ORIGINAL ARTICLE

Comparison of the neurocognitive profiles of individuals with elevated psychotic or depressive symptoms

or following the onset of psychotic symptoms (Reichenberg et al., 2002), span multiple domains (Fusar-Poli et al., 2012) and, if left untreated, contribute to long-term disability and poorer prognosis for patients with chronic illness (Bowie et al., 2010). Individuals at clinical high risk for psychosis display impairment across neurocognitive domains that are small to moderate in magnitude, and intermediate to healthy controls and first episode samples (Giuliano et al., 2012). There is some specificity in the domains that confer risk for psychosis. For example, slower processing speed and poorer learning and memory performance are strongly predictive of illness onset (Riecher-Rössler et al., 2009; Seidman et al., 2010), and a meta-analysis found that verbal fluency and memory functioning are most sensitive in discriminating individuals at risk for psychosis from controls (Fusar-Poli et al., 2012).

Although psychosis prediction is enhanced with the inclusion of multiple clinical and demographic risk factors (ie, sensitivity in the 50%-70% range), the specificity of predictive models across studies is relatively low, with rates in the 10%-30% range (Addington et al., 2017). Indeed, over two-thirds of individuals considered at risk for psychosis who do not convert go on to develop other psychiatric conditions, most typically mood disorders (Lin et al., 2015). Full threshold major depression is the most common comorbid disorder in psychosis risk samples, with approximately 40% meeting diagnostic criteria at baseline (Fusar-Poli, Nelson, Valmaggia, Yung, & McGuire, 2014) and comparable rates (eg, 30%-50%) reported at long-term follow-up periods (Lin et al., 2015; Rutigliano et al., 2016). The low specificity for psychosis prediction models may be partly explained by the marked clinical heterogeneity within clinical high risk samples, and the stability of nonspecific symptoms and functional difficulties, irrespective of whether conversion occurs. Cognitive impairments are similarly not specific to psychosis, with evidence for mild to moderate deficits in mood disorders (Bora, Harrison, Yücel, & Pantelis, 2013). Therefore, further research is needed to examine whether factors, such as neurocognition, may be able to better differentiate at risk individuals who later convert to psychosis compared to those who later convert to other psychiatric conditions, such as mood disorders.

Neurocognitive deficits in mood disorders are qualitatively similar to but less severe than those seen in psychotic disorders (Reichenberg et al., 2009). In contrast to the stability of neurocognitive deficits in psychotic disorders, the trajectory of cognitive functioning in mood disorders appears to be less consistent (Allott, Fisher, Amminger, Goodall, & Hetrick, 2016), given that some domains (eg, attention and executive functions) show persistent impairment even during periods of remission (Rock, Roiser, Riedel, & Blackwell, 2014), whereas other domains (eg, verbal learning and memory, and processing speed) tend to vary depending on clinical status (Douglas & Porter, 2009). It is now widely accepted that difficulties in attention, verbal learning and memory, processing speed, and executive functions are evident by the early stages of both disorders, although the magnitude of impairment is more pronounced in first episode psychosis (Cohen's *d*s = −.64 to −1.20; Mesholam-Gately, Giuliano, Goff, Faraone, & Seidman, 2009) relative to first episode major depressive disorder (Cohen's *d*s = −.13 to −.59; Lee, Hermens, Porter, & Redoblado-Hodge, 2012). Nevertheless, there is limited empirical support for whether patterns of neurocognitive impairment in recent-onset samples extend to those who exhibit elevated, but subclinical symptoms for either illness. To our knowledge, only 1 study reported that individuals with non-psychotic mood disorders performed intermediate to healthy control and clinical high-risk groups on domains of working memory and executive functions (Schulze et al., 2013), yet no studies have directly compared the neurocognitive performance of individuals with elevated psychotic or depressive symptoms. Given the clinical relevance of neurocognitive deficits to emerging psychotic and mood disorders, the purpose of the present study was to examine the neurocognitive profiles of individuals who exhibit elevated psychotic symptoms (EPS) relative to those with elevated depressive symptoms and non-clinical comparisons.

