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Evidence accumulation during self-referential social processing captures social functioning and psychopathology dimensions in a transdiagnostic sample

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Abstract

Background. Psychosis, social anxiety, and autism are clinical constructs that share important phenotypic features, particularly social dysfunction. A critical determinant of social functioning is an individual's ability to recognize when social cues, such as eye gaze, are meant for them. Emerging computational modeling data in psychosis suggest that altered gaze perception stems from deficits in evidence accumulation – the process of gathering and integrating information – when processing social cues. We investigated whether aberrant evidence accumulation during gaze perception is associated with social functioning or, as a secondary aim, with psychopathology in a transdiagnostic sample with varying levels of psychotic, socially anxious, or autistic characteristics.

Methods. We examined gaze perception in 111 individuals (aged 14–30) with varying levels of social dysfunction, psychosis proneness, social anxiety, and autistic traits. Drift diffusion models (DDM) characterized key processes driving perceptual judgements in a self-referential gaze perception task, including the efficiency of evidence accumulation. We tested whether evidence accumulation was associated with social functioning, social cognition, and these different psychopathology dimensions.

Results. Impaired evidence accumulation during gaze perception showed strong associations with impaired social cognition and modest associations with diminished social functioning and elevated psychosis and social anxiety symptoms. Evidence accumulation was not associated with autism traits.

Conclusions. Evidence accumulation for social cues relates to social cognition – a key determinant of social functioning. It may also be relevant to real-world social functioning and multiple psychopathology dimensions, including psychosis and social anxiety. Therefore, evidence accumulation should be investigated as a mechanism supporting social difficulties and related psychopathology.

Introduction

Social dysfunction is a key transdiagnostic feature of psychopathology that is associated with diminished quality of life and worsened prognosis (de Lijster et al., 2018; Handest et al., 2023; Hoertnagl et al., 2020). For instance, psychosis spectrum disorders, autism spectrum disorder, and social anxiety are all accompanied by prominent social dysfunction (Blanchard, Mueser, & Bellack, 1998; Bottema-Beutel, Kim, & Crowley, 2019; Davila & Beck, 2002), such as challenges initiating and sustaining meaningful interpersonal relations and navigating interpersonal conflict. Thus, social dysfunction is an important functional domain to target in interventions for psychopathology. Identifying the many factors that lead to impairment in social functioning remains at the forefront of research, in the hope of better tailoring treatments and alleviating the burden of mental illness.

A critical determinant of social functioning is an individual's ability to recognize when social cues, like a person waving 'hello' or calling their name, are meant for them. Among the most crucial is *self-referential gaze perception*: the ability to discern whether others are looking at them (Emery, 2000; Itier & Batty, 2009). Gaze processing underlies more advanced social processes, such as interpreting others' attention and intention (Shepherd, 2010), and its disruption is associated with poorer functional outcomes (Campbell et al., 2006; Wastler & Lenzenweger, 2018). Unsurprisingly, disruptions in gaze perception are observed across various forms of

psychopathology accompanied by social dysfunction. For example, individuals with social anxiety (Chen, Nummenmaa, & Hietanen, 2017; Gamer, Hecht, Seipp, & Hiller, 2011; Harbort et al., 2013; Schulze, Lobmaier, Arnold, & Renneberg, 2013) and psychosis (Chan et al., 2021; Hooker & Park, 2005; Tso, Mui, Taylor, & Deldin, 2012; Tso, Taylor, & Johnson, 2021) often overperceive eye contact. Those with autism (Pantelis & Kennedy, 2017) and psychosis make slower, less accurate, and/or less consistent gaze judgments (Grove et al., 2021; Tso et al., 2021; Zhu et al., 2007). Disrupted gaze processing may thereby provide a transdiagnostic explanation for prominent social dysfunction that occurs across these disorders. Examining these features in a transdiagnostic sample, rather than arbitrarily defined diagnoses, offers the opportunity to identify shared and distinct mechanisms of social dysfunction across diagnostic categories.

Importantly, mechanistic interpretations of putative associations between gaze processing deficits, functioning, and symptoms are complicated by the multiple cognitive processes that underpin self-directed gaze perception. These are difficult to tease apart using traditional performance indices that are aggregated across trials (e.g., mean accuracy and reaction time [RT]). Fortunately, computational models offer a unique approach to quantify those processes using systems of theory-driven mathematical equations. Our recent work (Lasagna, Pleskac, Weigard, & Tso, 2026a; Lasagna, Tso, Blain, & Pleskac, 2026b) showed that the cognitive mechanisms driving gaze perception can be captured using Drift Diffusion Models (DDM; Ratcliff & McKoon, 2008; Figure 1). DDMs describe two-choice decisions as a process by which noisy evidence accumulates over time until it reaches a decision threshold; in this way, it models both choices and RT. In the context of a self-referential gaze perception task, individuals start with an initial expectation and, from there, they begin accumulating evidence about where that person is looking. The quality of evidence accumulated is not fixed but depends on the external stimulus (intensity of the gaze signal, or how clearly self-directed gaze cues are) and the attributes of the individual (how sensitive they are to subtle changes in self-directed gaze). This characteristic of evidence accumulation can be assessed by systematically manipulating the intensity of the gaze signals across experimental trials and then mathematically modeling a "drift sensitivity" parameter that quantifies the extent to which evidence accumulation efficiency is modulated by gaze signal intensity. Psychologically, higher drift sensitivity means that the individual is more attuned to self-directed gaze cues in their environment. For simplicity, we call this "*evidence accumulation sensitivity*" hereafter. Although the DDM outlines several additional cognitive processes that impact decision-making (all described in Figure 1), our recent work in samples with schizophrenia demonstrated that evidence accumulation sensitivity, among all cognitive processes of the DDM during gaze processing, was most strongly related to social cognition (Lasagna, Tso, Blain, & Pleskac, 2026b) and paranoia (Lasagna, Pleskac, Weigard, & Tso, 2026a). As such, the present analysis focuses on this specific process.

However, it remains unclear if evidence accumulation (in)sensitivity to self-directed gaze cues is unique to those with psychosis, or represents a shared mechanism of psychopathologies accompanied by social dysfunction. Emerging evidence suggests that inefficient evidence accumulation across various cognitive tasks may represent a common mechanistic disruption that may confer transdiagnostic risk for various psychopathologies (Sripada & Weigard, 2021; Weigard & Sripada, 2021). It is, therefore, possible that insensitive evidence accumulation observed in schizophrenia during gaze processing could represent a risk factor for not just the disorder (i.e., schizophrenia), but also other forms of psychopathology characterized by significant social dysfunction. Transdiagnostic investigations are needed to test this directly.

Present study

The present study examines the cognitive processes underlying altered self-referential gaze perception and their clinical and functional relevance in a relatively young, transdiagnostic sample spanning a full spectrum (from none to marked) of social dysfunction. This sample is therefore ideal because: 1) ages 14–30 represent a time of greatest risk for developing psychopathology (Kessler et al., 2007) and social difficulties, and 2) it includes psychopathologies (psychosis proneness, autism, and social anxiety) that are highly comorbid and characterized by prominent social dysfunction. To approximate the multiple layers of ambiguity that individuals encounter when perceiving eye contact in the real world, we manipulated both the "gaze signal" (i.e., gaze direction) and the signal-to-noise ratio (SNR) of faces in the gaze perception task (Figure 1). We hypothesized that, across SNR levels, greater evidence accumulation sensitivity to gaze cues would predict better social cognition (Lasagna, Tso, Blain, & Pleskac, 2026b), and by extension, social functioning. Additionally, we hypothesized that less evidence accumulation sensitivity would predict greater levels of psychosis proneness. Given areas of clinical and cognitive overlap with psychosis, but a lack of cognitive modeling research in these disorders, as a secondary aim we explored the relationships between evidence accumulation sensitivity, autism, and social anxiety traits.

