Effective and Efficient Visual Stimuli Design for Quantitative Autism Screening: an Exploratory Study

Tri Vu1, Hoan Tran1, Kun Woo Cho1, Chen Song2, Feng Lin1, Chang Wen Chen1, Michelle Hartley-McAndrew2, Kathy Radabate Doody3, and Wenyao Xu4

Department of Computer Science and Engineering1, Department of Pediatrics2, Department of Exceptional Education3

Introduction

Early detection and intervention for ASD are critical for increasing child success. Previous study show that when interventions for children with ASD begin before age 5, children's success rate is 67%, compared to the 11% success rate seen when interventions begin after age 5 [1]. However, the effect of visual stimulus on early ASD screening has not been considered as a diagnostic consideration in the past. In this paper, we conduct an exploratory study on effective visual stimuli design with two main contributions to improve efficiency of early ASD screening:

- Visual stimuli database design for the ASD screening.
- Evaluation of the impact and efficiency of picture stimuli and exposure time on ASD screening accuracy both independently and dependently.

Methods

ASD SCREENING SYSTEM (Fig. 2): To collect gaze point distribution and perform classification between children with and without ASD.

- **Visual stimuli design (Fig. 3)**: the main focus of the paper, constructed by 16 pictures for stimuli design database with respect to two assessing aspects:
  - Visual stimuli categories: picture stimulus in different categories to analyze the efficiency of stimuli.
  - Exposure time: gazing duration, to assess the impact of time on ASD screening.
- **Data acquisition**: setup consists of two main parts (Fig. 1):
  - Tobii EyeX Controller: to accumulate eye positions of movements
  - P2214H monitor: to display visual stimulus for participants
- **Similarity matching**:
  - Wesserstein Distance: to calculate the distance between distributions of gaze point data.
  - kNth Nearest Neighbors: to distinguish children with or without ASD by the given distances.

Evaluation Results

Stimuli comparison:
- "Social scene" stimulus gives consistently high accuracy, at about 98%.
- Followed are "human face" (97.22%) and "object" (90.26%).

Impact of exposure time
- 5-second duration has the highest result, at 98.24%.
- Followed are 3-second (90.01%) and 1-second (85.56%) duration respectively.

Stimuli and duration combination
- Social scene with full duration yields the optimal result at nearly 100%.

Visual Stimulus Design: A Closer Look

VITAL VISUAL CATEGORIES
Total of 12 pictures are divided into three stimuli categories:

- **Social scene (SS)**: widely known for its association with ASD. Consist of two reverse versions of the same picture, birthday party scene and workplace scene.
- **Human face (HF)**: children with ASD typically struggle to process characteristics of a human face. Consist of a pair of blurred/normal faces, a pair of direct gaze/averted gaze faces and two pairs of happy/sad faces.
- **Object (OJ)**: children with ASD appear to show no impairment in processing global information. Contain four pictures of food, toys, animals and an abstract drawing.

Figure 4. A comparison between gaze patterns of children with and without ASD in regard to visual stimuli categories

Conclusion

"Social scene" stimulus in fusion with full exposure duration (5-second) show the most promising visual stimuli correlation for effect ASD screening and early ASD detection.

References