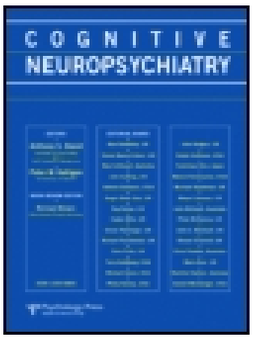

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Spontaneous perspective-taking and its relation to schizotypy

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ABSTRACT

Introduction: Patients with schizophrenia differ from healthy controls in the extent that they spontaneously take another's perspective. For such effects, it is difficult to separate the influence of schizophrenia from multiple potential confounders. Here, for the first time, associations between spontaneous perspective-taking and schizotypy were investigated in a nonclinical population.

Methods: Adult participants completed both a Schizotypal Personality Questionnaire (SPQ-BRU) and a novel online adaptation of a visual perspective-taking task that required participants to make judgements both from their own perspective and that of a human avatar.

Results: Response times were elevated when the avatar's perspective was inconsistent with that of the participant, providing evidence of spontaneous perspective-taking. This demonstrates that the visual perspective-taking task can be successfully implemented in an online format. However, schizotypy did not predict these spontaneous perspective-taking effects.

Conclusions: Unlike explicit mentalising, this form of implicit mentalising is not affected by nonclinical manifestations of schizotypy traits. This implies that impairment of general neurocognitive function contributes to altered spontaneous perspective-taking in schizophrenia. A novel account based on the cognitive control processes involved in perspective selection and the role of attention in perspective calculation reconciles apparently contradictory findings of earlier studies comparing patients with schizophrenia and healthy controls.

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Theory of Mind; perspective-taking; schizotypy; schizophrenia; nonclinical

Theory of Mind or mentalising deficits in schizophrenia are well established (Chung et al., 2014; Harrington et al., 2005; Savla et al., 2013). People with schizophrenia tend to have difficulties taking other people's points of view and have less understanding of what another person may be thinking or feeling. Research that furthers our understanding of these deficits is important because difficulties in relating to others can impede

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social interactions and relationships (Bora et al., 2006). This paper contributes to this broad challenge by assessing how schizotypy relates to *spontaneous perspective-taking*, which refers to the automatic monitoring of what others see.

Research on mentalising deficits in schizophrenia has focused on explicit measures whereby individuals intentionally reason about mental states (Eddy, 2019). This includes studies employing perspective-taking tasks to assess explicit mentalising in which participants are instructed to take on other people's point of view, and thus do so intentionally (Eack et al., 2013, 2017; Langdon et al., 2001). By contrast, less research has been directed towards deficits in *implicit mentalising*, which refers to the ability to monitor mental states in a way that is fast and inflexible, rather than slow and controlled, and occurs automatically whether we want it to or not. This ability is assessed in adults by indirect tests, such as those measuring interference effects in reaction time tasks resulting from others' knowledge (e.g., Samson et al., 2010) or intentions (e.g., Sebanz et al., 2003). According to two-systems accounts of Theory of Mind (Apperly & Butterfill, 2009; Frith & Frith, 2008; Phillips, 2021), implicit and explicit mentalising are mediated by different cognitive systems and have different properties (early developing, fast, automatic vs. later developing, slow, effortful). Because of these differences in cognitive systems and properties, we cannot make conclusions regarding implicit mentalising from explicit mentalizing. Therefore, more attention toward understanding implicit mentalising is warranted given the paucity of research in this area.

Recently, two studies have assessed altered implicit mentalising in schizophrenia measured using an indirect test (Kronbichler et al., 2019; Simonsen et al., 2020). Both adapted a task introduced by Samson et al. (2010) that measures spontaneous visual perspective-taking (hereafter, VPT task). Performance in the VPT task is typically poorer when making judgements from one's own perspective if an avatar has a conflicting perspective. This effect, referred to as an *altercentric intrusion*, suggests that what another person can see may intrude or interfere with our own perceptual judgements even when that person's perspective is not task relevant. One study found reduced evidence of spontaneous perspective-taking, relative to controls, with altercentric intrusions absent in the schizophrenia sample (Kronbichler et al., 2019). As performance was not disrupted when the avatar had conflicting knowledge, this implies that patients were not calculating the avatar's perspective. The other study, by contrast, found greater evidence of spontaneous perspective-taking, with altercentric intrusions present for reaction time only in the schizophrenia group, and not in controls (Simonsen et al., 2020). These contrasting results were interpreted by the authors as indicating patients had a diminished ability to inhibit conflicting knowledge held by the avatar, perhaps due to difficulties distinguishing themselves from others (referred to as "self other-control processes", de Guzman et al., 2016). A possible explanation for this discrepancy in findings is differences in task parameters, particularly whether judgements were made both from Self and Avatar perspectives (Simonsen et al., 2020), or just from the Self perspective (Kronbichler et al., 2019), given that this feature influences disposition for spontaneous perspective-taking (O'Grady et al., 2020). Nonetheless, it is impossible to attribute altered mentalising to symptomology of schizophrenia with confidence, given group differences in general cognitive ability were also found in both studies (Kronbichler et al., 2019; Simonsen et al., 2020).