Methods

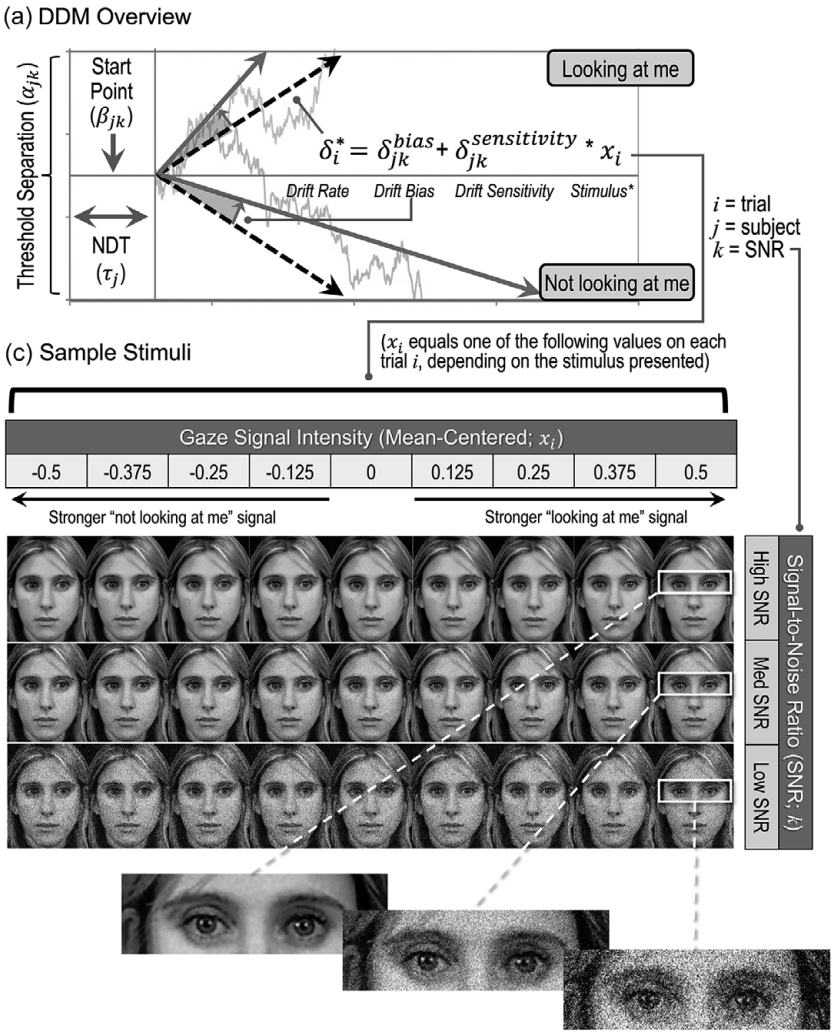
Code and outputs are available on GitHub (https://github.com/CarlyLasagna/ddm_socialnoise_transdiagnostic) and OSF (osf.io/57zub). Data will be available upon study completion at nda.nih.gov (Collection ID: 3489).

Participants and procedure

The sample consisted of 111 participants from a larger study on the mechanisms of social dysfunction (Tso et al., 2020) with complete data from the gaze perception task (described below). Participants had varying levels of psychosis proneness, autism, and social anxiety traits, which are highly comorbid and characterized by prominent social dysfunction. Demographics are provided in Table 1.

Inclusion criteria were as follows: aged 14–30; visual acuity ≥20/30; IQ ≥ 80; and no Mendelian disorder, neurological conditions, or substance use in the last month (see Supplementary Material S1 for additional criteria). To capture a broad range of social functioning, approximately two-thirds of the sample was recruited in the socially "dysfunctional" range (Global Functioning [GF] Scale-Social≤6 -OR- MIRECC Global Assessment of Functioning [GAF]-Social≤69; Piskulic, Addington, Auther, & Cornblatt, 2011, Niv, Cohen, Sullivan, & Young, 2007). The rest were recruited in the socially "functional" range (GF-Social≥7 -OR- MIRECC GAF-Social≥70). Those in the "functional" range had no DSM-5 diagnoses and were not taking psychotropic medications. To ensure sufficient representation of our three clinical dimensions of interest, recruitment aimed for those in the "dysfunctional" range to consist of approximately 20% with a psychotic disorder and 20% with social anxiety disorder (based on Mini International Neuropsychiatric Interview for DSM-5; Sheehan et al., 1998), and 20% with autism spectrum disorder (based on Autism Diagnostic Observation Schedule 2nd Edition [ADOS-2] revised scoring; Hus & Lord, 2014; Lord et al., 2012). Ultimately, in our analytic sample, 47%, 22%, 11%, and 19% respectively, met

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(b) DDM Parameter Definitions

Parameter	Psychological Description	Mathematical Description
Drift Sensitivity ($\delta^{sensitivity}$)	Extent to which gaze signal intensity modulates evidence accumulation efficiency.	Continuous modulation of trial-level drift rates by the intensity of the mean-centered gaze signal (x_i).
Drift Bias (δ^{bias})	Processing bias for one decision over another, regardless of gaze signal intensity.	Constant offset in the drift rate, independent of the gaze signal (x_i). • $\delta^{bias} > 0$: bias toward "at me" • $\delta^{bias} < 0$: bias toward "not at me"
Start Point (β)	Initial expectation bias about others looking at me.	How close to either choice boundary evidence accumulation begins from. • $\beta > 0.5$: bias toward "at me" • $\beta < 0.5$: bias toward "not at me"
Threshold Separation (α)	Caution in trading speed for accuracy.	Distance between choice thresholds. • Higher α means more evidence, resulting in longer RTs and more accurate choices.
NDT (τ)	Time for non-decision processes (sensory, motor).	Controls left/right shifting of RT distribution. • Higher τ means slower sensorimotor processes, resulting in longer RTs.

Figure 1. Drift Diffusion Model (DDM) account of self-referential gaze perception. *Note*: According to the DDM, gaze perception can be conceptualized as a process of evidence accumulation: the process of extracting and integrating information from the environment to make a decision. Each subject begins accumulating evidence from a *start point*, indexing initial expectations that others are looking at them. From there, how efficiently they accumulate information is determined by their drift rate. Higher magnitude drift rates mean more efficiency and faster and more accurate/consistent responses. On a given trial, their drift rate is determined by: 1) how strong the physical gaze signal is on a given trial (x_i; which is mean-centered and shown above in red), 2) their *drift sensitivity*, a parameter capturing how sensitive they are to the gaze signal in the physical stimulus, and 3) their *drift bias*, a parameter capturing their perceptual bias for self-referential information, regardless of the actual gaze signal. Here, trial-level drift rates underwent additional transformations that allowed for a non-linear mapping between gaze signals (x_i) and trial-level drift rates (δ_i; see Supplementary Material S3 for details). The *threshold separation* controls how much evidence is needed before deciding, indexing caution in trading speed for accuracy. Finally, *non-decision time* (NDT) captures time for encoding and motor execution. To approximate the multiple layers of ambiguity that individuals encounter in the real world (i.e., naturally ambiguous social cues, often judged under less-than-ideal viewing conditions), this task manipulates both the gaze signal (x_i) of the stimulus (shown above in red) and the overall signal-to-noise ratio (SNR) of faces (k; shown above in green). The gaze signal (x_i) varies pseudorandomly from trial-to-trial and is modeled as a continuous predictor of the trial-level drift rate. Alternatively, the SNR manipulation is arranged in three blocks, where block 1 is high SNR (no noise), block 2 is medium SNR (low noise), and block 3 is low SNR (high noise). The effect of SNR is modeled by estimating the drift sensitivity, drift bias, threshold separation, and start point as separate, correlated parameters across the three SNR levels (k). Together, these key parameters determine choice and RT behavior on any given trial (i) for a given subject (j). The time at which the accumulated evidence first hits a boundary (yielding a RT) and the boundary that is hit (yielding a choice) are modeled as a joint outcome of a Wiener diffusion process that is governed by four parameters: (1) trial-level drift rate (determined by subject-level drift sensitivity, subject-level drift bias, and trial-level gaze signal), (2) subject-level threshold separation, (3) subject-level start point, and (4) subject-level NDT. As such, the DDM parameters account for information about RT and choices simultaneously. Complete model specifications are provided in Supplementary Material S3.

criteria for social anxiety, autism spectrum, psychosis-spectrum, or multiple disorders.

