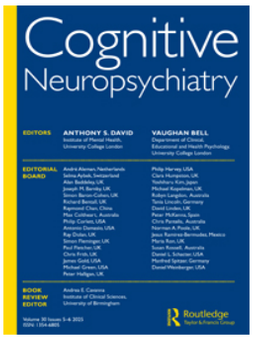

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Can the ability to infer relevance account for dimensional psychoticism? An exploration of a representative community sample

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ABSTRACT

Purpose: Psychoticism is a common feature of psychological disorders. Deficits in perceptual inference have been associated with the development of psychotic symptoms. Traditional testing of perceptual inference has had low ecological validity, limiting the ability to infer functional relationships. The aims of this study were to investigate the relationship between the capacity to infer relevance in dynamic environments and dimensional psychoticism, as well as to investigate the association between inferring relevance and dimensional psychoticism.

Method: Four hundred participants, representative of the general population of the USA, completed an online questionnaire consisting of the Brief Symptom Inventory, as well as demographic and clinical questions, followed by a computerised Inferring Relevance Task.

Results: Dimensional psychoticism was not significantly associated with inferring relevance. An ability to infer relevance also did not significantly distinguish between individuals with and without symptoms of psychoticism.

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Conclusions: The ability to infer relevance may not be a reliable marker of psychotic-like experiences in general population samples. Future research should use a clinical population to better understand the potential interactions between neurocognitive mechanisms and how this may be associated with psychoticism.

Introduction

The contemporary definition of psychoticism is a dimensional construct reflecting psychotic-like experiences in general, subclinical, and clinical populations, including perceptual anomalies and cognitive disruptions such as unusual beliefs or thought interference. This framing is distinct from Eysenck's original term of "psychoticism", which reflects traits such as impulsivity and is more closely aligned with antisociality, which is diagnostically and structurally separate from psychotic-like experiences (Lenzenweger, 2025). Psychoticism, in its clinical form, is characterised by a loss of contact with external reality (Arciniegas, 2015). Symptoms present as delusions, hallucinations, and incoherent, illogical, and disordered speech (Harvey, 1983; Strauss, 1969). Psychoticism is a core feature in psychotic disorders, including schizophrenia, schizoaffective disorder, and schizophreniform disorder (American Psychiatric Association, 2013; Arciniegas, 2015). However, psychotic-like experiences also occur beyond these clinical populations, with presentations ranging from mild interpersonal alienation to severe psychosis (Van Os et al., 2009; Verdoux & van Os, 2002). Individuals experiencing extreme and prolonged psychoticism are at higher risk of poverty, incarceration, loneliness, and reduced overall well-being (Morgan et al., 2008; Stain et al., 2012). When observed across the lifespan, experiences of subclinical psychoticism symptomology during daily life can increase in severity, resulting in the development of psychotic disorders (Dominguez et al., 2011). It is then important to identify markers of psychoticism for early diagnosis during the prodromal period (i.e., the time when the symptoms first appear; Bruggemann et al., 2013). Exploring mechanisms that contribute to the development, maintenance, and severity of psychoticism is crucial for developing effective early intervention and treatment for psychoticism (Arciniegas, 2015).

Lower-level perceptual abilities influence how individuals understand and interact with the environment (Adams et al., 2020; Aggelopoulos, 2015; LaBerge & Samuels, 2017). Difficulties in the ability to form perceptual inferences, particularly during events in which circumstances change, are linked to neurocognitive deficits (Armstrong et al., 2018; Knolle et al., 2023). Additionally, deficits in inferential processing mechanisms may play a crucial role in the aetiology of psychoticism across a continuum (Adams et al., 2013; Sterzer et al., 2018). When these processing mechanisms are disrupted, irrelevant stimuli may be misinterpreted as relevant, resulting in the onset and persistence of perceptual distortions characteristic of psychoticism, such as hallucinations and delusions (Blackwood et al., 2001; Fletcher & Frith, 2009; Friston et al., 2016). Development of psychotic disorders characterised by psychoticism is due to impaired inferential ability; however, the precise functional associations across the literature are inconsistent (Armstrong et al., 2018; Baker et al., 2019; Moustafa et al., 2016; Randeniya et al., 2018; Sterzer et al., 2018). The dominant use of traditional nosological assessment of

psychopathology in studies might influence this inconsistency (Haywood, Castle, et al., 2024a; Haywood, Henry, et al., 2024b; Kotov et al., 2021; Wong et al., 2024).