One way to address this issue is to assess the relationship between spontaneous perspective-taking and schizotypy in a nonclinical population where differences in cognitive

ability are not expected to be as pronounced. Schizotypy refers to a range of personality traits thought to reflect the subclinical expression of schizophrenia in the general population (Claridge, 1994). Research examining schizotypy in nonclinical samples can address questions relating to schizophrenia on the basis that schizotypy is either a risk factor for schizophrenia (van Os et al., 2009), or a spectrum upon which schizophrenia falls at the most extreme end (Nelson et al., 2013). Such studies additionally have the methodological advantage of avoiding confounds, such as chronic illness and treatment, that can obscure the mechanisms involved in the etiology of schizophrenia (Ettinger et al., 2015; Mason, 2015). This approach has been pursued in earlier research, but always for explicit tasks assessing deliberate perspective-taking (Langdon & Coltheart, 2001; Michael et al., 2020; Mohr et al., 2006; Vastano et al., 2014), or other types of explicit mentalising (e.g., Barragan et al., 2011; Langdon & Coltheart, 1999; Pickup, 2006). For spontaneous perspective-taking, an association may be expected primarily with positive schizotypy, given that altercentric intrusions are positively related with the severity of some of the positive symptoms of schizophrenia thought to be exacerbated by impaired self-other control (Simonsen et al., 2020).

The aim of the current study was to assess associations between spontaneous perspective-taking, measured by the VPT task, and dimensions of schizotypy, measured by the Schizotypal Personality Questionnaire – Brief Revised Updated (SPQ-BRU, Davidson et al., 2016). The VPT task measures spontaneous visual perspective-taking by having participants view avatars and stimuli in a picture and judge the number of stimuli based on either their own perspective or the avatar's perspective. Dimensions of schizotypy were examined, rather than a total schizotypy score, in order to assess any differential associations with positive schizotypy. On the basis that clinical psychotic symptoms are an extreme manifestation of schizotypal traits (Nelson et al., 2013), two alternate predications can be made. If altered spontaneous perspective-taking is a consequence of psychotic symptoms of schizophrenia, then schizotypal traits will be associated with altercentric intrusions. If, instead, altered spontaneous perspective-taking is a secondary consequence of general features of psychiatric illness, no evidence for such an association would be expected.

Materials and methods

Participants

148 adult participants whose first language was English were recruited from the "Testable Minds" participant pool integrated with the online platform used to implement the VPT task, and paid $4. They did not have a history of psychiatric illness or head injury, by self-report. The study was powered to detect $R^2 = .1$ (i.e., Cohen's $f^2 = .11$), in light of the range of reported fit of previous research regressing explicit mentalising (measured by behavioural tasks) onto schizotypy traits, $R^2 = .12–.29$ (Barragan et al., 2011; Pickup, 2006). We recruited more than required to detect this effect with 80% power ($N = 113$; computed by G*Power, Faul et al., 2007), in order to accommodate anticipated data exclusions. The preregistered analysis plan is available at: https://aspredicted.org/blind.php?x=s9n7cp.

Preregistered exclusion criteria were designed to assure data quality, excluding data from participants that were not paying adequate attention. Of those recruited, 21

(14.2%) were excluded based on an overall error rate exceeding 30% on the VPT task. One further participant was dropped for likely fraudulent responding, indicated by an unusual combination of demographic data. However, none had to be excluded for violating exclusion criteria relating to the SPQ-BRU – omitting more than 25% of items or "straightlining" through the questionnaire (defined as inter-item SD < .03; Davidson et al., 2016).

