



Schizotypal traits and their relationship to reading abilities in healthy adults

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ABSTRACT

Schizotypal traits (i.e., personality characteristics that range from mild eccentricities to more pronounced schizophrenia-like perceptions, thought patterns, and behaviours) have been associated with a variety of cognitive impairments, including difficulties in language processing. Although these difficulties span several aspects of language (e.g., semantic processing, verbal fluency, visual word recognition), it is unclear whether reading abilities are also affected. Thus, the current study employed the Schizotypal Personality Questionnaire (SPQ) – Brief (Raine and Benishay, 1995) to examine how schizotypal traits impact both word-level and text-level reading skills (using a battery of standardized assessments) in a sample of healthy young adults. We found some evidence that higher schizotypal traits, specifically, increased Disorganized factor scores (reflecting aberrant thinking, communication patterns, and behaviour), were associated with reduced word-level reading abilities. However, this finding did not remain significant after correcting for multiple comparisons. Overall, our study suggests that reading may be another aspect of language affected by schizotypal traits, although additional research (with greater power) is needed to further explore and confirm this finding.

1. Introduction

Schizotypy is a multidimensional construct that encompasses a spectrum of cognitive, perceptual, and behavioural/interpersonal characteristics that are related to, but generally less severe than those experienced in the schizophrenia-spectrum disorders (Kwapil and Barrantes-Vidal, 2015; Lenzenweger, 2018; Raine, 1991). That is to say, schizotypal traits reflect normal variation in personality, ranging from mild features in the general population to more severe manifestations similar to those observed in psychosis (Claridge, 1995; Claridge and Davis, 2003; Rawlings and Locarnini, 2008). Depending on the framework or model used, schizotypy comprises three to four dimensions, including a Cognitive-Perceptual Dimension (i.e., distorted or unusual thoughts and perceptions, such as odd beliefs and magical thinking); an Interpersonal Dimension (i.e., social difficulties, such as trouble forming close relationships and social anxiety); a Disorganized Dimension (i.e., disorganized thinking and behaviour, such as incoherent speech and eccentric behaviours); and, sometimes, a separate Affective Dimension (i.e., disturbances in emotional processing, such as flattened or inappropriate affect). Psychometric tools used to assess schizotypal traits

often include self-report questionnaires, such as the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) and its abbreviated version, the SPQ – Brief (Raine and Benishay, 1995); the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason and Claridge, 2006); and the Wisconsin Schizotypy Scales (WSS; Chapman et al., 1976).

Increasing evidence suggests that elevated schizotypal traits may reflect vulnerability to schizophrenia-spectrum psychopathology in the general population (Barrantes-Vidal et al., 2003; Racioppi et al., 2018; reviewed in Debbané et al., 2015), prompting investigations into potential pathophysiological overlap. Research examining molecular genetic overlap between schizotypy and schizophrenia has been limited in scope and has yielded mixed findings due to methodological differences across studies. As both schizotypy and schizophrenia are polygenic in nature, pinpointing specific genetic commonalities (especially among diverse populations) has been challenging (reviewed in Allen et al., 2008; Nelson et al., 2013). Although research in this area is still ongoing, adoption and family studies have suggested genetic overlap (e.g., Baron et al., 1985; Kendler et al., 1981, 1995, 1996). For instance, in a genome-wide study, Fanous et al. (2007) found that certain risk-genes for

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schizophrenia (e.g., *DISC1*, *NRG1*) were associated with schizotypal levels in non-affected relatives of people with schizophrenia.

Research examining shared neurobiological mechanisms between schizotypy and schizophrenia has reported similar neurofunctional and neurostructural changes (reviewed in Kirschner et al., 2022). For instance, studies have found that higher schizotypal traits (using several psychometric tools, including the SPQ, SPQ – Brief, and O-LIFE) among healthy individuals (aged 16–68) were positively associated with cortical thickness in the medial orbitofrontal/ventromedial prefrontal cortex. Further, the cortical thickness profile in those with higher schizotypal traits was positively related to cortical thickness abnormalities seen in schizophrenia (see Kirschner et al., 2022). Studies have also found that higher schizotypal traits (measured with the SPQ, and especially Cognitive-Perceptual factor scores) among healthy adults were negatively associated with white matter structure in several frontal and temporal region pathways (Nelson et al., 2011; see also Tonini et al., 2021; Zouraraki et al., 2023, for additional related findings).

