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CITATION

Carey, Eleanor; Gillan, Diane; Healy, Colm; Dooley, Niamh; Campbell, Donal; McGrane, Josen; et al. (2022): Early adult mental health, functional and neuropsychological outcomes of young people who have reported psychotic experiences: a 10-year longitudinal study. Royal College of Surgeons in Ireland. Journal contribution. https://hdl.handle.net/10779/rcsi.19013936.v1

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10779/rcsi.19013936.v1

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https://repository.rcsi.com/articles/journal_contribution/Early_adult_mental_health_functional_and_neuropsychological_outcomes_of_young_people_who_have_reported_psychotic_experiences_a_10-year_longitudinal_study/19013936/1

Early Adult Mental Health, Functional and Neuropsychological Outcomes of Young People who have reported Psychotic Experiences: A 10-year Longitudinal Study.

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Abstract: 250
Word Count: 4,045

Abstract

Background: Psychotic experiences (PE) are highly prevalent in childhood and are known to be associated with co-morbid mental health disorders and functional difficulties in adolescence. However, little is known about the long-term outcomes of young people who report PE.

Methods: As part of the Adolescent Brain Development (ABD) Study, 211 young people were recruited in childhood (mean age 11.7 years) and underwent detailed clinical interviews, with 25% reporting PE. A 10 year follow-up study was completed and 103 participants returned (mean age 20.9 years). SCID-5 clinical interviews and interviewer-rated assessments of functioning were conducted. A detailed neuropsychological battery was also administered. Analyses investigated group differences between those who had ever reported PE and controls in early adulthood.

Results: The PE group were at a significantly higher risk of meeting DSM-5 criteria for a current (OR=4.08, CI 1.16-14.29, *p*=.03) and lifetime psychiatric disorder (OR=3.27, CI 1.43-7.47, *p*=.005). They were also at a significantly higher risk of multi-morbid lifetime psychiatric disorders. Significantly lower scores on current social and global functioning measures were observed for the PE group. Overall, there were no differences in neuropsychological performance between groups apart from significantly lower scores on the Stroop Word Accuracy task and the Purdue Pegboard task for the PE group.

Conclusions: Our findings suggest that reports of psychotic experiences are associated with poorer mental health and functional outcomes in early adulthood, with some persisting cognitive and motor deficits. Young people who report such symptoms could be considered a target group for interventions to aid functional outcomes.

Key words: Psychotic Experiences/Early Adulthood/Mental Health Outcomes/Neuropsychology/ Functioning

Introduction

Psychotic experiences (PE) refer to sub-threshold hallucinations and delusions that occur in the absence of a psychotic disorder. PE are considered part of the extended psychosis spectrum and are reported in the general population (McGrath et al., 2015). Estimates of the prevalence of PE vary considerably across cohorts and studies (van Os et al., 2009). However, the median prevalence rate is approximately 5.3%, highlighting that the occurrence of PE in the general population is much higher than that of non-affective psychotic disorders (van Os et al., 2009). Notably, PE are most prevalent in childhood and adolescence (Kelleher et al., 2012) and co-occur with psychopathology, including common mental health disorders (Kelleher et al., 2012) and suicidality (Yates et al., 2018). Research from population based studies found that at least one non-psychotic psychiatric disorder was diagnosable in young adolescents reporting PE (Kelleher et al., 2012). This association increased with age, with rates as high as 80% found in older adolescents. Depression has been shown to be highly co-morbid with PE (Kounali et al., 2014). Armando et al. (2010) observed that depressive symptoms in a community sample of older adolescents who reported PE increased in a dose-dependent manner, where the greater the number of PE reported predicted greater depressive symptomology. Thus far, there has been a lack of research extending such findings into early adulthood, a time of transition where mental health difficulties can become more prevalent (Suvisaari et al., 2009).

PE have also been shown to have wider implications for an individual, including maladaptive coping strategies (Lin et al., 2015) and reduced global functioning (Trotta et al., 2019; Heinze et al., 2018; Kelleher et al., 2015; Armando et al., 2010). Evidence of decreased global functioning throughout adolescence in those who report PE has been exhibited (Healy et al., 2018). Trotta et al (2019) found that PE at age 12 increased the risk of life dissatisfaction, loneliness, social isolation, risky sexual behaviours and parenthood, as well as lower educational attainment at age 18 years. Many of these measures were however self-report, and to date functioning in young adults who have reported PE has not been assessed clinically. Whether functional deficits continue into early adulthood, and if so, which facets of functioning are most affected, is yet to be determined.

