

# Relationships between social responsiveness and visual attention to faces in a transdiagnostic sample of adults with autism, schizophrenia, and a non-clinical comparison group

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## Background

- Social differences are shared in individuals with autism (ASD) and schizophrenia spectrum disorders (SCZ) compared to non-clinical controls (NC).
- Difficulty processing faces may underlie the social communication difficulties in both clinical populations.<sup>1,2,7</sup>
- Indeed, atypical visual attention to faces is reported in ASD and SCZ.<sup>6</sup>
- Patterns of visual attention may differ based on where the individual is looking, emotional expression of the face, and individual differences in social responsiveness.

## Objective

Examine how patterns of visual attention differ in ASD, SCZ, and NC based on region of the face, emotional expression of the face, and social responsiveness.

## Methods

### Participants

	ASD (N=31)	SCZ (N=24)	NC (N=42)	Overall (N=97)
Age (years)				
Mean (SD)	24.0 (5.47)	26.5 (7.34)	27.4 (6.78)	26.1 (6.64)
Sex				
Female	6 (19.4%)	5 (20.8%)	18 (42.9%)	29 (29.9%)
Male	25 (80.6%)	19 (79.2%)	24 (57.1%)	68 (70.1%)

Table 1. Participant demographics.

### Methods

#### Gaze-Contingent Eye-tracking Paradigm

- Participants passively viewed counterbalanced fixation cues followed by a neutral face that shifted to either a happy or fearful expression after 500ms (Figure 1).
- Visual attention was operationalized as percentage of time looking (%looking) at informative regions of the face (RoF; Figure 2).

#### Clinical Measures

- The Social Responsiveness Scale (SRS-2) and Broader Autism Phenotype Questionnaire (BAPQ) assessed self-reported social responsiveness.

#### Statistical Analysis

- For each RoF, separate mixed model ANOVAs were run to assess differences in %looking with Face Valence (fearful, happy) as a within-subjects factor and Diagnostic Group (ASD, SCZ, NC) as a between-subjects factor.
- Due to non-normality in the data, %looking was logit-transformed.
- To examine how social responsiveness relates to visual attention across diagnostic group, we tested the social responsiveness x diagnosis interaction when predicting %looking to the whole face given sparsity of looking to specific RoFs (Table 2).

	ASD (N=31)	SCZ (N=24)	NC (N=42)
<b>Left Eye</b>	0.0838 (0.0749)	0.0583 (0.0887)	0.0856 (0.0979)
<b>Right Eye</b>	0.0770 (0.0788)	0.0659 (0.0819)	0.109 (0.110)
<b>Between Eyes</b>	0.156 (0.121)	0.122 (0.0742)	0.131 (0.106)
<b>Nose</b>	0.411 (0.214)	0.381 (0.200)	0.291 (0.160)
<b>Mouth</b>	0.0626 (0.0883)	0.0570 (0.108)	0.0318 (0.0854)
<b>Whole Face</b>	0.964 (0.0446)	0.973 (0.0324)	0.994 (0.0118)

Table 2. Mean (SD) Percent Looking to RoFs (shown in Figure 2) by diagnostic group.

Figure 2. RoFs overlaid on Fearful Face Stimuli.

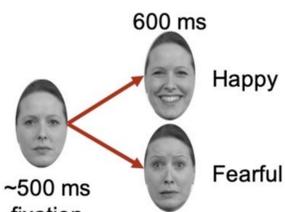
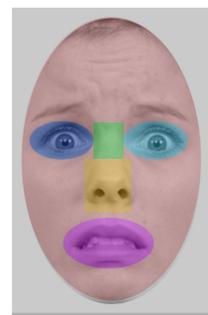


Figure 1. Trial structure with sample stimuli.

## Results

Significant main effect of Diagnostic Group [ $F(2,94)=16.67, p<0.001$ ] in % looking to Whole Face (Figure 3).