Research has also reported shared neurocognitive abnormalities between schizotypy and schizophrenia. These abnormalities include similar impairments in executive functioning, such as reduced attention, inhibition, and working memory (Cadenhead and Braff, 2002; Chen et al., 1997; Cimino and Haywood, 2008; Daly et al., 2012; Glahn et al., 2003; Gooding et al., 1999; Kim et al., 2011; Louise et al., 2015; Rawlings and Goldberg, 2001; cf. Steel et al., 1996; Stelton and Ferraro, 2008; reviewed in Ettinger et al., 2015); similar impairments in visuo-oculomotor control, such as reduced antisaccade and smooth pursuit performance (reviewed in Ettinger et al., 2015; O'Driscoll and Callahan, 2008); and similar impairments in language processing, such as odd speech, impaired word association, and semantic deficits (reviewed in Kiang, 2010; Tonelli, 2014).

Although the above-mentioned neurocognitive processes (i.e., executive functioning, visuo-oculomotor control, and language) are all involved in reading, surprisingly little research has investigated the association between schizotypal traits and reading abilities, despite the importance of reading in everyday life (e.g., academic/employment performance, understanding legal and medical documents, following the news, social media, recipes, etc.). This is further surprising given growing research reporting reading impairments in schizophrenia (e.g., abnormal word- and text-level reading; abnormal eye movement reading behaviour) that are similar in nature to those observed in developmental dyslexia (Whitford et al., 2023; reviewed in Vanova et al., 2021; Whitford et al., 2018). Of the limited research that has examined schizotypal traits and reading, most studies have employed methods that lack ecological validity (e.g., tasks that require artificial decisions) or have assessed reading indirectly (i.e., reading performance was not a primary focus). Moreover, this small body of research has yielded a mixed pattern of results.

For instance, some work investigating visual word recognition via lexical decision tasks (i.e., deciding whether a word is real or not via button press) has reported negative associations. A study by Vanova et al. (2022a) found that positive schizotypal traits (measured with the O-LIFE), and specifically Unusual Experiences, accounted for 4% of the variance in lexical decision performance among 78 healthy young adults. This effect was, however, marginal. In a subsequent study by the same group, Vanova et al. (2022b) used neuroimaging (fMRI) to examine brain activation in 22 healthy young adults while performing lexical decision tasks. The authors found that higher positive schizotypal traits (measured with the O-LIFE), and specifically Unusual Experiences, related to lower cerebellum activity when recognizing words, particularly low-frequency ones (e.g., *accord*) versus nonwords (e.g., *youns*). Furthermore, a neurophysiological study by Kimble et al. (2000) found a negative relationship between schizotypal traits (measured with the Scheduled Interview for Schizotypy; SIS; Kendler et al., 1989) and semantic processing. More specifically, using a sentential event-related potential (ERP) reading task with sensible versus insensible final words in 15 first-degree relatives of individuals with schizophrenia and

15 matched controls, the authors found that higher schizotypal scores (among the control group only) related to a reduced N400 effect at electrode Cz. Studies investigating other related aspects of language processing, including semantic fluency (e.g., Daly et al., 2012) and verbal fluency (e.g., Carrigan et al., 2017; Tsakanikos and Claridge, 2005), have similarly reported negative associations between schizotypal traits (using the SPQ and O-LIFE) and language performance.

However, not all studies have reported impaired lexical (i.e., word-level) processing in those with increased schizotypal traits. A study by Tan et al. (2016) found no associations between schizotypal traits (measured with the O-LIFE) and performance on a lexical decision task (using stimuli from the Psycholinguistic Assessment of Language Processing in Aphasia; PALPA; Kay et al., 2001) nor lexical production/verbal processing (using the Controlled Oral Word Association Test; COWAT; Benton et al., 1983) in 61 young adults. Similar null results have been reported in studies investigating associations between schizotypal traits and speech processing (Weinstein et al., 2008), as well as with vocabulary/verbal IQ (Carrigan et al., 2017).

These discrepant between-study findings are potentially driven by differences in participant characteristics and sample sizes, limited variability in the data (i.e., relatively low schizotypal scores; Tan et al., 2016), and/or potentially non-linear relationships between schizotypal scores and language measures (i.e., positive associations may only emerge with more extreme schizotypal scores; see Schofield and Mohr, 2014; Tan et al., 2016).