Haywood et al. (2021; 2024d) claim that a dimensional approach is required to better understand the associations between psychopathology and neurocognition. Previous literature relies heavily on traditional diagnostic systems, such as the Diagnostic and Statistical Manual (DSM; American Psychological Association, 2013) and the International Classification of Diseases (ICD; World Health Organization, 2022), which use symptoms of illness to categorise the general population as either pathological or non-pathological (Linscott & Van Os, 2013). Using these systems in clinical practice is valuable for communication, distinguishing between psychotic disorders, and treatment planning (Esterberg & Compton, 2009; Lawrie et al., 2010). However, there are well-documented limitations on the use of traditional diagnostic systems (Haywood, Kotov, et al., 2024; Potuzak et al., 2012). Haywood et al. (2021, 2022) argue that the use of traditional diagnostic systems limits understanding of the functional association between neurocognition and mental illness due to high comorbidity, poor diagnostic stability, and within-disorder symptom heterogeneity. Newman et al. (1998) demonstrated the comorbidity of DSM-defined disorders, finding that 50% of individuals who meet the criteria for a single DSM-defined disorder are likely to fulfil the criteria for a second disorder, and 50% of the subsequent group would fulfil the criteria for a third disorder. This is understandable when certain disorders, such as schizophrenia and bipolar affective disorder, share genetic, environmental, neurological, and cognitive domains (Craddock & Owen, 2010; Smucny et al., 2014).

The dimensional approach views psychopathological features, like psychoticism, across a continuum within the entire population (Esterberg & Compton, 2009; Kotov et al., 2021). Using a dimensional approach to study psychoticism could be useful in identifying less extreme symptom levels common in the population, given that a dimensional approach measures psychoticism symptoms across a continuum (Linscott & Van Os, 2013). This may mitigate issues of comorbidity and diagnostic stability found in the traditional nosological approach (Kotov et al., 2021; Peralta et al., 2012; Ringwald et al., 2021). These limitations highlight the need for dimensional approaches to better capture symptom variability and neurocognitive associations.

Recent studies using a dimensional approach report that psychotic experiences in the community are associated with poorer inference ability (Dzafic et al., 2020; Oestreich et al., 2019; Stuke et al., 2017). However, there remains a lack of literature exploring whether inferring relevance can distinguish between those with some level of psychoticism and those without. Research on how inferring relevance impacts the severity of psychoticism may help inform approaches that better mitigate symptom development (Hedman et al., 2015). As far as we know, no study has used a dimensional approach to explore the association between psychoticism and inferring relevance.

A novel experimental paradigm developed by Wilson and Niv (2012) seeks to better simulate real-world scenarios by incorporating complex, dynamic, and uncertain elements that more closely mirror the intricacies of everyday life. More specifically, the task aims to align with the real-world environment in that not all actions lead to an expected outcome, and that even actions that are judged to be correct may occasionally be met with negative responses. The task, therefore, incorporates unfamiliar task dimensions and an irregular reward system (Wilson & Niv, 2012). If employed in psychoticism,

this experimental paradigm may provide valuable insights into how individuals with varying levels of psychosis infer relevance and respond to complex and uncertain situations. Coupled with the dimensional approach, using the novel experimental paradigm to study psychoticism across a spectrum of presentations may assist in the comprehension of individuals' susceptibility to psychiatric disorders that present symptoms of psychoticism.

The current study aimed to examine whether the ability to infer relevance was associated with dimensional psychoticism. It was hypothesised that after controlling for demographic variables such as age and gender, a higher capacity to infer relevance would be significantly negatively associated with dimensional psychoticism (H1) among individuals exhibiting some level of symptomology. A further aim of the study was to examine the relationship between the capacity to infer relevance in dynamic environments and the presence or absence of psychotic symptoms. After controlling for demographic variables, it was hypothesised that individuals' capacity to infer relevance would significantly differentiate those with from those without psychoticism symptoms (H2).

Method

Participants

A pre-existing data set was used in this study (see Haywood et al., 2022). A sample of 425 USA-based participants (above 18 years) was recruited through Prolific – a valid and reliable online platform where researchers recruit participants in exchange for remuneration (Haywood et al., 2025). Using census data on age, gender, and ethnicity, Prolific ensured the sample of participants recruited was representative of the USA population. Participants with visual impairments and abnormal motor functioning were excluded from the dataset. This study received approval from Curtin University Human Research Ethics Committee (HRE2021-0105).

