Critical Review of Eye Tracking Technology in the Study of Autism

Jonah Goldman
School of Mechanical and Materials Engineering
University College Dublin, Ireland

Introduction

There is rarely a single component that can be pinpointed as a root cause of ASD, rather a series of behavioural patterns that can be observed in therapeutic and simulation settings. In order to successfully connect with children with autism, one of the most important keys in therapy is to hold their attention to reinforce skills like emotional mimicry and eye contact. Focusing on a human speaker for long periods of time can be a serious challenge, so alternate forms of communication are being tested using eye-tracking technologies to follow the child's gaze and understand just what is capturing their attention (Boraston and Blakemore, 2007).

Methodology

This critical review was performed entirely through literature analysis, exploring where eye tracking technologies were being applied when they first became recognized as a research tool in autism studies. Based on past and current applications, the limitations of the technology were determined and addressed in newer projects or further development of the technology that is currently available.

Results

While tangible results were not a component of this research project, it was determined that locational accuracy, signal speed, and stimulus type are important factors in effective eye tracking for autism studies. Ecologically dynamic scenes elicit the most diverse attention responses between children with ASD and without (Chevallier *et al.*, 2015), but to keep up with such quick movement while also maintaining accurate and precise regions of interest within the frame, a quick signal response is necessary.

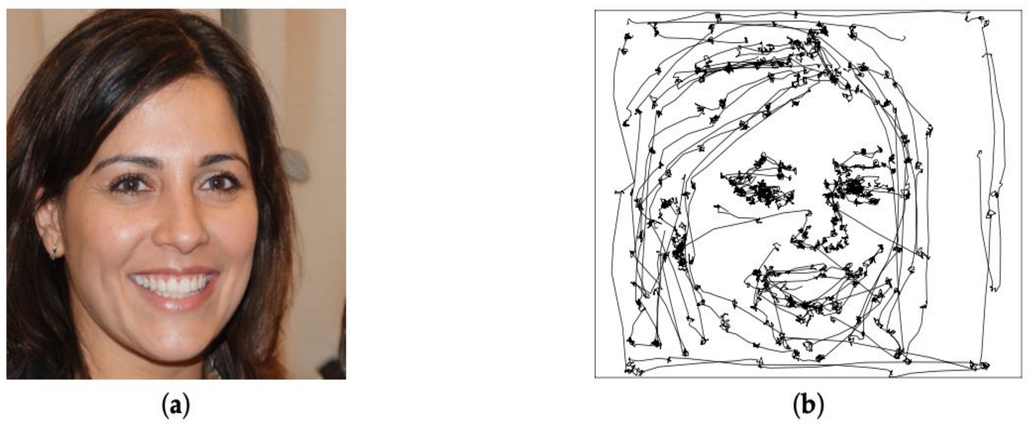

Figure 1: (a) Original image traced by human eye in eye tracking-controlled robotic drawing study by Scalera *et al.* (2021) (b) Fixations and saccades as recognized by the eye tracking device

A social-emotional component of an eye tracking study was also determined to be vital, integrated as a post-study interview, as eye tracking does not tell the observer what the child is thinking, feeling, or gaining from the display they're shown, despite what they may be fixating on (Marcari *et al.*, 2021). Adults with autism, when prompted with a questionnaire after an eye tracking study to describe what they just watched, used more cognition verbs (think, know, believe) in their answer if they fixated on the faces of the characters in the display more.

Discussion

By pre-processing video displays ahead of a study and calibrating participants gaze patterns, very specific regions of interest can be tracked. Using artificial intelligence, Oliveira, Franco, and Revers (2021) identified fifteen characteristics that when fixated on or not, can distinguish an ASD diagnosis. This approach had a higher success rate than other studies of its size (106 children) because of its focus on actual behavioural symptoms in display viewing, like fixations on the center of the screen or the horizon.

Features	# of ASD features	# of TD features
Steerable pyramids	3	4
Saliency toolbox: color, intensity, orientation and skin	4	4
RGB color	0	1
Horizon line	1	1
Presence of face	1	1
Presence of people	1	1
Distance to the frame center	1	0
Motion value	1	1
Presence of biological movement	1	0
Presence of geometrical movement	1	1
Distance to the side-specific scene center	1	1
Total	15	15

Figure 2: 15 characteristics of note, determined by Genetic Algorithm

Integrating eye tracking into more social settings can also allow for more genuine insight into a child's mental state, especially when joined by a human supervisor or observer. Kaspar, a humanoid child robot, was employed successfully as a tool in a nursery for children with autism. Teachers found children could connect with it more comfortably than face-to-face lessons (Syrdal *et al.*, 2020) . Utilizing eye tracking in therapy robots like Kaspar can help maintain a more casual environment than other eye tracking studies while getting more natural gaze patterns from children.

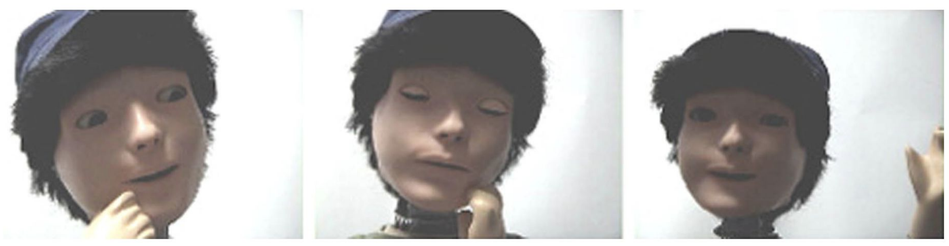

Figure 3: Kaspar robot showing a range of emotions

Conclusion

With eye tracking, more can be understood about what someone on the autism spectrum is focusing on in social interactions and guide not just the identification of their location on the spectrum but how to facilitate a learning and growing environment in which their specific needs can be met.

References

Boraston, Z. and Blakemore, S. (2007) 'The application of eye-tracking technology in the study of autism', *The Journal of Physiology*, 581(3), pp. 893-898. https://doi.org/10.1113/jphysiol.2007.133587

Chevallier, C. *et al.* (2015) 'Measuring social attention and motivation in autism spectrum disorder using eye-tracking: Stimulus type matters', *Autism Research,* 8(5), pp. 620-628. https://doi.org/10.1002/aur.1479

Macari, S. *et al.* (2021) 'Puppets facilitate attention to social cues in children with ASD', *Autism Research,* 14(9), pp. 1975-1985. https://doi.org/10.1002/aur.2552

Oliveira, J.S., Franco, F.O., and Revers, M.C. (2021) 'Computer-aided autism diagnosis based on visual attention models using eye tracking', *Sci Rep,* 11(10131). https://doi.org/10.1038/s41598-021-89023-8

Scalera, L. *et al.* (2021) 'Human–Robot Interaction through Eye Tracking for Artistic Drawing', *Robotics,* 10(54). https://doi.org/10.3390/robotics10020054

Syrdal, D. *et al.* (2020) 'Kaspar in the wild: Experiences from deploying a small humanoid robot in a nursery school for children with autism', *Journal of Behavioral Robotics,* 11(1), pp. 301-326. https://doi.org/10.1515/pjbr-2020-0019