1.1. Current study

To help elucidate the extant literature, the present work investigated relationships between schizotypal traits (measured with the SPQ – Brief), reading abilities (at both the word and text levels), and reading-related abilities (e.g., phonological processing, vocabulary) in a general population sample of young adults. The SPQ – Brief has three factors: (1) a Cognitive-Perceptual factor (suspiciousness, magical thinking, unusual perceptions); (2) an Interpersonal factor (no close friends, constricted affect, social anxiety); and (3) a Disorganized factor (odd speech, eccentric behaviour). We hypothesized that higher SPQ – Brief scores, and especially higher Disorganized factor scores (reflecting abnormal thought and language processing), would be associated with reduced reading abilities (in accordance with previous related research, such as Kimble et al., 2000; Vanova et al., 2022a, 2022b).

2. Methods

2.1. Participants

A total of 175 native and dominant English-speaking young adults, with no uncorrected visual impairments and no self-reported hearing, language, learning, neurological, or psychiatric disorders participated in the study (see Table 1). Participants were recruited from the University of New Brunswick and greater Fredericton, Canada, community. Participants were compensated with course credit or \$15/h. The study was approved by the University of New Brunswick's Research Ethics Board (#2020-150).

2.2. Materials

To assess their reading and reading-related language skills, participants completed the (1) Sight Word Efficiency and Phonemic Decoding Efficiency subtests of the Test of Word Reading Efficiency (TOWRE; Torgesen et al., 1999); (2) Word Reading and Pseudoword Decoding subtests of the Wechsler Individual Achievement Test (WIAT-II; Wechsler, 2005); (3) LexTALE vocabulary test (Lemhöfer and Broersma, 2012); and (4) Reading Rate and Reading Comprehension subtests of the Nelson-Denny Reading Test (NDRT; Brown et al., 1993). Lastly, to assess their schizotypal traits, participants completed the SPQ – Brief (see

Table 1
Participant demographic/background characteristics.

	Mean (SD)
Age (years)	23.62 (4.67)
Sex (male-to-female ratio) ¹	63:112
Education (years)	14.35 (1.93)
Parental socioeconomic status (SES) ²	2.88 (1.39)
English speaking proficiency ³	9.82 (0.56)
English reading proficiency ³	9.78 (0.67)
Handedness ⁴	76.38 (56.11)
BDS (span) ⁵	5.84 (1.50)
BDS (total score) ⁵	7.80 (2.29)

Note 1: Sex was based on self-reported assigned sex at birth.
Note 2: Parental SES was based on the Hollingshead Occupational Scale (Hollingshead, 1975): 1 (major professional) to 9 (unemployed).
Note 3: English proficiency was assessed with an adaptation of the Language Experience and Proficiency Questionnaire (LEAP-Q; Marian et al., 2007): 1 (beginner), 5 (intermediate), 10 (native-like).
Note 4: Handedness was assessed with the Edinburgh Handedness Inventory (EHI; Oldfield, 1971): -100 (left-hand dominance), 0 (no preference), +100 (right-hand dominance).
Note 5: To ensure healthy executive functioning (working memory capacity), a backwards digit span (BDS) task was administered. BDS span: 2 (lowest possible) to 8 (highest possible); BDS total score: 0 (lowest possible) to 14 (highest possible).

Table 2
Participant standardized assessment and SPQ – Brief scores.

	Mean (SD)
TOWRE Sight Word Efficiency (standard score) ¹	95.53 (12.43)
TOWRE Phonemic Decoding Efficiency (standard score) ¹	99.42 (9.41)
WIAT-II Word Reading (standard score) ²	100.65 (8.34)
WIAT-II Pseudoword Decoding (standard score) ²	95.07 (9.59)
LexTALE (% correct) ³	88.18 (9.41)
NDRT Reading Rate (scaled score) ⁴	201.02 (22.66)
NDRT Reading Comprehension (scaled score) ⁴	217.43 (20.88)
SPQ – Brief Total Score ⁵	6.92 (4.57)
SPQ – Brief Cognitive-Perceptual Factor ⁵	2.59 (2.05)
SPQ – Brief Interpersonal Factor ⁵	2.70 (2.21)
SPQ – Brief Disorganized Factor ⁵	1.63 (1.80)

