for ASD screening**
  - Proposed an LSTM-based classification model
    - Leverages eye gaze parameters (pupil diameter, fixation duration, fixation location) for the screening
    - Returns an average F-score of 77%

  - Angry, and happy emotion stimuli are found more effective in screening ASD

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Thank You!!

surjya.ghosh@gmail.com

tanaya.guha@warwick.ac.uk

https://surjya-ghosh.github.io/

https://www.tanayag.com/