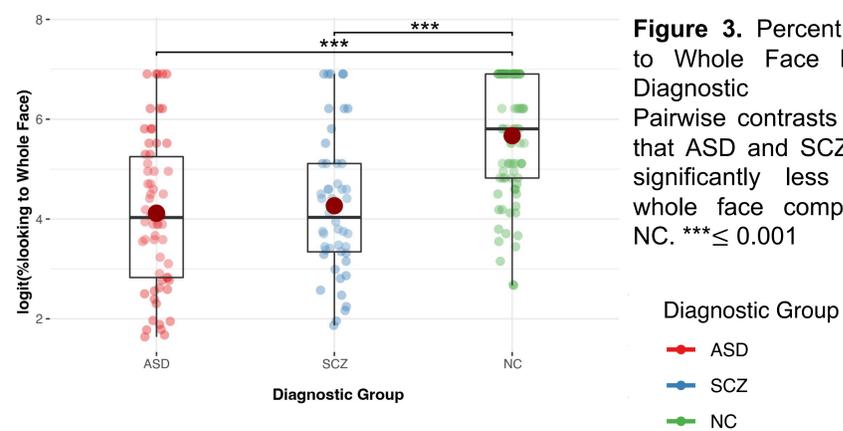


Figure 3. Percent looking to Whole Face between Diagnostic Groups. Pairwise contrasts showed that ASD and SCZ looked significantly less to the whole face compared to NC.  $***\leq 0.001$

Significant between-group differences in % looking appeared for Nose [ $F(2,94)=4.70, p=0.01$ ] and Mouth [ $F(2,94)=4.49, p=0.01$ ] with ASD looking more to these regions than SCZ and NC (Figure 4).

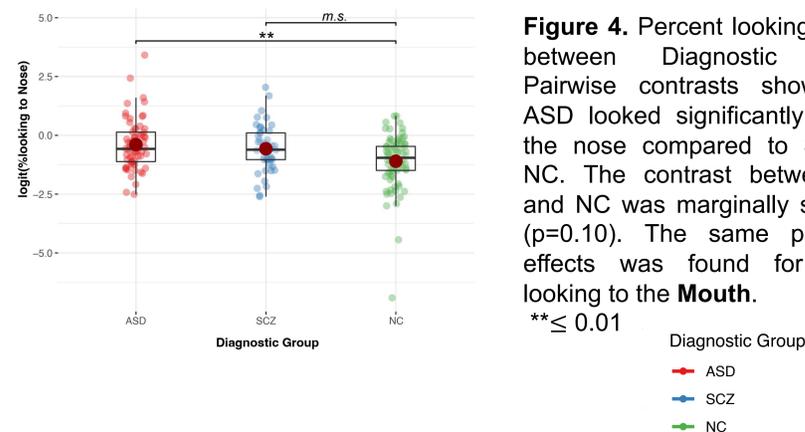


Figure 4. Percent looking to Nose between Diagnostic Groups. Pairwise contrasts showed that ASD looked significantly more to the nose compared to SCZ and NC. The contrast between SCZ and NC was marginally significant ( $p=0.10$ ). The same pattern of effects was found for percent looking to the Mouth.  $**\leq 0.01$

- Only within **Right Eye**, the valence x group interaction was significant [ $F(2,94)=4.99, p<0.01$ ] such that SCZ looked less to Right Eye during Fearful Face compared to Happy Face [ $t(94)=-3.30, p=0.02$ ]; this pattern was absent in ASD and NC.

In the full sample, greater social difficulties measured by SRS-2 [ $F(1,89)=12.62, p<0.001$ ] and BAPQ [ $F(1,91)=11.15, p=0.001$ ] relate to less visual attention (% looking) to the whole face (Figure 5).

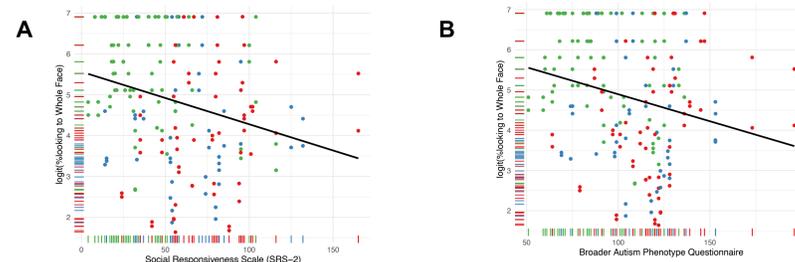


Figure 5. Relationship between (A) SRS-2 and (B) BAPQ with visual attention to whole face.

## Results, cont.

The relationship between social responsiveness and visual attention significantly differed by diagnostic group. Greater social difficulties in ASD related to increased visual attention; this relation was not detected in SCZ and NC (Figure 6).