Measures

The Brief Symptom Inventory Index (BSI, Derogatis & Melisaratos, 1983) measures psychopathological symptoms across nine symptom dimensions. The BSI is considered reliable for use in community and clinical samples (Akhavan Abiri & Shairi, 2020). Each item uses a 5-point Likert scale (0 – "not at all" to 4 – "extremely likely") that assesses symptoms based on the level of distress they cause an individual over seven days. One of the nine symptom dimensions is psychoticism. The psychoticism subscale contains five items, an example being: "The idea that someone can control your thoughts." The psychoticism score was calculated by dividing the total sum of the psychoticism subscale items by 5, which resulted in a score between 0–4. The BSI psychoticism subscale demonstrated good internal consistency (Cronbach's Alpha = .787) in this sample.

Inferring relevance was measured using an Inferring Relevance Task (Wilson & Niv, 2012). Using a computer, participants were presented with three stimuli with three different dimensions. Participants were informed that only one of the three dimensions (colour, shape, pattern) was relevant to determine the probability of winning a point and

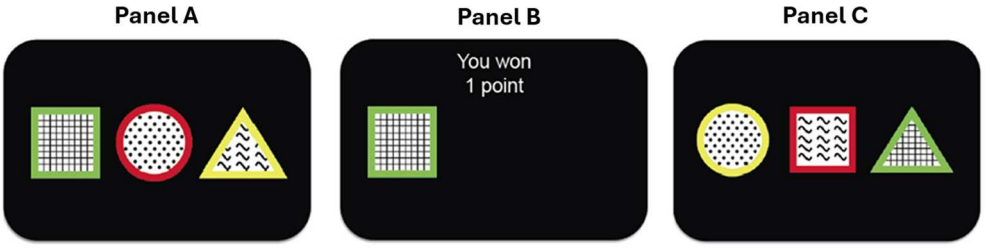

Figure 1. Depiction of a trial of the inferring relevance task. Note. Adapted from Wilson and Niv (2012). (A) The participant is shown three stimuli, each varying across three feature dimensions – shape, colour, and texture. (B) The participant selects one of the stimuli and then receives binary feedback, earning either one point (as illustrated) or zero. (C) After a brief interval, the next trial begins, presenting the participant with a new set of three stimuli to choose from.

that a singular feature in the relevant dimension would result in rewards more often. After selecting one of the three on-screen stimuli, participants were provided on-screen feedback – receiving 1 point for a "win" and 0 points for a "loss". The next trial would then run, presenting a new set of three stimuli. The relevant dimension changed after 15–25 consecutive trials. Irrelevant feedback, whereby even when participants provided did the task correctly, they were provided with "incorrect" feedback and vice versa, was provided in 25% of trials to interfere with participant certainty in their response. This interference allowed examination of participants' ability to infer feedback as "relevant." The task is depicted in Figure 1. The primary outcome utilised the Rate Corrected Scoring method (RCS; Vandierendonck, 2017). This is a highly common approach to utilising both speed and accuracy in behavioural tasks to provide a single score of performance. RCS uses the total number of correct responses divided by the total reaction time. Thus, the primary outcome measure was a participant's number of correct responses obtained across 200 trials divided by their reaction time.

Procedure

Participants accessed the study online through Prolific. Participants were provided with study information and consent forms. After providing informed consent, participants were instructed to complete questionnaires in a quiet environment that was free of distraction. Participants undertook demographics and clinical information questionnaires, the BSI, and the Inferring Relevance Task. Data collection was conducted online, which precluded control over the participants' test environments. Whereas, there are potential drawbacks to online administration, research by Johnson et al. (2022) has shown that the validity of crowd-sourced neurocognitive data is comparable to that collected in laboratory settings. Following completion, participants were provided information regarding support resources they could access if they had experienced distress from participating in the study.

Analyses

Data analysis was conducted through SPSS V24. To test H1, a bivariate correlation analysis was completed to examine the relationships between psychoticism, the ability to infer

relevance, age, and gender. A hierarchical multiple regression analysis was then used to assess the predictive utility of the ability to infer relevance on psychoticism while controlling for covariates. As the general population often record low levels of psychoticism (Johns & Van Os, 2001), participants who scored 0 on the BSI Psychoticism subscale were not included in this analysis as it was specifically testing the utility of the ability to infer relevance on psychoticism symptom severity within those who present with some level of symptomology.

