

Abstract

Monitor-based eye tracking studies indicate children with ASD show atypical patterns of gaze to faces, particularly eyes. Quantifying gaze in naturalistic interactions typically does not address looks to features within the face because stationary, tripod-mounted cameras are used. We assessed whether children's eye-to-eye gaze during social interactions can be reliably coded from video captured by a "point of view" (PoV) camera worn by the social partner, compared to videos from tripod-mounted camcorders. Coders more reliably identified looks to eyes, face, and away and detected more looks to eyes when using the PoV videos. Children with ASD looked less frequently to the eyes and face and looked away longer than TD children. The PoV camera presents an easily-deployed and cost-effective method for capturing gaze during social interactions.

Background

- Monitor-based eye tracking studies indicate that young children with autism spectrum disorder (ASD) show atypical patterns of attention to internal features of the face, particularly the eyes (Chawarska & Shic, 2009; Chawarska, Macari, & Shic, 2012; see Guillon, Hadjikhani, Baduel, & Rogé, 2014 and Falck-Ytter, Bolte, & Gredeback, 2013 for reviews).
- Children who go on to develop ASD may be specifically less likely to look at the eyes in the context of more complex social interactions (e.g., Guillon et al., 2014).
- Eye contact has conventionally been measured from recordings of interactions with examiners (e.g., ESCS; CSBS, PFCP). Independent raters code the videos after establishing reliability on the coding scheme. One or more cameras are used to capture the interaction, but the resolution of resulting images is better suited to coding "looks to face" rather than measuring eye-to-eye gaze directly (e.g., Rozga et al., 2011)
- Impaired eye contact has been a major clinical feature used in the diagnosis of autism spectrum disorder (ASD), yet its direct measurement in research contexts has proven challenging.
- Two naturalistic methods of measuring children's eye gaze in social interactions—stationary room cameras and an adult-worn "point of view" (PoV) camera—were compared in terms of:
 - Raters' coding reliability
 - Detection of differences in eye-to-eye gaze in children with ASD compared to typically developing (TD) children.

Research Questions

- Do children with ASD and TD children display different patterns of eye gaze during a social interaction?
- Will the PoV camera detect more instances of eye-to-eye gaze compared to the stationary room cameras?

Method

Sample

Eight children with ASD ($M = 33.5$ months; $SD = 3.5$ months; 6 males) and seven typically developing (TD) children ($M = 34.6$ months; $SD = 6.0$ months; 7 males). All children with an ASD diagnosis received the Autism Diagnostic Observation Schedule (ADOS) and a parent interview; the ASD diagnosis was made by a licensed psychologist.

Apparatus

Children's eye contact during a social interaction was measured two ways:

- Using 3 synchronized, stationary cameras (SC) positioned in the room.
- Using eyeglasses, worn by the adult, containing an outward facing (point of view, PoV) camera in the nose bridge (Pivothead Kudu Black) (Fig 1).



Figure 1: Apparatus and Views from the PoV and Stationary Cameras (same frame)

Procedure

- Adult and child sat across from each other for a five-minute social interaction comprising three parts, repeated three times:
 - Adult directs child's gaze to her eyes, nose, mouth
 - Adult sings 'Itsy-Bitsy Spider' with accompanying gestures
 - Adult models and labels exaggerated facial expressions: Happy, Sad, Surprised, Scared
- Procedure videotaped simultaneously with PoV and stationary cameras

Coding

- Onsets and offsets of four categories of eye gaze to adult were coded in ELAN:
 - Gaze to Eyes
 - Gaze to Face (not eyes)
 - Gaze Away (not eyes or face)
 - Uncodeable
- Pairs of coders, blind to child's diagnostic status, coded videos from either the PoV or the stationary camera (Fig 2).

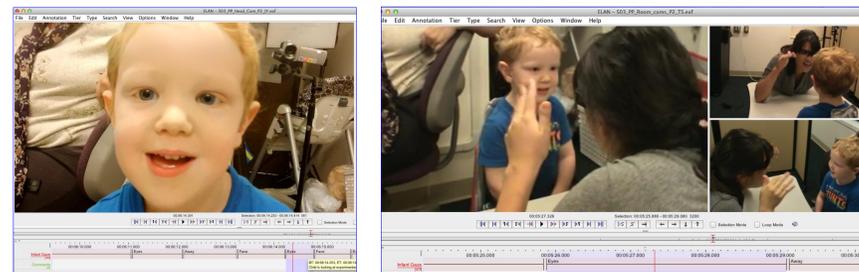


Figure 2: Coding Views for PoV (left) and Stationary Cameras (right) in ELAN

Analytic Plan

- Coders' reliability was examined *within* camera type: PoV or Stationary Camera (Fig 3).
- Once adequate reliability was established, differences in children's gaze patterns by camera type and diagnostic status were examined.