Participants completed a screening visit (clinical assessments, self-ratings, demographics), an in person visit (eye tracking, gaze perception and social cognitive tasks, observation-based clinical assessments), and an fMRI visit. Data from the current study comes from the first two visits The study was approved by the university's Institutional Review Board. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. Additional study procedures are detailed in Supplementary Material S1.

Measures

Self-referential gaze perception task

Participants judged whether faces were looking at them (yes/no; Lasagna et al., 2020). Stimuli consisted of grayscale face images of 6 actors (George, Driver, & Dolan, 2001). The task used two

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Table 1. Sample demographics

Domain	Variable	M	SD	N
	Age	23.21	3.96	111
	Sex (% Female)	76%	–	111
	Education (Years)	15.37	2.77	111
Demographics	Parent education (Years)	16.50	2.75	105
	African American (%)	5%	–	111
	Asian (%)	21%	–	111
	Multiracial (%)	4%	–	111
Race	White (%)	71%	–	111
Ethnicity	Hispanic (%)	5%	–	110
	Antipsychotic user (%)	13%	–	108
	Antidepressant user (%)	40%	–	108
	Mood stabilizer user (%)	12%	–	108
	Stimulant user (%)	23%	–	108
Medications	Anticholinergic user (%)	4%	–	108
General intelligence	IQ	116.58	12.19	111
	Psychosis proneness – PDI (Total endorsed)	2.83	2.76	106
	Psychosis proneness – PDI (Total distress)	9.05	9.56	98
	Psychosis proneness – CAPS (Total endorsed)	3.75	4.06	106
	Psychosis proneness – CAPS (Total distress)	10.58	11.73	104
	Social anxiety – SADD	1.35	0.95	106
	Social anxiety – SPIN	31.49	17.05	106
	Autism traits – AQ	25.62	9.58	109
Symptoms	Autism traits – ADOS-social affect	3.55	3.63	110
	RME (total correct)	28.32	3.77	107
Social cognition	TASIT (% correct)	80%	8%	111
	SRS[a]	55.50	31.97	88[b]
	MIRECC GAF-Social[a]	68.64	15.50	105
	GF-Social/Current[a]	6.69	1.63	111
Social functioning	SASSR-Social[a]	2.44	0.85	104

Note: %, proportion; IQ, age/gender corrected full scale intelligence quotient (FSIQ2) on the Wechsler abbreviated scale of intelligence 2nd edition; PDI, Peters et al. delusion inventory; CAPS, Cardiff anomalous perception scale; SADD, Social anxiety disorder dimensional scale; SPIN, Social phobia inventory; AQ, Autism spectrum quotient; ADOS, Autism diagnostic observation schedule 2nd edition; RME, Reading the mind in the eyes test; TASIT, The awareness of social inference test (Short form); SRS, Social responsiveness scale; MIRECC GAF, MIRECC global assessment of functioning; GF, Global functioning scale; SASSR, Social adjustment scale. *N*, participants with complete data.

[a]Values for social functioning measures are pooled across entire sample, but the breakdown by "dysfunctional" and "functional" subgroups is as follows: SRS, dysfunctional (M = 31.75, SD = 22.90) and functional (M = 64.40, SD = 30.41), MIRECC GAF-Social, dysfunctional (M = 60.55, SD = 10.70) and functional (M = 87.09, SD = 5.87), GF-Social/Current, dysfunctional (M = 5.87, SD = 1.09) and functional (M = 8.72, SD = 0.68), SASSR-Social, dysfunctional (M = 2.79, SD = 0.72) and functional (M = 1.61, SD = 0.50).

[b]Higher proportion of data missing than other measures because measures were completed by informants and not all invited informants completed the questionnaire.

manipulations to approximate the multiple layers of ambiguity that individuals encounter when judging eye contact in the real world (Figure 1c). First, the gaze direction was manipulated in gradual increments, spanning 9 "gaze signal" strengths from not looking at me (signal strength = 0) to looking at me (signal strength = 1). Gaze signals varied pseudorandomly from trial to trial. Second, as an added level of ambiguity, the SNR of stimuli was also manipulated by superimposing different levels of Gaussian noise over stimuli. This manipulation reflected the fact that real-world social cues are often judged under less-than-ideal viewing conditions (e.g., judging the facial expression of someone who is wearing a mask or is across the room at a crowded party). SNR manipulations were arranged across three blocks: 1 = high SNR (no noise), 2 = medium SNR (low noise), and 3 = low SNR (high noise). The task was programmed in Experiment Builder (SR Research) and lasted ~15 minutes. It consisted of 324 trials (12 per signal strength × 9 signal strengths × 3 SNR levels), each consisting of a 2000 ms stimulus and a 1-500 ms inter-stimulus interval (ISI). Erroneously fast responses <200 ms were removed (n = 6 total trials). In addition to using DDMs, we calculated two more traditional, performance metrics: choice-based sensitivity (derived from a psychometric function fitted to choice behavior that resembled the DDM drift sensitivity parameter (Ratcliff, 2014) and RT. - Supplementary Material S2 contains details on how choice-based sensitivity was estimated, additional details about the task/stimuli, and visualizations of basic task behavior, including choice proportions and RT quantiles.

Social cognition

Social cognition was assessed using accuracy on the Reading the Mind in the Eyes test (RME; Baron-Cohen et al., 2001) and emotion evaluation and social inference subtests of the Awareness of Social Inference Test-Short Form (TASIT; McDonald, Flanagan, Rollins, & Kinch, 2003). The RME is a perceptual theory-of-mind task consisting of 36 pictures of eyes portraying different emotional states and participants must select the correct emotional state from four options. The TASIT examines emotion evaluation and social inference abilities. The emotion evaluation test includes 10 videos of actors portraying different emotional states. Participants must select the correct emotion from seven options. The social inference test includes 18 videos of social interactions. Participants must answer four yes/no questions about the characters' actions and mental states for each video. Both tasks allowed unlimited time for responses. For analyses, we extracted a single principal component (variance captured = 45%) of social cognitive ability from z-scores of these measures using pca-Methods. This approach was preferred over averaging because it allowed for Bayesian imputation for missing data (Stacklies et al., 2007).

Social functioning

Social functioning was assessed using self-report, informant-report, and interviewer ratings. The Social Adjustment Scale-Social Scale-Social/Leisure Scale (SAS-SR-Social) (Weissman, 1999) is a self-report of social functioning. The Social Responsiveness Scale (SRS-2; Constantino & Gruber, 2012) is an informant-report in which an identified individual (e.g., parent, friend) rates the participant's ability to engage effectively with others. Interviewer-rated measures included the GF-Social/Current (Piskulic, Addington, Auther, & Cornblatt, 2011) and MIRECC GAF-Social (Niv, Cohen, Sullivan, & Young, 2007). For consistency of score interpretation, all measures were recomputed (i.e., z-score*-1 where needed) so that higher scores indicated better social functioning. For analyses, we extracted a single principal component of social functioning (variance captured = 71%) using the approach described above.