To test H2, first an independent sample *t*-test was completed to assess whether there were any significant age differences between the group without psychoticism symptoms and the comparison group. A Pearson's chi-square test was then conducted to identify whether there were gender differences in the presence or absence of psychoticism symptoms. A binary logistic regression analysis was then used to explore the predictive utility of the ability to refer relevance concerning the presence/absence of levels of psychoticism. Finally, a sensitivity analysis was performed to calculate the post-hoc achieved power for the regression models based on the observed effect sizes using G*Power V3 (Faul et al., 2009).

Results

Descriptive statistics

A summary of clinical statistics for the overall sample is provided in Table 1. The overall sample consisted of 194 men and 206 women. Participants' ages ranged from 18 to 83 (M = 44.47, SD = 16.35), and 250 participants (62.5%).

The correlations among all target variables, used to identify potential confounding variables, are presented in Table 2. Age had a significant association with psychoticism and inferring relevance and thus, it was identified as a potential confounding variable and controlled for in the subsequent analysis.

Table 1. Participant characteristics.

Variable		Total (SD)/%
Has clinical diagnosis	Yes	114 (28.5)
	No	286 (71.5)
Disorder Diagnosed	Depression	66 (16.5)
	Generalised anxiety	57 (14.2)
	Post-traumatic stress	19 (4.8)
	Bipolar	17 (4.3)
	Social anxiety	7 (1.8)
	Panic	4 (1.0)
	Substance use	3 (0.8)
	Obsessive-compulsive	3 (0.8)
	Borderline personality	3 (0.8)
	Agoraphobia	2 (0.5)
	Psychosis	2 (0.5)
	Schizoaffective	1 (0.3)
	Eating disorder	1 (0.3)
	Cyclothymia	1 (0.3)
	Impulse control	1(0.3)
	Trichotillomania	1 (0.3)
Psychotropic medication use	Yes	60 (15.0)
	No	340 (85.0)

Note. Table 1 illustrates the total participant number and standard deviation (SD) for each clinical characteristic; N = 400. The percentage count of diagnoses is greater than the total sample due to comorbid diagnoses.

Table 2. Bivariate correlations identifying confounding variables.

	Age	Gender	Psychoticism	Inferring relevance
Age	1	−.020	−.330*	−.278*
Gender	−.020	1	.097	.113
Psychoticism	−.330*	.097	1	.085
Inferring relevance	−.278*	.113	.085	1

Note. *$p < 0.01$. Table 2 illustrates the correlation coefficients between the variables of age, gender, psychoticism, and inferring relevance.

The *t*-test used to identify covariates was statistically significant, with the asymptomatic group ($M = 52.06$, SD = 15.19) being 12.01 years older, 95% CI [8.99, 15.21], than the symptomatic group ($M = 39.96$, SD = 15.34), $t(398) = 7.654$, $p < .001$, two-tailed, d = 15.29. Our chi-square test was not statistically significant, χ^2 (1, $N = 400$) = 1.94, $p = .163$, indicating that the presence of symptoms was not reported more by men than women.

Hypothesis one

In the first step of the hierarchical multiple regression analysis, age was included to account for its variance. Age accounted for a significant 8.4% of the variability in psychoticism, $R^2 = .08$, $F(1, 249) = 22.80$, $p < .001$. In the second step, the ability to infer relevance was added to the regression equation, but did not account for any additional variance in psychoticism, $R^2 = .00$, $\Delta F(1, 248) = .01$, $p = .908$. By Cohen's (1988) conventions, a combined effect of this magnitude can be considered "small". Thus, while age played a significant role, H1 was not supported as the ability to infer relevance did not significantly contribute to explaining the presence or absence of psychoticism in individuals.

Unstandardised (B) and standardised (β) regression coefficients and squared semi-partial correlations for each predictor in the regression model are reported in Table 3. The results show that for every one-unit increase in the ability to infer relevance, psychoticism was expected to increase by 0.018 units while controlling for age. The ability to infer relevance had a non-significant positive association with psychoticism. The only variable with significant predictive variance was age. The very high power (0.992) indicates sufficient sensitivity to detect small effect sizes in this analysis, suggesting that the non-significant findings are unlikely to be due to inadequate sample size or low statistical power.

Hypothesis two

The omnibus model for the logistic regression analysis was statistically significant; see Table 4, χ^2 (df = *2, N = 400)* = 53.40, $p < .001$. Cox and Snell $R^2 = .13$, Nagelkerke R^2

Table 3. Hierarchical multiple regression accounts for psychoticism from the ability to infer relevance, in addition to age.