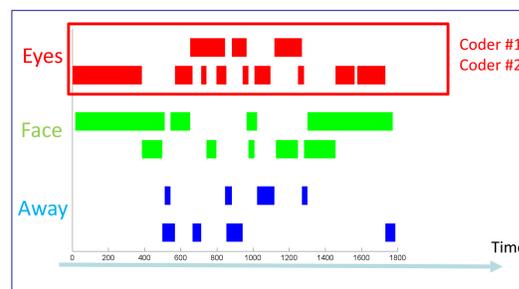


Figure 3: Visual Comparison of Coders' Annotations of Gaze Locations

Reliability

- Overall Kappas for frame-level agreement were $k=.67$ for the PoV camera and $k=.49$ for the camcorders (Fig 4).
- Coding from the PoV video produced more reliable estimates of children's looks to the partner's eyes (vs. other areas) than coding based on videos from stationary cameras, but both were acceptably reliable (e.g., Fleiss et al., 2003; Landis & Koch, 1977), justifying their use in group-difference analyses

Results

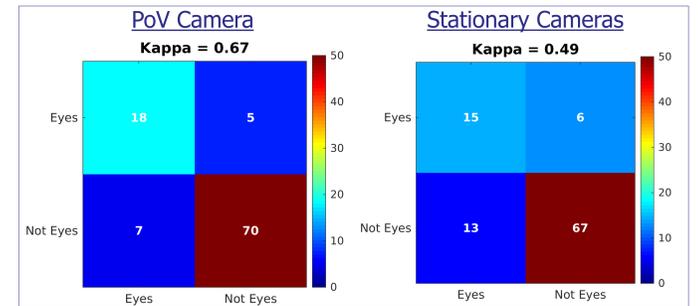


Figure 4: Kappa for frame-level agreements for looks to eyes vs. all other locations: PoV camera (left), stationary cameras (right).

Differences in Eye Gaze by Diagnostic Status and Camera Type

Multivariate ANOVAS examined the effect of diagnosis on looks to eyes, face, away, and uncodeable as correlated dependent variables for PoV and Stationary Camera views separately.

PoV Camera

- Children's rate of looks varied by diagnosis, $F(4,10)=4.55, p=.02$.
 - ASD children looked at the examiner's eyes and face less frequently than did TD children,** $F(1,14)=6.11, p=.03$ and $F(1,14)=16.44, p<.00$ respectively (Fig 5).
- Children's average duration of looks varied by diagnosis, $F(4,10)=4.70, p=.02$.
 - ASD children had longer average looks away from the examiner,** $F(1,14)=22.21, p<.001$.

Limitation: Uncodeable moments

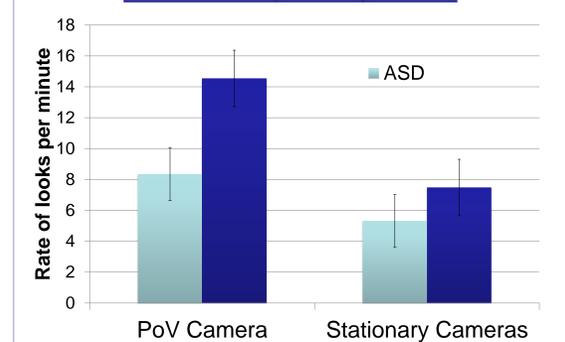
Coding with the POV camera produced more "uncodable" frames than did the stationary cameras, $F(1,13)=14.21, p=.002$



Stationary Cameras

- ASD and TD children did not differ in their overall rate of looks or average duration of looks to the examiner's eyes (Figure 5), face, away or in uncodeable moments.

Figure 5: Rate per Minute of Children's Eye-to-Eye Gaze



Conclusions

- This pilot study provided proof of concept that coders can make reliable estimates of young children's eye-to-eye gaze using video from a PoV camera worn by the child's social partner.
- Coding based on the PoV camera identified group differences in children's gaze – with children with ASD showing less frequent looks to the adult's eyes and face and longer looks away from her—that were not found using the stationary cameras. It is possible that stationary cameras are less effective at detecting eye-to-eye gaze.
- This approach is unobtrusive, easily deployed in multiple settings, and cost-effective. Future directions include replication with larger samples, comparison to monitor-based eye tracking, examining use in natural settings, and developing automated coding of gaze from PoV videos.