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Symptom dimensions

Psychosis proneness was assessed using self-ratings on the Peters Delusion Inventory (PDI; Peters, Joseph, Day, & Garety, 2004) and Cardiff Anomalous Perception Scale (CAPS; Bell, Halligan, & Ellis, 2006). Total items endorsed and distress subscales were used because each provides useful information regarding severity and outcomes (Oh et al., 2024). *Autism traits* were assessed using totals on the self-rated Autism Spectrum Quotient (AQ; Baron-Cohen et al., 2001) and the clinician-rated/observed ADOS-2 (revised scoring; see Supplementary Material S1 for inter-rater reliability; Hus & Lord, 2014; Lord et al., 2012). We focus on the ADOS-2 Social Affect Subscale to capture interaction-based difficulties not captured via the AQ self-report. *Social anxiety* was assessed using self-rated totals on the Social Phobia Inventory (SPIN; Connor et al., 2000) and Social Anxiety Disorder Dimensional Scale (SADD; Lebeau et al., 2012). Higher scores on each measure indicated more severe psychopathology. For each dimension, we extracted a single principal component (variance captured = 47%–90%) using the approach described above. Overlaps between these three dimensions are visualized in Supplementary Material S4.5.

Intellectual functioning

General intelligence was assessed using Full-Scale Intelligence Quotient (FSIQ2) scores on the Wechsler Abbreviated Scale of Intelligence, 2nd Edition (Wechsler, 2011).

Drift diffusion modeling

We extended the DDM from (Lasagna, Pleskac, Weigard, & Tso, 2026a; Figure 1) to capture the cognitive processes contributing to gaze perception across different SNR levels. Complete model specifications and testing details are provided in Supplementary Material S3. To summarize, the gaze perception task approximates multiple layers of ambiguity that individuals encounter when making gaze judgments in the real world (Figure 1) by: (1) continuously manipulating gaze signals (x_i) pseudorandomly from trial-to-trial, *and* (2) categorically manipulating the SNR (k) of faces across three task blocks. Continuous effects of gaze signals (x_i) on trial-level drift rates were modeled via the drift sensitivity parameter using the equation in Figure 1. This was done using transformations that allowed for non-linear mappings between gaze signals and drift rates (see Supplementary Material S3). Categorical effects of SNR were modeled by estimating the drift sensitivity, drift bias, threshold separation, and start point as separate, correlated parameters across each SNR level (k). As model evaluations for this task and model have been performed previously (Lasagna, Pleskac, Weigard, & Tso, 2026a), we do not repeat those.

Preliminary results indicated that decreasing the SNR reduced drift sensitivity for gaze signals (Supplementary Material S4.1). However, drift sensitivity parameters were *highly* correlated across SNR levels (r's = 0.86–0.98; Supplementary Material S4.2), suggesting that they reflected variants of the same underlying process (Sripada & Weigard, 2021; Stevenson et al., 2024; Weigard & Sripada, 2021). To simplify analyses, we averaged drift sensitivity parameters across SNR levels.

Statistical analyses

Analyses were performed in RStudio 4.3.1 using Bayesian statistics.

To examine drift sensitivity's prediction of social cognition, social functioning, psychosis proneness, social anxiety, and autism traits, we employed robust univariate Bayesian regressions in brms using standardized variables (details in Supplementary Material S5). Robust regressions helped mitigate the effects of non-normal distributions (Supplementary Material S4.4). To account for the over-representation of females and the broad age range of this sample, a hierarchical approach was used, adding age and sex (Female = 1, Male = 0) at Step 1 and drift sensitivity at Step 2. Previous work shows that associations between functioning, symptoms, and standard measures of social cognition often have small-to-medium effect sizes. While quantifying behavior using cognitive models can strengthen these associations (Haines et al., 2025), it is unlikely that improvements would yield large associations. Therefore, priors for beta coefficients reflected the range of plausible values established in prior work centered at 0 effect (N[0, 0.5]). Supplemental analyses confirmed that effects remained when using weaker priors (N[0,1]) and frequentist statistics (Supplementary Materials S5–S6), suggesting that findings were not merely due to our prior choice. Predictors were evaluated based on: *credibility* (i.e., whether the 95% highest density interval [HDI] for the predictor contained zero); *evidence strength* (i.e., using predictor-level Bayes Factors [BF-Predictor], calculated using Savage-Dickey Density Ratio (Wagenmakers, Lodewyckx, Kuriyal, & Grasman, 2010); and *fit improvements* over an age-and-sex-only model (i.e., using changes in expected log posterior density [ELPD] from leave-one-out cross-validation, and model-level BFs [BF-Model]). Higher ELPD indicates better fit, and ELPD changes within the standard error indicate negligible improvements. BFs index the relative strength of evidence for the alternative (association exists; BF > 1) over the null (no association; BF < 1). Conventional BF interpretations were used (Lee & Wagenmakers, 2014). If BF > 1: 1–3 = anecdotal, 3–10 = moderate,10–30 = strong, 30–100 = very strong, >100 = extreme. If BF < 1: 0.33–1 = anecdotal, 0.10–0.33 = moderate, 0.033–0.10 = strong, 0.01–0.033 = very strong, <0.01 = extreme.

Supplementary Material S6.3–S6.4 including similar exploratory analyses of bias-related DDM parameters (i.e., drift bias and start point). To determine whether results were due to intellectual deficits, or could be observed using behavioral metrics derived from choice or RT data alone, supplemental analyses re-ran regressions covarying for IQ and using RT and choice-based sensitivity as predictors.

Results

Associations with functional dimensions

Social cognition

Drift sensitivity statistically predicted social cognition (M = 0.31 [0.13, 0.50], ΔR^2 = 8.2%, BF-Predictor = 68.78; Table 2). Relative to an age- and sex-only model, the full model was favored by very strong BF evidence (BF-Model = 36.84) and improved the out-of-sample predictive accuracy of social cognition (ΔELPD = 3.98 > SE = 3.65). This indicates that those with higher drift sensitivity to gaze cues tend to show better social cognitive abilities – a key determinant of social functioning.

Social functioning

Drift sensitivity statistically predicted social functioning (M = 0.23 [0.04, 0.42], ΔR^2 = 4.3%; Table 2), supported by moderate BF evidence (BF-Predictor = 3.81). Relative to the reduced age- and sex-only model, the full model was favored by moderate BF evidence (BF-Model = 3.77) and improved the predictive accuracy of social functioning (ΔELPD 2.38 > SE 2.32). This suggests a modest association between higher drift sensitivity to gaze cues and better social functioning.

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Table 2. Predicting social functioning and social cognition from drift sensitivity parameters

	Model change[a]			Predictors	
Outcome/ Model/Predictor	ELPD (ΔELPD/SE)	BF (Favors/Strength)	R^2 (ΔR^2)	M [95% HDI]	BF (Favors/Strength)
A) Social cognition					
Regression 1	−152.59 (3.98/3.65)	36.84 (Alt/Very Strong)	0.11 (0.08)		
Sex				−0.03 [−0.41, 0.35]	0.40 (Null/Anecdotal)
Age				−0.07 [−0.24, 0.11]	0.23 (Null/Moderate)
Drift sensitivity				**0.31 [0.13, 0.50]**[b]	**68.78 (Alt/Very Strong)**
B) Social functioning					
Regression 2	−158.79 (2.38/2.32)	3.77 (Alt/Moderate)	0.07 (0.04)		
Sex				−0.30 [−0.71, 0.10]	1.17 (Alt/Anecdotal)
Age				−0.04 [−0.23, 0.14]	0.20 (Null/Moderate)
Drift sensitivity				**0.23 [0.04, 0.42]**[b]	**3.81 (Alt/Moderate)**

Note: M, posterior mean of beta coefficient; Alt, alternative hypothesis; HDI, highest density interval; ELPD, expected log posterior density (higher values = better fit); ΔELPD, change relative to reduced age- and sex-only model; SE, standard error.
[a]Changes relative to reduced age- and sex-only model. Intercepts excluded for brevity but are included in Supplementary Material S5.1–S5.2.
[b]Credible (bolded for clarity).

Associations with symptom dimensions

Psychosis proneness

Drift sensitivity statistically predicted psychosis proneness (M = -0.23, [−0.41, −0.02], ΔR^2 = 4.2%, BF-Predictor = 2.62; Table 3). The full model was favored over the reduced model by anecdotal BF evidence (BF-Model = 2.70) and negligibly improved predictive accuracy of psychosis proneness (ΔELPD 1.82 < SE 2.33). Thus, individuals with diminished evidence accumulation sensitivity to gaze cues experienced more severe psychotic-like experiences, but the association was modest.