The participants contributing usable data ($N = 126$), were predominately male (72%); age: $M = 30.1$ years ($SD = 10.2$). They were located worldwide, with the most prevalent locations UK (29%), India (21%), and the US (18%). The majority of the sample reported were university graduates (75%), with a substantial subset also educated to postgraduate level (22%).

Measures

Schizotypal personality questionnaire – brief revised updated (SPQ-BRU)

The SPQ-BRU is a brief self-report schizotypy questionnaire (Davidson et al., 2016, where items are available). Earlier forms of the SPQ (Raine, 1991; Raine & Benishay, 1995; Wuthrich & Bates, 2005) have often been used in research examining associations with explicit mentalising (e.g., Deptula & Bedwell, 2015; Henry et al., 2008; Langdon & Coltheart, 1999). The updated SPQ-BRU was selected for the present study because its items consistently refer to first person experience (e.g., "I"), thus avoiding a confound present in earlier versions that use second person pronouns for some of the dimensions (e.g., "You"; Brunyé et al., 2009). It has 32 items that relate to subclinical manifestations of symptoms of schizophrenia, described in the first person ("I … ", "my … ", etc) that are endorsed using a five-point ordinal response scale ("strongly disagree" – "neutral" – "strongly agree"). Separate scores were calculated for four higher-order schizotypy traits – cognitive-perceptual, interpersonal, disorganised, and social anxiety. These were computed by summing scores for the items loading on each factor according to Davidson et al.'s (2016) four-factor solution. High scores on each trait indicate more severe schizotypy; lower scores correspond to less severe schizotypy. Each of the traits were found to have good-to-excellent internal consistency in the current sample – Cognitive Perceptual: $\alpha = .90$; Interpersonal: $\alpha = .83$; Disorganised: $\alpha = .84$; Social Anxiety: $\alpha = .92$. Total SPQ-BRU scores were not employed because a single-factor was found to provide inadequate fit for the pattern of covariance among item responses for this instrument (Davidson et al., 2016).

Visual perspective-taking (VPT) task

Samson et al.'s original VPT task (2010, Experiment 1) was closely replicated but adapted for online administration. Original stimuli were employed, depicting female avatars[1] facing either to the left or right, centred within a simple virtual room. Discs were presented on walls behind and/or in front of the avatar, so that in half the trials the participant could see the same number of discs as the avatar ("consistent" condition), and in the remainder the participant could see a different number of discs ("inconsistent" condition). Each trial commenced with the presentation of a fixation cross, followed by a perspective prompt (YOU/SHE), then by a digit (0–3), and finally by the avatar and a variable number of discs (0–3). These stimuli were presented for 750 ms with an

interstimulus interval of 500 ms, apart from the final stimulus which was presented until a response was detected, up to a maximum of 2000ms. Participants responded "Yes" (J key) or "No" (K key) based on whether the number of discs from the cued perspective corresponded to the digit.

After a short practice block with feedback (26 trials), 208 experimental trials were administered without feedback across four blocks in a pseudorandom order. These were of the standard composition – 24 of each combination of Consistency x Perspective x Match / No-Match, plus 16 "filler" trials in which no dots were presented (included, for balance, so that there would be instances when "Yes" was the correct response during self-perspective trials when the digit presented was "0").

Both speed and accuracy of responding were measured; participants were asked to respond "as quickly as possible without sacrificing accuracy". Accuracy was assessed by determining the percentage of trials in which an error was made judging whether the digit corresponded to the number of discs seen from the cued perspective. This measure was used to check for any speed/accuracy artefacts, and to exclude participants not paying adequate attention to the task. Speed of responding was assessed by measuring the response time (RT) between the final stimulus in the sequence (depicting the room with the avatar and discs) and the participant's key press response. Of particular interest were RTs during "self-perspective" trials (perspective cue: "YOU") because these allow an assessment of whether the other's perspective influences performance spontaneously, even when not technically relevant to the task. An altercentric intrusion is indicated by an elevation of RT during self-perspective trials when the number of discs seen by avatar and participant are inconsistent, compared to when these quantities are consistent.