2 | METHODS

2.1 | Participants

A total of 3083 consecutive referrals to a university-based assessment center (M_{age} lu(e)-486.3-97.7261255.1(universibetw264.1(90ichenluency)-23(that

(measures the ability to hold and manipulate information in short-term memory), and (4) Processing Speed (measures the ability to process information quickly and efficiently). The Full Scale Intelligence Quotient (FSIQ) is based on the combined scores of the 4 WAIS-IV indices, and provides an estimate of global intellectual functioning. Cognitive flexibility was assessed using the D-KEFS Colour-Word Interference Test (Delis, Kaplan, & Kramer, 2001), which requires respondents to inhibit an automatic response of reading the printed words of a colour and instead naming the colour of the discordant ink. Only a subset of participants (*n* = 168) had completed the D-KEFS Colour-Word Interference Test. The Trail Making Test A and B (TMT A, TMT B; Reitan &

TABLE 3 Relationships between symptom dimensions and cognitive functioning

	PAI psychotic symptoms	PAI depressive symptoms
WAIS-IV VCI	−.202**	−.008
WAIS-IV PRI	−.099	.155**
WAIS-IV WMI	−.113*	.115*
WAIS-IV PSI	−.142**	−.053
WAIS-IV FSIQ	−.192**	.071
D-KEFS	−.192**	−.013
TMT A	−.001	−.106
TMT B/A	.015	.040
COWAT	−.015	.003

Abbreviations: COWAT, Controlled Oral Word Association Test; D-KEFS, D-KEFS Colour Word Interference Test; PAI, Personality Assessment Inventory; PRI, Perceptual Reasoning Index; PSI, Processing Speed Index; TMT A, Trail Making Test A; TMT B/A, Ratio of Trail Making Test B to Trail Making Test A; VCI, Verbal Comprehension Index; WAIS-IV, Wechsler Adult Intelligence Scale—Fourth Edition; WMI, Working Memory Index. *$P < .05$; **$P < .01$.

performed significantly worse on domains of verbal comprehension, perceptual reasoning, working memory and cognitive flexibility, and demonstrated trend level difficulties on processing speed and verbal fluency. Even when EPS participants were dichotomized based on the presence (EPS + EDS) or absence (EPS − EDS) of elevated depressive symptoms, neurocognitive performance was comparable between these 2 groups, and often fell below their EDS or NCC counterparts. Interestingly, individuals with EDS displayed superior performance on WAIS-IV perceptual reasoning, and a specific weakness in psychomotor speed as measured by TMT A. In addition, elevated levels of psychotic symptoms were associated with poorer cognitive functioning, whereas elevated levels of depressive symptoms were largely unrelated to cognitive functioning, and positively correlated with domains of perceptual reasoning and working memory.

From these results, it appears that even without a formal psychiatric diagnosis, individuals with EPS experience significantly lower neurocognitive performance relative to clinical comparison (EDS) and clinical control (NCC) groups, with small to medium effect sizes reported. Nevertheless, it should be noted that mean performance for the EPS group across the WAIS-IV indices mostly fell within the Average range, which implies that many individuals with EPS, EDS, or NCC may not be experiencing qualitative differences in their neurocognitive functioning. Our results highlight that the severity, rather than pattern, of neurocognitive difficulties can provide more clinically meaningful information to help differentiate individuals with EPS from EDS, and similar findings have been previously reported. For instance, Albus et al. (1996) found that mood disorder patients *without* psychotic features displayed better neurocognitive performance than early psychosis patients, whereas mood disorder patients *with* psychotic features performed comparably to patients with early psychosis. These findings also extend to patients with chronic psychotic or mood disorders (Jeste et al., 1996), suggesting that greater neurocognitive deficits may be uniquely related to psychosis in both the early and later stages of illness.

Our findings are also consistent with other studies demonstrating relationships between EPS and neurocognitive domains, such as working memory (Martín-Santiago et al., 2016). In addition, previous research has reported slower processing speed for individuals with EPS (Riecher-Rössler et al., 2009; Seidman et al., 2010), and we found a trend-level effect on the WAIS-IV processing speed index. Interestingly, on a test of psychomotor speed (TMT A), EPS participants performed equivalently to NCC, and it was individuals with EDS that had slowed processing speed. Individuals with EDS also performed significantly better than NCC and EPS participants on perceptual reasoning. Taken together, these findings may provide some evidence for the analytical rumination theory of depression (Andrews & Thomson Jr., 2009), which suggests that depressive symptoms can slow down the decision-making process to facilitate better performance on problem solving tasks. Alternatively, other factors may be at play. Individuals with high cognitive abilities who present at a university-based assessment centre may expect to perform better and/or cope more effectively with their academic demands, and consequently report greater subjective distress in the form of EDS.