Social anxiety

Drift sensitivity statistically predicted social anxiety (M = -0.22 [−0.41, −0.03], ΔR^2 = 3.7%, BF-Predictor = 2.29; Table 3), such that diminished evidence accumulation sensitivity to gaze cues was associated with more prominent social anxiety. This was supported by anecdotal BF evidence (BF-Model = 2.59) and negligible improvements in predictive accuracy (ΔELPD 1.90 < SE 2.14).

Autism traits

Drift sensitivity did not statistically predict autism traits (M = -0.17 [−0.37, 0.01], ΔR^2 = 3.1%, BF-Predictor = 0.88; Table 3).

Supplemental analyses

All results held after controlling for IQ (Supplementary Material S6.1), suggesting they were not merely due to general intellectual deficits.

Past work has placed particular emphasis on links between accuracy on various social cognitive tasks and social functioning. Therefore, post hoc follow-up analyses examined whether drift sensitivity during gaze perception (derived from choice *and* RT data) remained a credible predictor of social functioning after controlling for standard accuracy measures on two popular external social cognition tasks (i.e., RME, TASIT). Results (Supplementary Material S5.2.1) confirmed that drift sensitivity accounted for an additional 4.8% of the variance in social functioning after controlling for age, sex, and accuracy on these external social cognition tasks (M = 0.22 [0.02, 0.42]), albeit weakly so (BF-Predictor = 1.73).

Finally, no credible associations with functional or symptom dimensions were found when choice-based sensitivity (derived from a psychometric fitted to only choice data) or RT during gaze perception were used as predictors (Supplementary Material S6.2). Together with earlier results, this suggests that measuring the *efficiency* of social information processing using drift sensitivity (which leverages RT *and* choice data) (Ratcliff, 2014, rather than social cognitive measures based on choice or RT data alone, may strengthen associations with clinical measures and social functioning.

Discussion

This study examined evidence accumulation during a critical social process – self-referential gaze detection – in a transdiagnostic sample with varying levels of social dysfunction. We found that diminished evidence accumulation sensitivity to self-referential gaze signals was associated with poorer social functioning, worse social cognition, and symptom elevations in multiple psychopathology domains. However, associations with functioning and symptom domains were more modest. These findings may shed light on the difficulties that characterize psychopathologies marked by social dysfunction.

As hypothesized, when evidence accumulation was more attuned to available gaze signals, individuals tended to show better performance on external measures of social cognition and better social functioning across self-reports, informant reports, and clinician ratings. Foremost, these results provide compelling evidence that this computationally defined process relates to more complex social cognitive abilities, like theory-of-mind and social inference. Although associations with functioning were weaker, they provide some indication that the sensitivity of evidence accumulation to gaze cues – a measure derived from choices and response speed – accounted for social functioning beyond choice- or RT-based performance metrics on the gaze perception task or external tests of social cognitive accuracy. One explanation is that social interactions require both fast and accurate processing of social cues, like gaze. For example, during face-to-face conversations, periods of mutual gaze last ~360 ms (Rogers, Speelman, Guidetti, & Longmuir, 2018), providing brief windows to accumulate information. If processing

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Table 3. Predicting symptom dimensions from drift sensitivity

	Model change[a]			Predictors	
Outcome/ Model/Predictor	ELPD (ΔELPD/SE)	BF (Favors/Strength)	R^2 (ΔR^2)	*M* [95% HDI]	BF (Favors/Strength)
A) Psychosis proneness					
Regression 1	−151.59 (1.82/2.33)	2.70 (Alt/Anecdotal)	0.08 (0.04)		
Sex				0.16 [−0.25, 0.57]	0.55 (Null/Anecdotal)
Age				−0.13 [−0.32, 0.05]	0.48 (Null/Anecdotal)
Drift sensitivity				**−0.23 [−0.41, −0.02][b]**	**2.62 (Alt/Anecdotal)**
B) Social anxiety					
Regression 2	−150.28 (1.90/2.14)	2.59 (Alt/Anecdotal)	0.09 (0.04)		
Sex				**0.48 [0.06, 0.88][b]**	**5.44 (Alt/Moderate)**
Age				−0.09 [−0.28, 0.09]	0.32 (Null/Moderate)
Drift sensitivity				**−0.22 [−0.41, −0.03][b]**	**2.29 (Alt/Anecdotal)**
C) Autism traits					
Regression 3	−160.93 (0.37/2.04)	0.88 (Null/Anecdotal)	0.06 (0.03)		
Sex				−0.02 [−0.42, 0.41]	0.44 (Null/Anecdotal)
Age				0.01 [−0.19, 0.19]	0.20 (Null/Moderate)
Drift sensitivity				−0.17 [−0.37, 0.01]	0.91 (Null/Anecdotal)

Note: M, posterior mean of beta coefficient; Alt. alternative hypothesis; HDI, highest density interval; ELPD, expected log posterior density (higher values = better fit); ΔELPD, change relative to age- and sex-only reduced model; SE, standard error.
[a]Changes relative to age- and sex-only reduced model. Intercepts excluded for brevity but included in Supplementary Material S5.3–S5.5.
[b]Credible (bolded for clarity).

efficiency is poor, tradeoffs may be necessary. For instance, if long viewing times are required to maintain accuracy, others may perceive staring and avoid the viewer (Ellsworth, Carlsmith, & Henson, 1972). At brief viewing times, one settles for less information, often resulting in inaccurate judgments that can impair social interaction (Hamilton, 2016; Sergi & Green, 2003). Therefore, a complete account of the mechanisms of altered gaze perception must jointly characterize the speed and accuracy of perception, but this cannot be done with accuracy or RT metrics alone (Ratcliff, 2014. Instead, social cognitive measures that jointly account for choices and response speed – like the parameters of the DDM – may better capture the abilities that social contexts demand.

Individuals with lower evidence accumulation sensitivity to gaze cues experienced more prominent psychotic-like experiences and social anxiety. This aligns with previous findings in schizophrenia (Lasagna, Pleskac, Weigard, & Tso, 2026a; Lasagna, Tso, Blain, & Pleskac, 2026b) and shows that the sensitivity of evidence accumulation to gaze cues also captures broader transdiagnostic expression of socially relevant psychopathology, notably symptom dimensions marked by social fears. Psychosis and social anxiety show considerable phenomenological overlap (Chau, So, & Barkus, 2023; Horton, Barrantes-Vidal, Silvia, & Kwapil, 2014; Michail & Birchwood, 2009; Stopa, Denton, Wingfield, & Taylor, 2013). Suspiciousness or paranoia in psychosis and fears of scrutiny in social anxiety both entail threat anticipation in social contexts (Freeman et al., 2002). At higher levels of psychosis or social anxiety, individuals may be "hypervigilant" for social information signaling threat or negative evaluation. Such high arousal states are cognitively taxing and may detract from resources available for ongoing information processing. However, it has traditionally been challenging to identify explicit cognitive mechanisms that underlie relationships between social anxiety and psychosis. Critically, our findings propose a common cognitive mechanism that cuts across these symptom dimensions and helps to account for previous findings, including: slower and less precise gaze perception in psychosis (Grove et al., 2021; Tso et al., 2021; Zhu et al., 2007), and less precise gaze perception in social anxiety (Chen, Nummenmaa, & Hietanen, 2017; Gamer, Hecht, Seipp, & Hiller, 2011; Schulze, Lobmaier, Arnold, & Renneberg, 2013). However, our data were cross-sectional and future longitudinal studies are needed to clarify whether insensitivity to social cues is a precursor or a consequence of psychopathology.