	Variable	B [95% CI]	β	Sr^2
Step 1	Age	−0.015[−0.02, − 0.01]**	−0.29	.084
Step 2	Age	−0.014[−0.02, −0.01]**	−0.29	.076
	Inferring Relevance	0.018[−0.30, 0.33]	−0.01	.000

Note. *$p < .05$. ** $p < .001$. Table 3 illustrates the Unstandardised (B) and Standardised (β) regression coefficients and squared semi-partial correlations (sr^2) for inferring relevance in predicting psychoticism.

Table 4. Predictor coefficients for the model predicting psychoticism presence.

Variable	*B*	*b*	*SE (B)*	*p*	*Exp* (B) [95% CI]	*Exp* (b) [95% CI]
Constant	2.90	0.60				
Age	−0.05	−0.82	0.01	<.001	0.95 [0.94, 0.97]	0.44 [0.94, 0.97]
IR	−0.03	−0.10	0.12	.807	0.91 [0.42, 1.98]	0.97 [0.77, 1.23]

Note. Table 4 illustrates the predictor coefficients for inferring relevance in predicting the group members of presence of psychoticism; IR = Inferring relevance.

= .17. The model was 69% accurate in its predictions of the presence or absence of psychoticism symptoms. Hosmer and Lemeshow's test results confirmed that the model was a good fit for the data χ^2 (df = 8, N = 400) = 6.68, p = .572.

As indicated in Table 4, age was the only variable that significantly improved the predictive compatibility of the model ($p < .001$). This indicates that the ability to infer relevance could not significantly predict group membership over and above age. Thus, the second hypothesis was not supported. Nonetheless, a non-significant negative relationship was observed between inferring relevance and psychoticism. For every 1 standard deviation increase in the ability to infer relevance, there was a 2.8% decrease in the likelihood that participants presented with symptoms of psychoticism. However, the logistic regression models may have been less sensitive to detecting small effect sizes of inferring relevance (power = 0.141).

Discussion

The association between inferring relevance in a dynamically changing external environment and dimensional psychoticism was assessed, with no significant association detected. This suggests the cognitive ability to infer the relevance of stimuli in a dynamic and unpredictable environment does not influence levels of psychoticism within the general population. This finding was unexpected, as previous literature had found that a reduced inferential ability was associated with more psychotic-like experiences and reduced inferential ability (Dzafic et al., 2020; Oestreich et al., 2019). Stuke et al. (2017) reported a significant association between poor perceptual inference and psychotic experiences in healthy individuals. In contrast to our study, Stuke et al.'s (2017) task, which measured perceptual inference, lacked randomness and had fixed task probabilities in each trial.

While the present results were unexpected, they fit within a pattern in the existing literature. Specifically, when addressing the relationship between perceptual inference ability and psychotic experiences across a continuum in the community, non-random perceptual inference tasks record significant results, while tasks introducing uncertainty do not. This aligns with recent studies in the field of machine learning, which observed that responses to highly predictable stimuli were better indicators of subclinical psychotic-like experiences compared to unpredictable stimuli in volatile conditions (Adams et al., 2013; Taylor et al., 2021). This trend is also observed in individuals with schizophrenia (Sterzer et al., 2018). It is essential to emphasise that our study provides preliminary findings only. Future research is needed to confirm if the uncertainty designed within the inferring relevance task contributed to our findings.

The lack of a relationship between inferring relevance and psychoticism may have been due to the form of stimuli participants responded to during the inferring relevance

task. Recent research demonstrates that difficulties making inferences are related to increased psychotic-like experiences in non-clinical samples (Dzafic et al., 2020; Oestreich et al., 2019), which is inconsistent with our findings. However, past studies that observed difficulties making inferences had tested participants on their ability to infer the relevance of auditory stimuli (Dzafic et al., 2020; Oestreich et al., 2019), whereas this study tested participants on their ability to infer the relevance of external visual stimuli. The difference in these findings suggests that auditory and visual stimuli processing mechanisms may have distinct influences on the manifestation of psychotic experiences. This confirms previous findings where auditory cues were found to dominate over visual cues in changing, multimodal environments (Pálffy et al., 2021). Clinically, this null finding may suggest that inference-making deficits associated with psychoticism may be modality-specific, indicating that disruptions in auditory predictive processing, rather than general inferential impairments, are more strongly implicated in psychotic-like symptoms. Future research should further explore how different stimulus dimensions, like auditory and visual cues, impact perceptual inference in the formation and severity of psychoticism in the general population.