Impairments in cognition have been detected in individuals who are at clinical risk for psychosis, pre-dating the onset of overt positive symptoms (Bora & Murray, 2013). Individuals who report PE also display a poorer cognitive performance in particular neurocognitive domains, detectable in childhood (Kelleher et al., 2012), adolescence (Lindgren et al., 2010) and adulthood (Mollon et al., 2016). Although cognitive deficits do not present in all individuals who report PE, group differences indicate a lag in cognitive performance in those with PE particularly in working memory (Kelleher et al., 2012), visual attention (Kim et al., 2012), executive function (Martín-Santiago et al., 2016), processing speed (Niarchou et al., 2013) and fine motor skill (Carey et al., 2019). Such a lag has commonly been explained within a neurodevelopmental framework. Thus far, few studies have focused on whether such a pattern extends into early adulthood. Mollon et al. (2016) found that young adults who reported PE presented with a specific deficit in verbal knowledge. This was conceptualised by inferring that differences in profiles between psychotic experiences and psychotic disorders exist, the latter of which is associated with more global neuropsychological impairments. The data were however limited to cross-sectional comparison and therefore, only captured new onset of PE in early adulthood, despite the prevalence being much higher in childhood and adolescence.

Therefore, the aim of the present research was therefore to compare the mental health, functional and neuropsychological outcomes of a general population, non-help seeking sample of young adults with a lifetime report of PE to those of their age-equivalent peers, who had never reported PE. We also looked at these outcomes for individuals who only reported childhood PE, in order to investigate the utility of PE as an early marker for outcomes in early adulthood.

Methods

Ethical approval for the study protocols, including interviews and assessments, was granted by the Beaumont Hospital Medical Ethics Committee.

Participants

A community-based sample of young adults was recruited as part of a longitudinal cohort study entitled the Adolescent Brain Development (ABD) study. Recruitment of participants has previously been outlined (Kelleher, 2012). Briefly, 212 participants consented to take part in further testing from a larger sample of 1,131 young people aged 11-13 years who had been screened in primary schools in Leinster, Ireland in 2007. One participant was not included due to an intellectual disability, therefore 211 participants formed a baseline sample of young adolescents and were followed up over 10 years. Participants completed clinical and neuropsychological assessments at baseline (mean age 11.7 years) and were later followed up in early adulthood (mean age 20.9 years). Of note, a sub-sample of participants completed 2 further waves of participation during adolescence (mean age 15.8 years and 18.8 years respectively, as part of a neuroimaging study). For the purposes of this analysis, all of the initial 211 participants were invited back for participation in early adulthood. 103 participants took part.

Mental Health Assessment

Psychopathology was assessed at baseline in childhood, and in adolescence, using semi-structured clinical interviews. The Kiddie Schedule for Affective Disorders and Schizophrenia (K-SADS-PL) was administered by trained mental health clinicians.
PE was assessed using the psychosis subsection. At baseline during childhood, both the participant and caregiver were interviewed. Definite cases of PE in both childhood and adolescence were based on key components such as duration, type, level of distress and attribution of the event. Cases were decided upon following recruitment by consensus agreement with at least one psychiatrist. In early adulthood, participants were interviewed using the Structured Clinical Interview for DSM-5 (SCID-5), a semi-structured interview for making DSM-5 psychiatric disorder diagnoses. Only diagnoses from “core disorders” of the SCID-5 were assessed. Two interviewers were present in all cases, and diagnoses were agreed upon by both of the interviewers following each assessment. The psychosis section of the SCID-5 was used to assess PE and was supplemented with additional questions from the SOCRATES instrument, a template developed by Kelleher and Cannon (2014) to systematically assess for the presence of PE in youth populations. Interviewers were blind to information on whether the participants had previous PE. Rates of PE, as well as DSM-5 diagnoses, were consequently decided upon when recruitment had finished by consensus agreement with mental health clinicians and psychiatrists, in line with previous waves of the study. Multi-morbidity was considered meeting diagnostic criteria on more than one disorder in different categories (ie if two or more diagnoses were categorised as affective disorders, they were only counted as one). Both current (in the past month) and lifetime diagnoses were

measured. Data on the demographic information of the participants was taken during the current wave of the study, in early adulthood, with the exception of childhood psychopathology and socio-economic status (SES), which was taken at baseline. Childhood psychopathology was considered as threshold presentation of symptoms of a disorder from the K-SADS-PL. SES was measured on a 7-point scale where a lower number indicated a higher SES, 1-2 were professional/managerial roles and 3–7 included non-manual skilled, skilled manual, semi-skilled manual, unskilled manual, and unemployed respectively.