Procedure

With institutional ethics approval (ETH1920-2073), testing took place remotely online using participants' own computers and the Testable platform (www.testable.org; Rezlescu et al., 2020). After providing informed consent, participants answered demographic questions (age, gender, education, location). The SPQ-BRU was then presented as a "personality questionnaire", followed by the VPT task.

Results

VPT task: online replication

Across the 126 participants with usable data, there were relatively low levels of errors ($M = 6.9\%$, $SD = 6.7\%$). Participants' mean RT for correct responses were computed for each condition. As is conventional for this task, only data for trials in which the number of dots matched the digit (i.e., where "yes" was the correct response) were used. Similarly, "filler" trials (no dots presented) were also excluded (Samson et al., 2010). RT data for one further participant were excluded because they made no correct responses during the "other-inconsistent" condition.

Figure 1 illustrates the RT data, and indicates that RTs tended to be elevated for inconsistent relative to consistent conditions for both the self and other perspectives. These

impressions were examined by a 2 × 2 repeated measures analysis of variance (ANOVA) with Perspective (self *vs*. other) and Consistency (consistent *vs*. inconsistent) as factors. This revealed statistically significant main effects of Consistency, F (1, 124) = 221.6, $p < .001$, $\eta_p^2 = .64$, and Perspective, F (1, 124) = 5.77, $p = .018$, $\eta_p^2 = .04$. The interaction between Consistency and Perspective was also statistically significant, F (1, 124) = 60.35, $p < .001$, $\eta_p^2 = .33$. These observed effect sizes were comparable in magnitude to those originally found under laboratory conditions (Samson et al., 2010, Experiment 1: Consistency, $\eta_p^2 = .75$; Perspective, $\eta_p^2 = .03$; Consistency × Perspective, $\eta_p^2 = .55$), although Mean RTs for the current study were approximately 100 ms longer for all conditions (original data estimated from Samson et al., 2010, Figure 1). Crucially, related t-tests confirmed that statistically significant consistency effects were present both for "self-perspective", $M = 51$ ms ($SD = 85$), $t(124) = 6.69$, $p < .001$, indicating altercentric intrusions, as well as "other-perspective" trials, $M = 132$ ms, ($SD = 95$), $t(124) = 15.49$, $p < .001$.

Complementary results were found for the equivalent analysis of Percentage Errors (PE), thus ruling out a speed-accuracy trade-off. ANOVA revealed a main effect of Consistency, F (1, 125) = 95.6, $p < .001$, $\eta_p^2 = .43$, indicating that responses were also less error prone for consistent, $M = 2.6\%$ ($SD = 4.1$), than inconsistent trials, $M =$ 11.2% ($SD = 11.0$). These error rates were slightly higher than those first reported by Samson et al. (2010; Consistent, 1%; Inconsistent, 7.3%), but the effect size was comparable in magnitude ($\eta_p^2 = .59$). In line with previous findings, neither the main effect of Perspective, F (1, 125) = 1.95, $p = .165$, $\eta_p^2 = .02$, nor the interaction were statistically significant, F (1, 125) = 2.93, $p = .090$, $\eta_p^2 = .02$.

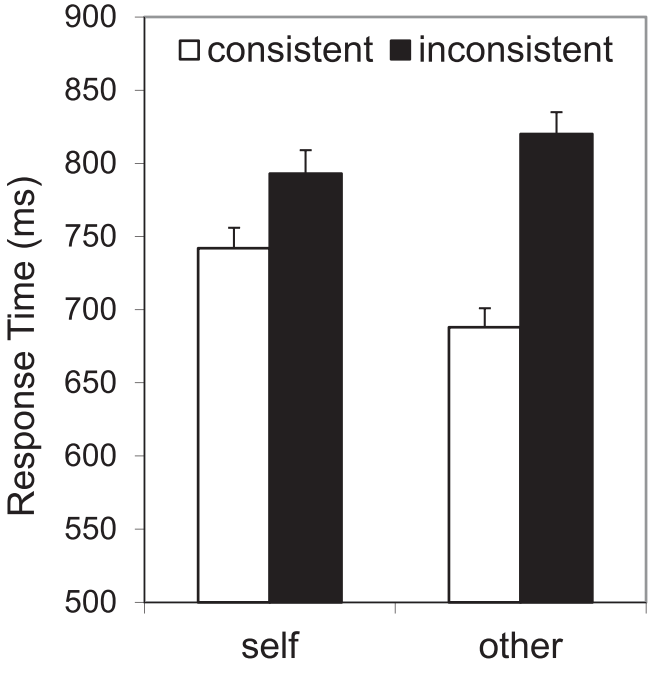

Figure 1. Mean response times in an online VPT task as a function of perspective taken, and whether the dots visible to the avatar and participant were consistent. Error bars indicate 1 SEM.