While heightened social fears are also common in autism (Montaser et al., 2023), additional features of the autism phenotype may contribute to the lack of association between autism traits and evidence accumulation sensitivity. People with autism often perform well on tasks that involve attending to high-contrast stimuli and local features (Robertson & Baron-Cohen, 2017). Deficits are more likely when higher-level inferencing is required, like inferring another's intentions from the direction they are looking (Robertson & Baron-Cohen, 2017; Shepherd, 2010). The gaze perception task used here required attending to a single, relatively high-contrast facial feature (i.e., eyes). Consequently, null associations between sensitivity of evidence accumulation during gaze perception and autism traits may be because this task was well-suited to the perceptual strengths of individuals with autism traits. Future studies should examine whether evidence accumulation is disrupted in autism when performing social cognitive tasks that require global information processing, like emotion identification and theory of mind.

From a methodological perspective, insensitive evidence accumulation for social cues – which drives choices and RT – may help reconcile paradoxical or null findings found using accuracy-based social cognitive metrics when potential tradeoffs with response

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speed were not accounted for (e.g., by not analyzing RT explicitly or by allowing unlimited stimulus viewing time) (Gamer, Hecht, Seipp, & Hiller, 2011; Gu et al., 2024; Harbort, Spiegel, Witthöft, & Hecht, 2017). If the primary mechanism driving dysfunctions stems from diminished evidence accumulation sensitivity, compensatory strategies (e.g., slowing down to "be sure") may be employed if the task design permits, to improve accuracy/choice consistency at the expense of slower reaction time. As a result, social cognitive performance can appear "intact" or even "improved" if only accuracy (and not RT) is considered, offering only a partial view of decision-making. For example, our previous work found that higher social anxiety was associated with more consistent choices during gaze perception (Gu et al., 2024). However, viewing time was unlimited, and RT was not analyzed. It is possible that diminished evidence accumulation sensitivity combined with an increased caution in those with higher social anxiety was at play. If RT had been accounted for, those results may be consistent with our findings showing the opposite effect. This underscores that routinely investigating speed and accuracy (including tradeoffs between them) is critical to achieving a more complete understanding of social cognitive decision-making in studies of psychopathology.

These findings should be considered in light of several limitations. *First*, we examined evidence accumulation during a basic form of social cue detection, but this represents just one facet of social cognition. However, this same process may also play a role in more complex social cognition, like emotion recognition and theory of mind. To test this, studies could jointly model if a common evidence accumulation process influences decisions across multiple social cognitive tasks at the same time (Stevenson et al., 2024), including simple and more complex ones. Importantly, this should be done using tasks with strong psychometric properties (e.g., Penn Emotion Recognition Task, Hinting Task, our gaze perception task) because the RME and TASIT, used to test convergent validity here, have relatively weak psychometric properties (Higgins, Kaplan, Deschrijver, & Ross, 2024; Lasagna et al., 2020; Pinkham, Harvey, & Penn, 2018). *Second*, general evidence accumulation disruptions across a range of non-social cognitive tasks (e.g., attention, working memory) confer risk for psychopathology (Sripada & Weigard, 2021; Weigard & Sripada, 2021). Although we accounted for intellectual functioning, future studies should model social and non-social tasks within the same participants to clarify whether dysfunctions are specific to social versus general cognitive disruptions, which may differentially relate to clinical phenomena (Blain et al., 2025; Lasagna, Pleskac, Weigard, & Tso, 2026a). *Third*, autism traits were measured using interview- and self-ratings, while social anxiety and psychosis traits were measured using only self-ratings. To tease apart the possible contributions of shared methods variance, future studies should utilize interviewer- and self-rated measures for all three clinical dimensions.

Ultimately, evidence accumulation sensitivity to subtle gaze cues may constitute a common mechanism underlying social dysfunctions observed across psychiatric populations – showing strong associations with determinants of social functioning, and modest associations with levels of real-world social dysfunction. Moreover, this mechanism may be particularly relevant to those psychopathologies characterized by heightened social fears and suspicions, like psychosis and social anxiety – future work should investigate this further. Most importantly, this work supports the notion that intact social functioning requires rapid and accurate processing of social cues, yet most studies of social cognition emphasize accuracy alone. To reflect this, it may be necessary to reconceptualize the measurement of social cognition in a way that accounts for speed and accuracy simultaneously.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/S003329172610573X.

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References

Baron-Cohen, S., Wheelwright, S., Skinner, R., Martin, J., & Clubley, E. (2001). The autism-Spectrum quotient (AQ): Evidence from Asperger syndrome/high-functioning autism, males and females, scientists and mathematicians. *Journal of Autism and Developmental Disorders*, **31**(1), 5–17. https://doi.org/10.1023/A:1005653411471

Bell, V., Halligan, P. W., & Ellis, H. D. (2006). The Cardiff anomalous perceptions scale (CAPS): A new validated measure of anomalous perceptual experience. *Schizophrenia Bulletin*, **32**(2), 366–377. https://doi.org/10.1093/schbul/sbj014

Blain, S. D., Kent, J. S., Allen, T. A., Lasagna, C. A., De Bord, C. A., Udochi, A. L., Sponheim, S. R., DeYoung, C. G., & Tso, I. F. (2025). Constructs across a hierarchical, dimensional model of psychopathology show differential associations with social and general cognitive ability. *PLoS One*, **20**(1), e0317377. https://doi.org/10.1371/journal.pone.0317377

Blanchard, J. J., Mueser, K. T., & Bellack, A. S. (1998). Anhedonia, positive and negative affect, and social functioning in schizophrenia. *Schizophrenia Bulletin*, **24**(3), 413–424. https://doi.org/10.1093/oxfordjournals.schbul.a033336

Bottema-Beutel, K., Kim, S. Y., & Crowley, S. (2019). A systematic review and meta-regression analysis of social functioning correlates in autism and typical development. *Autism Research*, **12**(2), 152–175. https://doi.org/10.1002/aur.2055

Campbell, R., Lawrence, K., Mandy, W., Mitra, C., Jeyakuma, L., & Skuse, D. (2006). Meanings in motion and faces: Developmental associations between the processing of intention from geometrical animations and gaze detection accuracy. *Development and Psychopathology*, **18**(01), 99–118. https://doi.org/10.1017/s0954579406060068

Chan, S. K. W., Liu, T., Wong, A. O. Y., Wong, G. H. Y., Hsiao, J., Hui, C. L. M., Chang, W. C., Lee, E. H. M., & Chen, E. Y. H. (2021). Self-referential gaze perception of patients with schizophrenia and its relationship with symptomatology and cognitive functions. *Schizophrenia Research*, **228**, 288–294. https://doi.org/10.1016/j.schres.2020.12.034

Chau, A. K. C., So, S. H., & Barkus, E. (2023). The role of loneliness and negative schemas in the moment-to-moment dynamics between social anxiety and paranoia. *Scientific Reports*, **13**(1), 20775. https://doi.org/10.1038/s41598-023-47912-0

Chen, T., Nummenmaa, L., & Hietanen, J. K. (2017). Eye contact judgment is influenced by perceivers' social anxiety but not by their affective state. *Frontiers in Psychology*, **8**. https://doi.org/10.3389/fpsyg.2017.00373

Connor, K. M., Davidson, J. R. T., Churchill, L. E., Sherwood, A., Weisler, R. H., & Foa, E. (2000). Psychometric properties of the social phobia inventory (SPIN). *British Journal of Psychiatry*, **176**(4), 379–386. https://doi.org/10.1192/bjp.176.4.379

Constantino, J., & Gruber, C. (2012). *Social responsiveness scale, second edition (SRS-2)*. Western Psychological Services.

