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Early Communicative Characteristics Across Samples From Two Infant Populations At-Risk for Autism

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ABSTRACT

Although no single etiology has been identified for Autism Spectrum Disorders (ASD), two infant populations have emerged as particularly high risk: younger siblings of children diagnosed with ASD and infants born prematurely with low birth weight. A key characteristic differentiating high-risk infants from low-risk peers is early eye gaze fixation behaviors. Early gaze fixation behavior is thought to be predictive of communication and language skills. Consequently, identifying differences in early eye gaze behaviors could lead to early intervention services tailored specifically on counteracting early social withdrawal behaviors. Though few studies have compared eye gaze patterns of these two high-risk infant groups, knowledge of differences between these two groups could inform early interventionists' service provision approach. The aim of the present exploratory study was to compare eye gaze fixation behaviors across two high-risk groups. The three participants were drawn from a larger pool of participants involved in the *Early Diagnostic Signs of Autism* study. One participant was a younger sibling of a child diagnosed with ASD and two were born prematurely with low birth weight. Data was collected using wearable eye gaze technology that captured the infant's eye movements as well as his/her visual surroundings. Infants were shown three 60-second silent videos containing social and nonsocial static visual stimuli. Eye gaze behaviors were analyzed to distinguish where the infant's pupil was directed during viewing and measured according to time spent fixated on social and non-social stimuli and further categorized as two dimensional (static social, status nonsocial) and three dimensional (dynamic social, dynamic nonsocial). The eye gaze patterns observed were similar across two participants, one from each high-risk group, and dissimilar for one participant born prematurely with low birth weight. Findings indicate differences in eye gaze behaviors across participants may reflect factors beyond high-risk group status.

Introduction

ASD: Life-long neurodevelopmental condition that interferes with an individual's ability to communicate and relate to others (Baio et. al. 2018)

- Current dx status:
  - 1 in 59 children diagnosed with ASD (Baio et. al., 2018)
  - Median age at dx: 50 months (Christensen et. al., 2016)
  - Average prevalence: 1-2% of population (Christensen et. al., 2016)
  - Etiology: Unknown; likely a epigenetic (combination of genetic and environmental factors)
    - Consequently, dx primarily based on behavioral features
    - Early differences in eye gaze fixation behaviors in high-risk infant groups later diagnosed with ASD compared with low-risk infants
- Rate of diagnosis for high-risk infants:
  - Younger siblings of child diagnosed with ASD: 18.7% (Ozonoff et. al., 2011)
  - Children born premature and with low birth weight: 10-12% (Joseph et. al., 2017)

Early Gaze Behavior Differences in Infants/Toddlers with ASD Compared to Low-risk Peers

- Focus more on the mouth than other facial features; more easily disengaged from face (Chawarska, Volkmar, & Klin, 2010; Klin & Jones, 2008)
- Toddlers later diagnosed with ASD spent more time looking at nonsocial videos than social videos (Pierce et. al. 2016)

At-Risk Populations' Eye Gaze Behaviors

- Gaze at eyes 50% less, bodies 25% more, and objects 50% more, differences in object permanence skills, shorter referential gaze time (Jones & Klin, 2013; Ryu et. al., 2017)

Gaze Fixation Difference Outcomes

- Predictive power for later language skills (Jones, Carr, & Klin, 2008; Tenenbaum et al, 2015)

Aim of Present Study

Compare at-risk infant groups to identify differences in early eye gaze fixation behavior

Research Question

Is there a difference in early eye gaze fixation behaviors for at-risk groups at 6 months of age when presented with social and nonsocial visual stimuli?

Methods

	Participant Category	Age (Corrected)	Gender	MSEL Receptive (t-score; %ile)	MSEL Expressive (t-score; %ile)	MSEL Visual Reception (t-score; %ile)	MSEL Fine Motor (t-score; %ile)	MSEL Gross Motor (t-score; %ile)
P1	Younger Sibling	6 months	Male	50; 50%	48; 42%	51; 54%	70; 98%	68; 96%
P2	Premature/LBW	6 months	Female	50; 50%	42; 21%	57; 76%	58; 79%	63; 90%
P3	Premature/LBW	6 months	Female	63; 90%	65; 93%	51; 54%	46; 34%	63; 90%

Participants

(n=3); age 6 months; selected for present study from a larger pool of participants involved in the *Early Diagnostic Signs of Autism* study.

Procedures

Present study data collected as part of the second data collection (out of seven with additional follow up) in the *Early Diagnostic Signs of Autism* study (ongoing; 2018-2019). Data collection took place in participant homes. While seated at a table on parent lap 1 meter from laptop, infants were shown three one-minute videos of static social and nonsocial image (180 seconds total).

Figure 1. Static social and nonsocial images shown in videos.