Altercentric intrusions and schizotypy

Following Nielsen et al. (2015), an altercentric intrusion index was computed from participants' "self-perspective" responses by subtracting RT for consistent trials from RT for inconsistent trials. This index thus indicates the degree that each participant's response times were elevated when an avatar could see a different number of dots; the greater the difference between RTs for inconsistent trials and RTs for consistent trials, the greater the altercentric intrusion. Data for 4 further participants were omitted due to partial SBQ-BRU data, resulting in $N = 122$.

Table 1 presents descriptive statistics and zero order correlations for the altercentric intrusion index and four higher-order factors measuring schizotypy traits. This indicates that although they positively relate to each other, none of the schizotypy traits correlated with altercentric intrusion scores. The distribution of scores for the four schizotypy traits was comparable to published norms (see Appendix C).

When altercentric intrusion index was regressed on the four schizotypy traits using multiple linear regression, the model only accounted for 2% of the variance (adjusted $R^2 = .02$), and was not statistically significant, $F(4, 117) = 1.53$, $p = .199$. All VIFs were less than 1.6 indicating that multicollinearity was not an issue. The regression coefficients for these predictor variables presented in Table 2 indicates some evidence for a positive relationship with the cognitive-perceptual trait, but this was the only trait uniquely associated with altercentric intrusions.[2] An unplanned analysis explored this further by restricting the cognitive-perceptual items to those previously considered relevant to self-other distinction (Simonsen et al., 2020; see Appendix A), and found no correlation, $r = .11$, $N = 125$, $p = .210$. When the same regression was repeated, as planned, controlling for age, gender and education, neither the schizotypal traits nor the background variables were found to predict altercentric intrusions (See Appendix B). In particular, the cognitive-perceptual trait was no longer uniquely associated with altercentric intrusions, $\beta = 0.23$, $p = .057$.

Table 1. Means, standard deviations, and zero-order correlations for the altercentric intrusion index, and four higher-order factors measuring schizotypy traits ($N = 122$).

			Zero order correlations				
	Mean	SD	1	2	3	4	5
1. Altercentric intrusion index (ms)	52.2	85.5	–				
2. Cognitive-perceptual	34.1	10.7	.15	–			
3. Interpersonal	16.9	5.3	−.07	.35***	–		
4. Disorganised	23.7	6.2	−.01	.55***	.29**	–	
5. Social anxiety	12.9	4.6	.06	.38***	.50***	.31***	–

*$p < .05$, **$p < .01$, ***$p < .001$.

Table 2. The unstandardised and standardised regression coefficients for the four higher-order factors measuring schizotypy traits.

	B	SE *B*	*β*	*p*
Cognitive-perceptual	1.85	0.90	0.23	.042
Interpersonal	−2.50	1.71	−0.16	.147
Disorganised	−1.54	1.50	−0.11	.305
Social anxiety	1.50	2.02	0.08	.457

Discussion

This study examined accounts for impaired implicit mentalising, by assessing relationships between schizotypy and spontaneous perspective taking in an online visual perspective-taking (VPT) task. Participants responded from their own perspective more slowly and made more errors when an avatar had a conflicting perspective. These altercentric intrusions demonstrate spontaneous perspective-taking, replicating results of laboratory-based studies (e.g., Furlanetto et al., 2016; Nielsen et al., 2015; Samson et al., 2010; Surtees et al., 2016). However, planned and exploratory analyses found little evidence that variation in altercentric intrusions related to schizotypy traits.