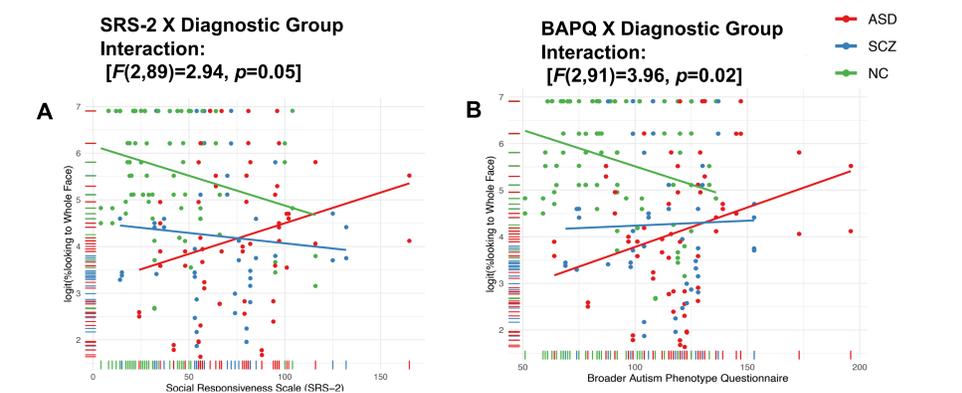


Figure 6. Post hoc contrasts of the significant interaction effects showed that ASD demonstrated a positive relationship between social difficulties and visual attention that was significantly different from the SCZ and NC groups ( $p's<.05$ ).

## Conclusions

### Findings & Discussion

- Findings suggest that visual attention may be a discriminatory marker (clinical vs. non-clinical) of social response.
- Results replicate previously reported visual attention biases visual attention bias to the mouth in ASD.<sup>3,4</sup>
- In the full sample, **greater social difficulties related to lower % looking to the face.**
- However, this relationship between social responsiveness and % looking to the face differed by diagnostic group.
  - Within the ASD group, greater social difficulties related to *increased* % looking. Given that adults provided self-reported scores on the SRS-2 and BAPQ, this may reflect that individuals with more social awareness and interest also demonstrate more attention to faces.
- It is important to consider **visual attention** and **region of face** when understanding atypical processing of social information in ASD and SCZ.

## References

1. Deste, G., Vila, A., Penn, D. L., Pinkham, A. E., Nibbio, G., & Harvey, P. D. (2020). Autistic symptoms predict social cognitive performance in patients with schizophrenia. *Schizophrenia Research*, 215, 113-119. <https://doi.org/10.1016/j.schres.2019.11.008>.
2. Fernandes, J. M., Caião, R., Lopes, R., Jerónimo, R., & Barahona-Corrêa, J. B. (2018). Social cognition in schizophrenia and autism spectrum disorders: A systematic review and meta-analysis of direct comparisons. *Frontiers in psychiatry*, 9, 504. <https://doi.org/10.3389/fpsy.2018.00504>
3. Jones, W., Carr, K., & Klin, A. (2008). Absence of preferential looking to the eyes of approaching adults predicts level of social disability in 2-year-old toddlers with autism spectrum disorder. *Archives of general psychiatry*, 65(8), 946-954. <https://doi.org/10.1001/archpsyc.65.8.946>
4. Neumann, D., Spezio, M. L., Piven, J., & Adolphs, R. (2006). Looking in the mouth: abnormal gaze in autism resulting from impaired top-down modulation of visual attention. *Social cognitive and affective neuroscience*, 1(3), 194-202. <https://doi.org/10.1093/scn/1.3.194>
5. Oliver, L. D., Moxon-Emre I., Lai M., Grennan L., Voineskos A. N., & Ameis S. H. (2021). Social cognitive performance in schizophrenia spectrum disorders compared with autism spectrum disorder: A systematic review, meta-analysis, and meta-regression. *JAMA Psychiatry*, 78(3), 281-292. <https://doi.org/10.1001/jamapsychiatry.2020.3908>
6. Pinkham, A., Morrison, K., Penn, D., Harvey, P., Kelsven, S., Ludwig, K., & Sasson, N. (2020). Comprehensive comparison of social cognitive performance in autism spectrum disorder and schizophrenia. *Psychological Medicine*, 50(15), 2557-2565. <https://doi.org/10.1017/S0033291719002708>
7. Sasson, N. J., Pinkham, A. E., Weittenhiller, L. P., Faso, D. J., Simpson, C. (2016). Context effects on facial affect recognition in schizophrenia and autism: Behavioral and eye-tracking evidence. *Schizophrenia Bulletin*, 42(3), 675-683. <https://doi.org/10.1093/schbul/sbv176>

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