Davila, J., & Beck, J. G. (2002). Is social anxiety associated with impairment in close relationships? A preliminary investigation. *Behavior Therapy*, **33**(3), 427–446. https://doi.org/10.1016/S0005-7894(02)80037-5

de Lijster, J. M., Dieleman, G. C., Utens, E. M. W. J., Dierckx, B., Wierenga, M., Verhulst, F. C., & Legerstee, J. S. (2018). Social and academic functioning in adolescents with anxiety disorders: A systematic review. *Journal of Affective Disorders*, **230**, 108–117. https://doi.org/10.1016/j.jad.2018.01.008

Ellsworth, P. C., Carlsmith, J. M., & Henson, A. (1972). The stare as a stimulus to flight in human subjects: A series of field experiments. *Journal of Personality and Social Psychology*, **21**(3), 302–311. https://doi.org/10.1037/h0032323

Emery, N. J. (2000). The eyes have it: The neuroethology, function and evolution of social gaze. *Neuroscience & Biobehavioral Reviews*, **24**(6), 581–604. https://doi.org/10.1016/s0149-7634(00)00025-7

Freeman, D., Garety, P. A., Kuipers, E., Fowler, D., & Bebbington, P. E. (2002). A cognitive model of persecutory delusions. *British Journal of Clinical Psychology*, **41**(4), 331–347. https://doi.org/10.1348/014466502760387461; www.bps.org.uk

Gamer, M., Hecht, H., Seipp, N., & Hiller, W. (2011). Who is looking at me? The cone of gaze widens in social phobia. *Cognition & Emotion*, **25**(4), 756–764. https://doi.org/10.1080/02699931.2010.503117

George, N., Driver, J., & Dolan, R. J. (2001). Seen gaze-direction modulates fusiform activity and its coupling with other brain areas during face processing. *NeuroImage*, **13**(6), 1102–1112. https://doi.org/10.1006/nimg.2001.0769

Grove, T., Lasagna, C., Martínez-Cancino, R., Pamidighantam, P., Deldin, P., & Tso, I. (2021). *Neural oscillatory abnormalities during gaze processing in schizophrenia: Evidence of reduced theta phase consistency and inter-regional theta-gamma coupling*. Cognitive Neuroscience and Neuroimaging.

Gu, P., Blain, S., Lasagna, C., Suzuki, T., Burton, C., Thakkar, K., Kent, J., & Tso, I. (2024). The influences of sensory quality and context congruity on gaze perception: Relations with traits of psychosis proneness, social anxiety, and autism in the general population. OSF. https://doi.org/10.31234/osf.io/5zytp

Haines, N., Kvam, P. D., Irving, L., Smith, C. T., Beauchaine, T. P., Pitt, M. A., Ahn, W.-Y., & Turner, B. M. (2025). A tutorial on using generative models to advance psychological science: Lessons from the reliability paradox. Psychological Methods. https://doi.org/10.1037/met0000674

Hamilton, A. (2016). Gazing at me: The importance of social meaning in understanding direct-gaze cues. *Philosophical Transactions of the Royal Society B: Biological Sciences*, **371**(1686), 20150080. https://doi.org/10.1098/rstb.2015.0080

Handest, R., Molstrom, I.-M., Gram Henriksen, M., Hjorthøj, C., & Nordgaard, J. (2023). A systematic review and meta-analysis of the association between psychopathology and social functioning in schizophrenia. *Schizophrenia Bulletin*, **49**(6), 1470–1485. https://doi.org/10.1093/schbul/sbad075

Harbort, J., Spiegel, J., Witthöft, M., & Hecht, H. (2017). The effects of social pressure and emotional expression on the cone of gaze in patients with social anxiety disorder. *Journal of Behavior Therapy and Experimental Psychiatry*, **55**, 16–24. https://doi.org/10.1016/j.jbtep.2016.11.004

Harbort, J., Witthöft, M., Spiegel, J., Nick, K., & Hecht, H. (2013). The widening of the gaze cone in patients with social anxiety disorder and its normalization after CBT. *Behaviour Research and Therapy*, **51**(7), 359–367. https://doi.org/10.1016/j.brat.2013.03.009

Higgins, W. C., Kaplan, D. M., Deschrijver, E., & Ross, R. M. (2024). Construct validity evidence reporting practices for the reading the mind in the eyes test: A systematic scoping review. *Clinical Psychology Review*, **108**, 102378. https://doi.org/10.1016/j.cpr.2023.102378

Hoertnagl, C. M., Kaufmann, A., Yalcin-Siedentopf, N., Pfaffenberger, N. M., Frajo-Apor, B., Pardeller, S., Kemmler, G., & Hofer, A. (2020). Premorbid social functioning and affective symptoms predict subjective outcome among outpatients with schizophrenia. *Frontiers in Psychiatry*, **11**, 570857. https://doi.org/10.3389/fpsyt.2020.570857

Hooker, C., & Park, S. (2005). You must be looking at me: The nature of gaze perception in schizophrenia patients. *Cognitive Neuropsychiatry*, **10**(5), 327–345. https://doi.org/10.1080/13546800444000083

Horton, L. E., Barrantes-Vidal, N., Silvia, P. J., & Kwapil, T. R. (2014). Worries about being judged versus being harmed: Disentangling the association of social anxiety and paranoia with schizotypy. *PLoS One*, **9**(6), e96269. https://doi.org/10.1371/journal.pone.0096269

Hus, V., & Lord, C. (2014). The autism diagnostic observation schedule, module 4: Revised algorithm and standardized severity scores. *Journal of Autism and Developmental Disorders*, **44**(8), 1996–2012. https://doi.org/10.1007/s10803-014-2080-3

Itier, R. J., & Batty, M. (2009). Neural bases of eye and gaze processing: The core of social cognition. *Neuroscience and Biobehavioral Reviews*, **33**(6), 843–863. https://doi.org/10.1016/j.neubiorev.2009.02.004

Kessler, R. C., Amminger, G. P., Aguilar-Gaxiola, S., Alonso, J., Lee, S., & Ustun, T. B. (2007). Age of onset of mental disorders: A review of recent literature. *Current Opinion in Psychiatry*, **20**(4), 359–364. https://doi.org/10.1097/YCO.0b013e32816ebc8c

Lasagna, C., McLaughlin, M., Deng, W., Whiting, E., & Tso, I. (2020). Deconstructing eye contact perception: Measuring perceptual precision and self-referential tendency using an online psychophysical eye contact detection task. *PLoS One*, **15**(3), 1–20. https://doi.org/10.1371/journal.pone.0230258

Lasagna, C., Pleskac, T., Weigard, A., & Tso, I. (2026a). Modeling self-reference in schizophrenia: General and specific mechanisms underlying decision-making are differentially associated with paranoia. *Schizophrenia Bulletin*, sbag124. https://doi.org/10.1093/schbul/sbag124

Lasagna, C., Tso, I., Blain, S., & Pleskac, T. (2026b). Cognitive mechanisms of aberrant self-referential social perception in psychosis and bipolar disorder: Insights from computational modeling. *Schizophrenia Bulletin*, **52**(1), sbae147. https://doi.org/10.1093/schbul/sbae147

Lebeau, R. T., Glenn, D. E., Hanover, L. N., Beesdo-Baum, K., Wittchen, H.-U., & Craske, M. G. (2012). A dimensional approach to measuring anxiety for DSM-5. *International Journal of Methods in Psychiatric Research*, **21**(4), 258–272. https://doi.org/10.1002/mpr.1369

Lee, M. D., & Wagenmakers, E.-J. (2014). *Bayesian cognitive modeling: A practical course*. Cambridge University Press. https://doi.org/10.1017/CBO9781139087759

Lord, C., Rutter, M., DiLavore, P., Risi, S., Gotham, K., & Bishop, S. (2012). *Autism diagnostic observation schedule* (2nd ed.). Western Psychological Services.