To our knowledge, the current study provides the first demonstration of spontaneous perspective-taking via an online administration of the VPT task. Online performance was more variable, with longer RTs and slightly higher error rates than the original experiment (Samson et al., 2010, Experiment 1). This may have been due to remote administration (e.g., no opportunity to clarify the task), or differences in sample demographics (e.g., older participants), or testing platform (Testable vs. DMDX). However, crucially, all effect sizes were comparable in magnitude; the only substantive difference (an additional main effect of perspective) is most likely due to our relatively large sample size (*N*s 125 vs. 16), providing greater statistical power. An elevation of RTs without reducing effect sizes appears to be a general feature of online testing (Semmelmann & Weigelt, 2017). The present findings imply that the VPT task can be successfully implemented online, providing a methodological foundation for future investigations, and facilitating novel research avenues where remote testing is advantageous (e.g., cross-cultural differences, Wu & Keysar, 2007).

Our data did not provide support for the hypothesis that spontaneous perspective-taking relates to schizotypy. Although regression coefficients indicated a positive association with the cognitive-perceptual dimension, the multiple linear regression model was weak and non-significant, accounting for only 2% of variance, and this association was no longer significant when demographic variables were included in the model. Moreover, equivalent bivariate correlations were absent – both for the cognitive-perceptual dimension, and a subset of items relevant to self-other distinction (Simonsen et al., 2020). This contrasts with the relatively clear evidence for a *negative* relationship between positive schizotypy and behavioural measures of *explicit* mentalising – (Barragan et al., 2011; Pflum et al., 2013; Pickup, 2006), despite the current study being similarly powered to detect small-to-moderate effect sizes. This suggests that, in contrast to explicit mentalising, altered implicit mentalising measured by the VPT task does not extend to nonclinical manifestations of schizotypy traits. Differential outcomes are compatible with two-systems accounts of Theory of Mind (e.g., Apperly & Butterfill, 2009), because such accounts propose cognitive systems with different characteristics underlie implicit- and explicit-mentalising.

This absence of a clear relationship with schizotypy may invite re-interpretation of studies showing altered spontaneous perspective-taking in schizophrenia (Kronbichler et al., 2019; Simonsen et al., 2020). Instead of schizotypy, it may be general nonspecific features that are related to altered spontaneous perspective-taking. These include executive functioning and attention deficits that are commonly associated with schizophrenia (Fioravanti et al., 2005). In support of this re-interpretation, executive function and attention are

widely believed to contribute to perspective-taking measured by the VPT task (Bukowski et al., 2016; Capozzi & Ristic, 2020; Todd et al., 2017). Furthermore, differences in general cognitive ability accompanied differences in spontaneous perspective-taking for both studies comparing patients with schizophrenia with healthy controls (Kronbichler et al., 2019; Simonsen et al., 2020). Alternatively, impairments in spontaneous perspective-taking may only manifest with more severe psychopathology – the distribution of schizotypic traits in this nonclinical sample may not include enough individuals in the high schizotypy range to detect a relationship. So, any re-interpretation of these studies in terms of executive functioning and attention deficits can only be speculative.

As the present results suggest that general abilities may be more important for spontaneous perspective-taking than specific symptoms, it may be valuable to consider whether deficits in executive functioning and attention associated with schizophrenia (Fioravanti et al., 2005) could potentially account for the specific alterations in spontaneous perspective-taking previously reported. On the one hand, the *increase* in spontaneous perspective-taking, as reported by Simonsen et al. (2020), might be due to impaired executive function (EF) in their schizophrenia sample. When self- and other-perspective trials are mixed, as was the case in Simonsen et al.'s procedure, depleted EF leads to increased spontaneous perspective-taking in the VPT task, even in nonclinical samples (Qureshi et al., 2010). Under this account, depleted EF may impair the ability to inhibit the automatically calculated other-perspective during "inconsistent" trials, resulting in more altercentric intrusions. Consistent with this account, impairment in executive functions (Fioravanti et al., 2005; Westerhausen et al., 2011) are among the cardinal signs of schizophrenia.