Flow diagram of data collection sessions
SRS, Social Responsiveness Scale; SCQ, Social Communication Questionnaire; CSBS DP, Communication and Symbolic Behavior Scales Developmental Profile; MSEL, Mullen Scales of Early Learning; CDI's, MacArthur-Bates Communicative Development Inventories;

Time Point	Evaluations
First screening (4 months)	Demographics Questionnaire SRS SCQ Head circumference
Onset of sitting (4-5 months)	Sitting Eye tracking MSEL
1 month post onset of sitting	Sitting Eye tracking Vocalization Sample
2 months post onset of sitting	Sitting Eye tracking CSBS DP
3 months post onset of sitting	Sitting Eye tracking Head circumference
12 months	MSEL CDI's CSBS DP Vocalization Sample Head circumference
18 months	MSEL CDI's CSBS DP Head circumference

Materials

Eye Gaze Hardware: Positive Science UltraFlex headgear cap and camera (Figure 2)
Software: PS Live Capture (30Hz, Figure 2), Yarbus, GazeTag

Data Analysis

Using Yarbus software, eye video to scene video was calibrated based on 6-10 calibration fixation points on a rattle before and after the presentation of the video.

Using GazeTag software, filtered usable and not usable data points (e.g., not usable: eye closed, camera is out of position), then coded each point in category (social 2D, social 3D, nonsocial 2D, nonsocial 3D). A fixation was considered 2D if it was on the laptop screen fixated on the video and 3D if it was fixated on people and objects in the environment. Fixations were coded as social if they were within the social image (2D) or on the face of someone in the environment (3D). They were coded as nonsocial if they were within the nonsocial image (2D) or anything else in the environment (3D). Fixations that were not coded included parts of bodies of people within the environment and/or parts of the recording equipment. The spatial parameters for a fixation point was set at 7 pixels and the temporal parameters at 100ms. Percentages were calculated from the output generated through GazeTag use.

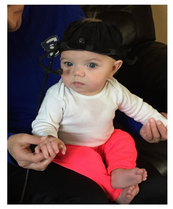


Figure 2. UltraFlex headgear and attached camera.

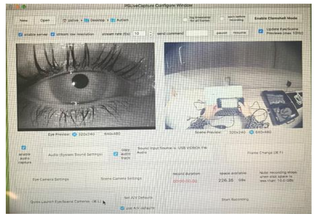
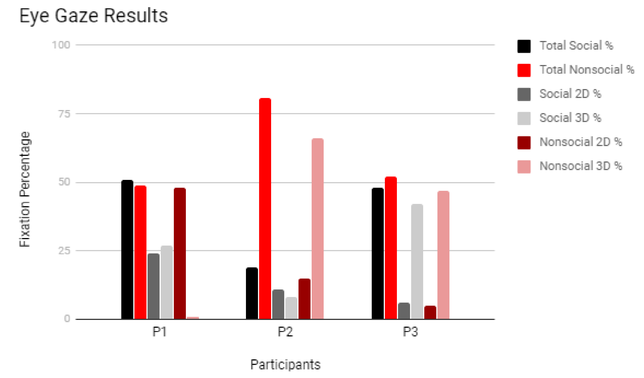


Figure 3. PSLiveCapture software recordings of eye movement and visual surroundings.

Results and Discussion



Total number of usable fixation points per 180 second sample: P1 = 221, P2 = 116, P3 = 239

P1 and P3: Similar in overall social fixations (51%, 48% respectively), but neither showed a clear preference for social fixations. Differed in preference for fixations to the screen (2D) vs. environment (3D) with P1 preferring 2D and P3 preferring 3D (P1: 72% 2D overall, P3: 89% 3D overall).

P2: Overall, showed more nonsocial fixations than other participants (81% vs 49-52%, respectively)

Conclusion: Differences across eye gaze fixation behavior may be reflective of factors beyond high-risk group status, but more research with larger group of participants needed.

One of few studies comparing these two at-risk groups, and collecting data on social vs. nonsocial gaze fixations. Findings may be compared to Pierce et. al. (2011 & 2016) in which they found that toddlers later diagnosed with ASD spent a significantly longer amount of time attending to videos with geometric shapes than social videos. P2's elevated eye gaze for nonsocial images may impact the information she is receiving, and demonstrate a decreased interest in social stimuli in general.

Limitations and Future Directions

Participants: Increase diversity and size of sample

Setting: In home is natural and ecologically valid, but limits idealized controlled atmosphere for eye gaze observations (e.g., differences in lighting, surroundings)

Research Design: Exploratory study; consequently, cannot generalize findings beyond participants of the study

Clinical Implications: Present study has limited clinical utility, but important for early childhood professionals to be aware of high-risk group status and differences in early behavioral signs, such as eye gaze fixation behavior, noted within the first 12 months of life. These may eventually be part of early developmental profile that leads to reduced dx age for ASD.

Selected References

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