McDonald, S., Flanagan, S., Rollins, J., & Kinch, J. (2003). TASIT: A new clinical tool for assessing social perception after traumatic brain injury. *Journal of Head Trauma Rehabilitation*, **18**(3), 219–238. https://doi.org/10.1097/00001199-200305000-00001

Michail, M., & Birchwood, M. (2009). Social anxiety disorder in first-episode psychosis: Incidence, phenomenology and relationship with paranoia. *The British Journal of Psychiatry*, **195**(3), 234–241. https://doi.org/10.1192/bjp.bp.108.053124

Montaser, J., Umeano, L., Pujari, H. P., Nasiri, S. M. Z., Parisapogu, A., Shah, A., & Khan, S. (2023). Correlations between the development of social anxiety and individuals with autism spectrum disorder: A systematic review. *Cureus*, **15**(9), e44841. https://doi.org/10.7759/cureus.44841

Niv, N., Cohen, A. N., Sullivan, G., & Young, A. S. (2007). The MIRECC version of the global assessment of functioning scale: Reliability and validity. *Psychiatric Services*, **58**(4), 529–535. https://doi.org/10.1176/ps.2007.58.4.529

Oh, H., Karcher, N. R., Soffer-Dudek, N., Koyanagi, A., Besecker, M., & DeVylder, J. E. (2024). Distress related to psychotic experiences: Enhancing the world health organization composite international diagnostic interview psychosis screen. *International Journal of Methods in Psychiatric Research*, **33**(1), e1977. https://doi.org/10.1002/mpr.1977

Pantelis, P. C., & Kennedy, D. P. (2017). Deconstructing atypical eye gaze perception in autism spectrum disorder. *Scientific Reports*, **7**(1), 14990. https://doi.org/10.1038/s41598-017-14919-3

Peters, E., Joseph, S., Day, S., & Garety, P. (2004). Measuring delusional ideation: The 21-item Peters et al. delusions inventory (PDI). *Schizophrenia Bulletin*, **30**(4), 1005–1022. https://doi.org/10.1093/oxfordjournals.schbul.a007116

Pinkham, A. E., Harvey, P. D., & Penn, D. L. (2018). Social cognition psychometric evaluation: Results of the final validation study. *Schizophrenia Bulletin*, **44**(4), 737–748. https://doi.org/10.1093/schbul/sbx117

Piskulic, D., Addington, J., Auther, A., & Cornblatt, B. A. (2011). Using the global functioning social and role scales in a first-episode sample. *Early Intervention in Psychiatry*, **5**(3), 219–223. https://doi.org/10.1111/j.1751-7893.2011.00263.x

Ratcliff, R. (2014). Measuring psychometric functions with the diffusion model. *Journal of Experimental Psychology. Human Perception and Performance*, **40**(2), 870–888. https://doi.org/10.1037/a0034954

Ratcliff, R., & McKoon, G. (2008). The diffusion decision model: Theory and data for two-choice decision tasks. *Neural Computation*, **20**(4), 873–922. https://doi.org/10.1162/neco.2008.12-06-420

Robertson, C. E., & Baron-Cohen, S. (2017). Sensory perception in autism. *Nature Reviews Neuroscience*, **18**(11), 671–684. https://doi.org/10.1038/nrn.2017.112

Rogers, S. L., Speelman, C. P., Guidetti, O., & Longmuir, M. (2018). Using dual eye tracking to uncover personal gaze patterns during social interaction. *Scientific Reports*, **8**(1), 1. https://doi.org/10.1038/s41598-018-22726-7

https://doi.org/10.1017/S003329172610573X Published online by Cambridge University Press

Schulze, L., Lobmaier, J. S., Arnold, M., & Renneberg, B. (2013). All eyes on me?! Social anxiety and self-directed perception of eye gaze. *Cognition and Emotion*, **27**(7), 1305–1313. https://doi.org/10.1080/02699931.2013.773881

Sergi, M. J., & Green, M. F. (2003). Social perception and early visual processing in schizophrenia. *Schizophrenia Research*, **59**(2-3), 233–241. https://doi.org/10.1016/S0920-9964(01)00405-4

Sheehan, D. V., Lecrubier, Y., Sheehan, K. H., Amorim, P., Janavs, J., Weiller, E., Hergueta, T., Baker, R., & Dunbar, G. C. (1998). The mini-international neuropsychiatric interview (M.I.N.I.): The development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *The Journal of Clinical Psychiatry*, **59**(20), 22–33.

Shepherd, S. (2010). Following gaze: Gaze-following behavior as a window into social cognition. *Frontiers in Integrative Neuroscience*, **4**, https://doi.org/10.3389/fnint.2010.00005

Sripada, C., & Weigard, A. (2021). Impaired evidence accumulation as a transdiagnostic vulnerability factor in psychopathology. *Frontiers in Psychiatry*, **12**, 627179. https://doi.org/10.3389/fpsyt.2021.627179

Stacklies, W., Redestig, H., Scholz, M., Walther, D., & Selbig, J. (2007). pcaMethods—A bioconductor package providing PCA methods for incomplete data. *Bioinformatics*, **23**(9), 1164–1167. https://doi.org/10.1093/bioinformatics/btm069

Stevenson, N., Innes, R. J., Boag, R. J., Miletić, S., Isherwood, S. J. S., Trutti, A. C., Heathcote, A., & Forstmann, B. U. (2024). Joint modelling of latent cognitive mechanisms shared across decision-making domains. *Computational Brain & Behavior*, **7**(1), 1–22. https://doi.org/10.1007/s42113-023-00192-3

Stopa, L., Denton, R., Wingfield, M., & Taylor, K. N. (2013). The fear of others: A qualitative analysis of interpersonal threat in social phobia and paranoia. *Behavioural and Cognitive Psychotherapy*, **41**(2), 188–209. https://doi.org/10.1017/S1352465812000422

Tso, I., Angstadt, M., Rutherford, S., Peltier, S., Diwadkar, V., & Taylor, S. (2021). Dynamic causal modeling of eye gaze processing in schizophrenia. *Schizophrenia Research*, **229**, 112–121. https://doi.org/10.1016/j.schres.2020.11.012

Tso, I., Lasagna, C., Fitzgerald, K., Colombi, C., Sripada, C., Peltier, S., Johnson, T., & Thakkar, K. (2020). Disrupted eye gaze perception as a biobehavioral marker of social dysfunction: An RDoC investigation. *Journal of Psychiatry and Brain Science*, **5**(5), e200021

Tso, I., Mui, M., Taylor, S., & Deldin, P. (2012). Eye-contact perception in schizophrenia: Relationship with symptoms and socioemotional functioning. *Journal of Abnormal Psychology*, **121**(3), 616–627. https://doi.org/10.1037/a0026596

Tso, I., Taylor, S., & Johnson, T. (2021). Applying hierarchical bayesian modeling to experimental psychopathology data: An introduction and tutorial. *Journal of Abnormal Psychology*, **130**(8), 923–936. https://doi.org/10.1037/abn0000707

Wagenmakers, E.-J., Lodewyckx, T., Kuriyal, H., & Grasman, R. (2010). Bayesian hypothesis testing for psychologists: A tutorial on the savage–dickey method. *Cognitive Psychology*, **60**(3), 158–189. https://doi.org/10.1016/j.cogpsych.2009.12.001

Wastler, H. M., & Lenzenweger, M. F. (2018). Cone of gaze in positive schizotypy: Relationship to referential thinking and social functioning. *Personality Disorders*, **9**(4), 324–332. https://doi.org/10.1037/per0000258

Wechsler, D. (2011). *Wechsler abbreviated scale of intelligence, second edition (WASI-II)*. NCS Pearson.

Weigard, A., & Sripada, C. (2021). Task-general efficiency of evidence accumulation as a computationally defined neurocognitive trait: Implications for clinical neuroscience. *Biological Psychiatry Global Open Science*, **1**(1), 5–15. https://doi.org/10.1016/j.bpsgos.2021.02.001

Weissman, M. M. (1999). Social adjustment scale – self-report technical manual. Multi-Health Systems.

Zhu, C., Lee, T. M. C., Li, X., Jing, S., Wang, Y., & Wang, K. (2007). Impairments of social cues recognition and social functioning in Chinese people with schizophrenia. *Psychiatry & Clinical Neurosciences*, **61**(2), 149–158. https://doi.org/10.1111/j.1440-1819.2007.01630.x

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