Note 1: Test of Word Reading Efficiency (TOWRE; Torgesen et al., 1999). Sight Word Efficiency subtest assessed the efficiency of word reading (timed: 45 s). Phonemic Decoding Efficiency subtest assessed efficiency of reading nonsense words (timed: 45 s). Raw subtest scores were converted to standard scores ($M = 100 \pm 15$).
Note 2: Wechsler Individual Achievement Test – Second Edition (WIAT-II; Wechsler, 2005). Word Reading subtest assessed accuracy of word reading (non-timed). Pseudoword Decoding subtest assessed the accuracy of reading nonsense words (non-timed). Raw subtest scores were converted to standard scores ($M = 100 \pm 15$).
Note 3: LexTALE measured vocabulary knowledge via a non-timed lexical decision task (real words vs. nonsense words). Accuracy (% correct) was recorded.
Note 4: Nelson-Denny Reading Test (NDRT; Brown et al., 1993). Reading Comprehension subtest measured silent text reading comprehension (7 passages and 38 multiple-choice questions; timed: 20 min). Reading Rate subtest measured the number of words read within the first minute of the first passage. Raw subtest scores were converted to scaled scores ($M = 200 \pm 25$).
Note 5: Schizotypal Personality Questionnaire (SPQ) – Brief (Raine and Benishay, 1995). Participants received a total score (max = 22), as well as a score for each of the three factors: (1) Cognitive-Perceptual; (2) Interpersonal; and (3) Disorganized (max = 8).

Table 2. We opted to use the SPQ – Brief (as opposed to other measures) given its three-factor structure, high validity, and high reliability (Raine and Benishay, 1995).

2.3. Procedure

Due to COVID-19 restrictions on in-person participant testing at the

time, the study was conducted online via Microsoft Teams or Zoom. After providing oral and written informed consent, participants completed the demographic/background questionnaires (administered via Qualtrics) and executive functioning measure (BDS), followed by the standardized reading/language measures. Some of these measures (e.g., TOWRE, WIAT) were audio-recorded for scoring purposes (to ensure high inter-rater reliability between two native English-speaking scorers). Lastly, participants completed the SPQ – Brief (administered via Qualtrics). Participants completed all tasks in their native and dominant language (English). Upon study completion, participants were orally debriefed, provided with a written debriefing form, and compensated for their time.

3. Results

3.1. Principal components analysis (PCA)

Due to the large number of standardized reading/language measures, a PCA was conducted using SPSS. Bartlett’s Test of Sphericity and Kaiser-Meyer-Olkin (KMO) Test were performed to determine whether the input measures were suitable for PCA and their correlation, respectively. Bartlett’s Test of Sphericity was significant ($p < .001$) and a KMO value of 0.787 was obtained (values >0.5 indicate suitability; Dziuban and Shirkey, 1974). The PCA was conducted, and principal components with an eigenvalue >1 were kept (Kaiser, 1960). As such, two components were retained (accounting for a significant amount of overall variability: 62.70%), and varimax rotations were applied to maximize differences in loadings and improve interpretability. One component (which contained the TOWRE Sight Reading Efficiency and Phonemic Decoding Efficiency subtests, WIAT Word Reading and Pseudoword Decoding subtests, and LexTALE) reflected more bottom-up (word-level) reading, and the other component (which contained NDRT Reading Rate and Reading Comprehension subtests) reflected more top-down (text-level) reading.

3.2. Linear regression analyses

Using a median split, we divided our sample into those with relatively “high” versus “low” schizotypal traits across the three SPQ – Brief factors: (1) Cognitive-Perceptual (high >2); (2) Interpersonal (high >2); (3) Disorganized (high >1), as well as the total score (high >6). We then ran linear regression models in R (version 4.4.1; Bates et al., 2015; R Development Core Team, 2024) to examine how schizotypal traits (among our “high” trait group) related to reading/language abilities (using the word-level and text-level reading factors). We included several covariates in our models: age, assigned sex at birth (due to some research reporting greater negative schizotypal traits in males and greater positive schizotypal traits in females; Raine, 1992; Schulte Holthausen and Habel, 2018; but see Miettunen and Jääskeläinen, 2010, for no sex differences in positive schizotypal traits), education, parental SES, and BDS span. We deviation coded all categorical variables ($-0.5, +0.5$) and standardized (z -scored) all continuous variables to reduce collinearity.