Neurocognitive impairments are predictive of conversion to psychotic disorders (Zammit et al., 2004), and are associated with poor academic (Mayes, Calhoun, Bixler, & Zimmerman, 2009) and occupational (Ree & Earles, 1992) functioning in the general population. Moreover, a longitudinal evaluation of individuals experiencing EPS over a 20-year period reported that functional difficulties persisted regardless of whether a diagnosable psychotic disorder developed (Rössler et al., 2007). From our results, it also appears that EPS individuals exhibit difficulties with neurocognitive functioning, which has been proposed as a primary reason for functional impairment in individuals with psychotic disorders (Green, 1996). Furthermore, it has been proposed that early declines in cognitive abilities may precede and actually predict the eventual onset of psychotic experiences (Kremen et al., 1998), suggesting that cognitive decline in this population represents a critical target for intervention.

Individuals, who exhibit elevated levels of psychotic symptoms, but without a diagnosable disorder, are often underserviced in traditional healthcare settings that focus on formal diagnostic criteria. Even without a formal diagnosis, interventions to enhance cognitive abilities may be important for supporting students with elevated symptoms in academic settings, since individuals with severe mental illness are significantly less likely to enter college (Kessler, Foster, Saunders, & Stang, 1995) and, once in college, report that illness-related factors are highly disruptive to their studies, and the most frequently cited reason for impaired learning and withdrawal from classes (Megivern, Pellerito, & Mowbray, 2003). An emphasis on promoting cognitive health in individuals identified with EPS may provide timely support to prevent the development of persistent functional challenges resulting from cognitive difficulties. Cognitive remediation therapy is a behavioural intervention with demonstrated efficacy for improving neurocognitive and social cognitive abilities in psychotic disorders (Wykes, Huddy, Cellard, McGurk, & Czobor, 2011), which may also be useful in a group of individuals who exhibit subclinical psychotic symptoms and observable cognitive challenges.

Adjunctive to cognitive interventions, structural accommodations may provide an environment in which individuals with EPS can achieve at a level consistent with their abilities. However, within academic settings, research suggests that students struggling with mental

illness are not receiving the specialized supports essential for successful completion of their degree requirements (Mowbray & Megivern, 1999). Our findings indicate that individuals with EPS are experiencing neurocognitive challenges that may warrant academic or workplace accommodations. Future work is needed to determine rates of accommodations provided to individuals who lack a formal psychiatric diagnosis, and if the intensity of supports is commensurate with their level of need.

Early help-seeking behaviour for attenuated psychiatric symptoms occurs through indirect pathways to care with first mental health contact, often through emergency services or family physicians (Addington, Van Mastrigt, Hutchinson, & Addington, 2002). Progressive difficulties with attention, learning and memory, and organization on academic tasks or steady declines in workplace performance are commonly reported among those in the prodromal or early stages of psychosis, and may prompt concerned individuals to seek out comprehensive psychoeducational assessments for diagnostic clarity. However, not all individuals at risk for psychosis experience neurocognitive decline. In contrast, there is evidence that cognitive performance improves for prodromal and first episode samples over time (Bora & Murray, 2013), and certain domains may improve with clinical stabilization or decline with illness progression (Jahshan, Heaton, Golshan, & Cadenhead, 2010), which highlights the variable trajectory of neurocognition in the premorbid and early stages of psychosis. Therefore, clinicians performing psychodiagnostic assessments may serve as an important point of contact prior to the manifestation of clinically significant symptoms, and could advocate for close monitoring or facilitate a more direct pathway to specialized care in emerging psychotic disorders.

The current findings should be interpreted within the context of several limitations. Our elevated symptom groups were categorized using empirically validated cut-offs on a self-report personality inventory. Future research in this area should examine EPS and EDS using validated symptom interviews to improve the validity of symptom ratings over self-report. This study was cross-sectional in nature, limiting our ability to determine whether neurocognitive changes covary with symptom presentations in the present sample. Longitudinal studies examining whether there is a causal link between the experience of elevated symptoms and poorer neurocognitive functioning may be important. The imbalanced ratio of females to males in the NCC group was not statistically accounted for in the present analyses, and future research should consider matching participants in terms of their sex to reduce this potential confound. We did not have data on several factors, including substance use and medications. Lastly, we did not have a measure of real-world functioning in this

Carrión, R. E., McLaughlin, D., Goldberg, T. E., Auther, A. M., Olsen, R. H., Olvet, D. M., ... Cornblatt, B. A. (2013). Prediction of functional out-