An association between the presence of psychotic disorders and deficits in inferential processing has been reported (Armstrong et al., 2018; Knolle et al., 2023). Previous studies that found a significant relationship inferring relevance and the presence or absence of psychoticism had used a nosological approach to psychopathology, which was limited by heterogeneity and comorbidity (Caspi et al., 2014; Haywood et al., 2022). The dimensional approach of this study addressed these limitations. It is possible that the difference in methodology between nosological studies and the current dimensional approach explains the conflicting findings. Conducting additional research to validate these preliminary findings is crucial. We also found that inferring relevance could not distinguish between individuals with various degrees of psychoticism and those without. As it is known that subclinical symptoms can lead to the development of psychotic disorders over time (Dominguez et al., 2011), it would be beneficial for future research to replicate this study using a longitudinal design.

Whereas the current study did not find a significant relationship between inferring relevance and psychoticism, it addressed a gap in the literature by investigating the relationship between neurocognitive inference with psychoticism using a dimensional approach. The dimensional measure of psychoticism in a large sample of the general population helped understand the experience of psychoticism in line with contemporary conceptualisations of psychopathology. Future research should include variations of the inferring relevance task, specifically to investigate how uncertainty and volatility of the inferring relevance task influence the relationship between inferring relevance and psychoticism. Future research should also investigate how different stimuli dimensions, like auditory and touch, influence the relationship between the ability to infer relevance and dimensional psychoticism.

Limitations and directions for future research

This study has several limitations. The inferring relevance task presented simplistic dimensions of colours, shapes, and patterns to participants. The simplistic nature of these images may not have been particularly stimulating or challenging for participants.

Further, the images were not typical visual stimuli engaged with in everyday life, such as faces (Armstrong et al., 2018). The images' lack of relatability to real-world visual stimuli may have reduced the generalisability of our findings to how individuals infer relevance to everyday visual stimuli (Brady & Oliva, 2008). Future research may seek to corroborate these findings with real-world stimuli.

Another limitation was the reliance on self-reported measures of psychoticism. It is possible that there is a disconnect between how individuals self-report their experiences of psychoticism and their performance on cognitive inference tasks. For instance, some individuals may report minimal or no psychoticism symptoms despite performing poorly on a task that requires cognitive inference. Prior research has highlighted the complex interplay between subjective experiences of psychoticism and objective cognitive performance (Chun et al., 2013; Humpston et al., 2017), suggesting that future studies should consider using clinician-rated measures to supplement self-report data.

Another limitation was the use of the BSI psychoticism subscale to measure psychoticism. Whereas the measure has demonstrated acceptable internal consistency (Derogatis & Melisaratos, 1983), it has been critiqued due to a lack of granularity and discriminant validity from general distress (Akhavan Abiri & Shairi, 2020). Future research should utilise more psychometrically sound and targeted measures, such as the Peters Delusions Inventory (Peters et al., 1999).

A further limitation is the relatively low prevalence of participants in this study presenting with more severe symptoms of psychoticism. As expected, given our sample comprised individuals from the general population (Johns & Van Os, 2001), most participants exhibited zero or few symptoms. Similarly, our sample size may not provide enough power to detect a subtle relationship between variables of interest. However, having a larger sample representing participants with more severe presentations would have provided valuable insights into how inferring relevance is associated with dimensional psychoticism across different levels of symptom severity. Future dimensional studies should aim to include participants with more severe presentations of psychoticism.

Conclusion

In summary, this study found no significant association between the ability to infer relevance and dimensional psychoticism. The capacity for inference was unable to distinguish significantly between individuals with and without psychotic symptoms. This investigation used Wilson and Niv's (2012) ecological task in a community sample, which represented a novel approach. Further research is needed to explore how individuals respond differently to dynamic versus stable environments, and how this relates to psychoticism. Longitudinal studies would be particularly useful to better understand the neurocognitive mechanisms underlying inference, and the association with psychoticism. Such work may ultimately contribute to developing interventions that mitigate risk factors and enhance resilience in disorders characterised by psychoticism.

Compliance with ethical standards

This study was approved by the Curtin University Human Research Ethics Committee (HRE2021-0105). Informed consent was obtained from all participants.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability

The dataset analysed during the current study may be made available from the corresponding author upon reasonable request and satisfaction of the granting human research ethics committee.

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