On the other hand, the *reduction* in spontaneous perspective-taking, as reported by Kronbichler et al. (2019), might be due to impaired social attention. For the "uncued" variants of the task employed by Kronbichler et al. (2019), when judgments are restricted to the Self Perspective, perspective-taking is less spontaneous (Gardner et al., 2018a; O'Grady et al., 2020), and more susceptible to moderation by the intrinsic salience of the stimulus (Westra et al., 2021). Indeed, under these conditions, altercentric intrusion effects have been found to be similarly absent even for nonclinical samples presented with perspective-taking agents of lower salience, such as Lego figures (O'Grady et al., 2020), humanoid robots (Xiao et al., 2022) or people within complex natural scenes (Del Sette et al., 2022). These boundary conditions point to the critical role of attention to the avatar stimulus for perspective calculation (Bukowski et al., 2016; Capozzi & Ristic, 2020). Since it is known that individuals with schizophrenia tend to experience deficits in attention, as indicated by studies finding abnormal gaze following (Dalmaso et al., 2013), deficits in social attention are a plausible alternative explanation for an absence of spontaneous perspective-taking in an uncued task rather than a specific impairment in implicit mentalising. Thus, deficits in general abilities are a credible alternative account for decreased as well as increased tendency for spontaneous perspective-taking. While speculative, these accounts may help to reconcile the apparently contradictory differences reported for schizophrenia (Kronbichler et al., 2019; Simonsen et al., 2020).

Several limitations should be considered. First, the sample was predominately male and educated, limiting the confidence by which these results may be generalised to the population at large. Second, not all potential mediating variables were measured and controlled for such as current medications or history of intellectual disability. This includes

cognitive factors, such as executive functions or social attention, that would have provided more direct evidence pertaining to the current account. Third, the VPT task did not include an asocial control condition (e.g., an arrow in place of the avatar). Therefore, the evidence for spontaneous perspective-taking is agnostic to a debate about whether domain general processes alone can explain altercentric intrusions ("submentalising": Cole & Millett, 2019; Santiesteban et al., 2014). Nonetheless, there is now good evidence for implicit mentalising in this task (Baker et al., 2016; Furlanetto et al., 2016; Gardner et al., 2018b), particularly when self- and other- perspective trials are mixed (O'Grady et al., 2020). Contemporary views on the mentalising/submentalising debate are consequently more nuanced, acknowledging a role for both (Capozzi & Ristic, 2020; Westra et al., 2021).

In conclusion, the current study provides evidence of spontaneous perspective-taking via a novel online administration of the VPT task and indicates that this does not relate to schizotypy. This evidence has two main implications. First, unlike explicit mentalising, this form of implicit mentalising does not appear to be influenced by nonclinical manifestations of schizotypy traits. Second, effect sizes for online administration of this test are comparable to laboratory studies providing a sound methodological foundation for future investigations. A recommended avenue for future research is to evaluate the hypothesis that executive functioning and attention deficits account for the various alterations in spontaneous perspective-taking reported in schizophrenia (Kronbichler et al., 2019; Simonsen et al., 2020).

Notes

1. Samson et al. (2010) originally employed male as well as female avatars, in order that stimuli were congruent to the gender of the participant. However, gender congruency has not found to be necessary (D. Samson, personal communication, April 22, 2014). Here, their female avatars were used throughout to reduce extraneous variables.
2. This relationship was also examined by comparing subgroups scoring high and low on the cognitive-perceptual trait. When RTs were analysed with a 2-way mixed ANOVA (Consistency x Subgroup), where subgroups comprised those above the 75th centile and those below the 25th centile, the interaction that would corroborate an association was non-significant, $F\ (1, 58) = 1.02$, $p = .318$, $\eta_p{}^2 = .02$.
3. Unexpectedly, we found a large number of responses with much lower number of years of education than would be anticipated (e.g., 14 participants responded < 5 years). We suspect that the question "How many years of formal education have you completed?" was misinterpreted by some as number of years university education. So, in a deviation from the pre-registered plan, we used the ordinal "What is the highest level of education you have completed" instead of years of education. Also, one additional participant was excluded from the model, who responded "other" to the gender question.

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Data availability statement

The data that support the findings of this study are available from the corresponding author, MG, upon reasonable request.

Notes on contributors

Mark R. Gardner is an experimental psychologist interested in normal and abnormal cognition. His current research focuses on the mechanisms of visual perspective-taking, while completed projects include reasoning biases in individuals with delusions.

Tom Buchanan, a professor of psychology, has been doing research at the interface of psychology and the internet since the late 1990s. Much of his work has focused on the validity of online research techniques, and current research activities include examining the role of schizotypy as a predictor of interaction with 'fake news' in social media.

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Appendices

Appendix A. "Relevant items" subscale

Simonsen et al. (2020) created a "relevant psychotic symptoms" subscale from the SAPS (Scale for Assessment of Positive Symptoms) by aggregating scores for positive symptoms typically linked to self-other distinction. These comprised the following symptoms: "auditory hallucinations, voices commenting, voices conversing, persecutory delusions, ideas and delusions of reference, delusions of being controlled, delusions of mind reading, thought broadcasting, thought insertion and thought withdrawal" (p. 3).