We only found a significant negative relationship between the SPQ – Brief Disorganized factor and word-level reading factor ($\beta = -0.15, SE = 0.06, t = -2.66, p = .009$), where relatively higher schizotypal traits related to lower reading scores (see Table 3). This relationship, however, did not survive the Holm-Bonferroni correction for multiple comparisons (smallest corrected $\alpha = 0.006$). As such, we ultimately found no significant relationships between schizotypal traits and reading abilities (across both levels of reading).

4. Discussion

Given research reporting both cognitive and language impairments in healthy individuals with high schizotypal traits (reviewed in Ettinger

Table 3

Effect sizes (β), standard errors (SE), 95% confidence intervals (CI) – lower limits (LL) and upper limits (UL), t values, and p values for linear regression model examining the relationship between SPQ – Brief Disorganized factor and word reading factor.

	Word reading					
	β	SE	95% CI		t	p
			LL	UL		
Disorganized factor	−0.15	0.06	−0.266	−0.039	−2.66	0.009**
Age	0.05	0.12	−0.259	0.177	0.39	0.696
Sex	0.18	0.19	−0.270	0.093	1.00	0.320
Education (years)	−0.04	0.11	−0.182	−0.551	−0.38	0.707
Parental SES	−0.09	0.09	−0.052	0.282	−0.97	0.337
BDS span	0.17	0.06	0.189	0.283	2.89	0.005**

** $p < .01$.

et al., 2015; Kiang, 2010; Siddi et al., 2017; Steffens et al., 2018), we investigated whether reading and reading-related abilities are also affected. Consistent with our hypothesis, we initially found that greater Disorganized traits (which reflect aberrant communication and thought processes) related to lower word-level reading abilities. We note, however, that this finding was non-significant after correction for multiple comparisons.

Our initial finding aligns with recent work by Vanova et al. (2022a, 2022b) who also reported negative associations between schizotypal traits (albeit a different aspect of schizotypy: Unusual Experiences using the O-LIFE) and bottom-up, word-level reading (albeit using a different task that probes visual word recognition: lexical decision). We note, however, some limitations of this prior work, including relatively small sample sizes, lack of correction for multiple comparisons, and missing participant language background information (e.g., native language(s), English proficiency levels), which could have affected interpretation of the results. While some research has reported deficits in top-down processing (e.g., comprehension, context processing, semantic integration) during reading in those with higher schizotypal traits (e.g., Del Goletto et al., 2016; Kimble et al., 2000), our finding was limited to bottom-up processing, suggesting that impairments in word-level reading may not necessarily scale-up to impact more global aspects of reading, though additional research is needed. Ultimately, however, our adjusted results (after correction for multiple comparisons) yielded null effects, aligning with other language studies in this area, including those employing vocabulary/verbal IQ, speech processing, and other lexical decision tasks (e.g., Carrigan et al., 2017; Tan et al., 2016; Weinstein et al., 2008).

As such, it is possible that schizophrenia-like personality traits do not pattern with reduced reading abilities in general population samples. However, it is important to note that our sample had relatively low levels of schizotypal traits, with even those categorized in the “high” trait group showing only modest scores (min = 6; max = 19). Consequently, the limited range of our sample’s schizotypal traits may have resulted in reduced power to examine the predicted relationships (and our initial finding may have been more robust had there been more participants with higher schizotypal traits). Thus, there may be a certain threshold beyond which only individuals with more pronounced schizotypal traits exhibit reading difficulties.

Taken together, our study suggests that, ultimately, schizotypal traits are not significantly associated with diminished reading abilities in healthy young adults. While our study represents an important step in elucidating the impact of healthy schizotypy on reading skills, future research would benefit from the inclusion of larger, more diverse sample sizes (with a greater range of schizotypal traits), as well as the use of experimental measures of reading performance, which may have increased sensitivity to detect potentially subtle impacts of schizotypal traits on reading.

CRediT authorship contribution statement

Narissa Byers: Data curation, Formal analysis, Investigation, Methodology, Writing – original draft, Writing – review & editing. **Sarah MacIsaac:** Data curation, Investigation, Methodology, Formal analysis, Writing – original draft. **Kate MacGregor:** Data curation, Investigation, Methodology. **Veronica Whitford:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors have no competing interests to declare.

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