Table A1. SPQ-BRU items summed to form a relevant items subscale.

Item#	Higher-order	Sub-factor	Text
1	CP	IR	I sometimes feel that people are talking about me.
2	CP	IR	I sometimes feel that other people are watching me.
3	CP	IR	When shopping, I get the feeling that other people are taking notice of me.
4	CP	SU	I often feel that others have it in for me.
21	CP	MT	I believe in telepathy (mind-reading).
24	CP	MT	I have felt that I was communicating with another person telepathically (by mind-reading).
29	CP	UP	I often hear a voice speaking my thoughts aloud.
31	CP	UP	My thoughts are sometimes so strong that I can almost hear them.

CP: Cognitive Perceptual; IR: Ideas of Reference; SU: Suspiciousness; MT: Magical Thinking; UP: Unusual Perceptions.

Table A1 indicates the eight items from the cognitive-perceptual factor of the SPQ-BRU corresponding to these symptoms that were summed to form a "relevant items" subscale. A score for one participant was omitted due to partial responding (one relevant item missing), resulting in $N = 125$. Descriptive statistics for the relevant items subscale are $M = 20.46$, $SD = 6.63$.

Appendix B. Hierarchical regression, controlling for age, gender and education

To examine whether any of the schizotypy traits predicted altercentric intrusion index when demographic variables were controlled for, a hierarchical multiple regression was carried out. Age, gender and educational level[3] were entered in Step 1, and four higher-order factors measuring schizotypy traits were entered at Step 2.

Neither model, nor the change in variance accounted for, was statistically significant. In Step 1, a "demographic" model accounted for none of the variance in altercentric intrusions (adjusted $R^2 = -.01$), and was not statistically significant, $F(3, 116) = 0.47$, $p = .704$. In Step 2, introducing the schizotypy traits did not increase the amount of variance explained (R^2 change $= -.04$, $F(4, 112) = 1.31$, $p = .272$). Indeed, this model still does not account for any of the variance in altercentric intrusions (adjusted $R^2 = -.003$), and so was not statistically significant, $F(7, 112) = 0.95$, $p = .471$. In particular, the cognitive-perceptual trait was no longer uniquely associated with altercentric intrusions when the demographic variables were controlled for, $\beta = 0.23$, $p = .057$.

Appendix C. Comparison of distribution of schizotypy traits with published norms

Table C1. Descriptive statistics for the four higher-order factors measuring schizotypy traits by gender for the present study, and published norms (retrieved from Davidson et al., 2016, Table S17).

	Current study				Published norms			
	CP	IP	SA	DO	CP	IP	SA	DO
Female								
Range	14–60	6–26	4–20	8–35	14–55	6–28	4–20	8–40
Mean	33.00	17.29	14.06	23.03	30.91	13.64	11.59	23.64
SD	11.28	5.71	4.11	6.40	7.51	4.78	3.90	6.23
Skew	0.07	−0.39	−0.84	−0.58	0.27	0.50	0.05	−0.20
Kurtosis	−0.51	−0.65	0.63	−0.01	−0.18	−0.12	−0.59	−0.39
Male								
Range	15–57	7–30	4–20	9–36	14–56	6–30	4–20	8–39
Mean	34.37	16.72	12.53	23.91	30.26	14.66	11.90	22.88
SD	10.48	5.25	4.58	6.22	7.74	4.94	4.05	6.17
Skew	0.15	0.34	−0.15	−0.45	0.26	0.40	0.05	0.04
Kurtosis	−0.58	−0.32	−0.97	−0.25	−0.23	−0.30	−0.50	−0.39

Note: CP: Cognitive Perceptual; IP: Interpersonal SA: Social Anxiety; DO: Disorganised.

Table C1 compares descriptive statistics for the four schizotypy traits for the present study to published norms (Davidson et al., 2016). These data appear to indicate that the distribution of scores in the current study were broadly comparable to these norms. For three of the traits (cognitive-perceptual, interpersonal, social anxiety), scores may have been marginally more variable (indicated by SD), with slightly more of the distribution at higher end the scale (indicated by Mean, and skewness).