Social, Role and Global Functioning Assessment

The clinical interview included questions assessing participants' current levels of functioning. Social, role and global functioning was assessed using the Social (SF) (Cornblatt et al., 2007), Role (RF) (Niendam, Bearden, Johnson & Cannon, 2006) and Global Assessment of Functioning (GAF) scales. The Social scale assesses peer relationships, peer conflict, age appropriate intimate relationships, and involvement with family members. The Role scale assesses performance and amount of support needed in one's specific roles (ie, school/work). Scores on the Social and Role scales ranged from 1 to 10 (1 = extreme dysfunction and 10 = superior functioning) and are interviewer-rated. The GAF is scored on a 100-point scale and is divided into 10 levels, with lower scores indicating more severe impairment, and is also interviewer-rated. A descriptive vignette of each category is attached to each 1 (SF, RF) and 10-point (GAF) score to aid the interviewer's accuracy. Current functioning encompassed levels of functioning over the past month.

Neuropsychological Assessment

A comprehensive battery of neuropsychological assessments was completed by all participants. The tests encompassed measures of proxy IQ, processing speed, executive functions, working memory (verbal and non-verbal), verbal learning, visual learning, and motor skills. A combination of subtests from the MATRICS Consensus Cognitive Battery (MCCB) plus additional measures were administered.

Statistical Analyses

Analyses were conducted using SPSS software (ver. 25.0; SPSS Inc., USA). The PE group included those who had ever reported PE throughout the ABD study (n=41). Those who had never reported PE (n=62) were the comparison (control) group. Demographic information of the groups was compared using independent t-tests and a chi-square test. An attrition analysis of baseline demographic characteristics was also performed to assess if the participants who returned for follow-up differed significantly from those who did not, using T-tests and a chi-square test. Frequencies in rates of DSM-5 psychiatric disorders were calculated and group differences were investigated using logistic regressions.

Analysis of group differences on functioning scales were conducted using multivariate analysis of covariance (MANCOVA), both unadjusted and adjusted gender and current DSM-5 diagnoses. Cut-off scores of 7 on the Social and Role functioning scales and 70 on the GAF (Polanczyk et al., 2015) were set, and those that fell below cut-off were categorised as impairments in functioning. Frequencies of those below the cut-off scores were calculated for both PE and control groups, and chi-square tests were employed to investigate group differences.

Neuropsychological raw test scores were analysed also using MANCOVA, firstly unadjusted and then adjusted for gender and current DSM-5 diagnoses. Holm-Bonferroni sequential corrections were applied and a statistical significance value of $p < 0.05$ was applied. Holm-

Bonferroni sequential corrections is a multiple test procedure that sequentially rejects hypotheses, which are rejected one at a time until no further rejections can be made, on unadjusted scores. The test has a prescribed level of significance protection against Type 1 error (Holm et al., 1979).

Secondary analyses was conducted for participants who reported PE in childhood only (childhood PE group) (*n*=31*)* and controls *(n*=62*)*, to see if a similar pattern of results emerged.

Results

Attrition Analysis
No significant differences were found at baseline between those who returned for follow-up in early adulthood (*n*=103) and those who did not (*n*=108) in terms of age (t=1.26, *p*=.21), gender ($\chi(1)$=0.01, *p*=.94), PE in childhood ($\chi(1)$=2.66, *p*=.10), childhood psychiatric diagnoses ($\chi(1)$=0.44, *p*=.51) or SES (t=-1.64, *p*=.10).

Demographic Characteristics
Participants' demographic information is presented in Table 1. No significant group differences were found between the PE and control groups in terms of age (t=-1.21, *p*=.23), SES (t=1.51, *p*=.14) or proxy IQ (t=0.78, *p*=.44) as calculated using the WASI-II Vocabulary and the WASI-II Matrix Reasoning subtests. However, there was a significant group difference for gender ($\chi(1) = 8.17$, *p*= <.001).

Mental Health Outcomes
48.5% of all participants met diagnostic criteria for at least one psychiatric disorder in their lifetime. The most common DSM-5 disorders were Major Depressive Episode (34%), which included diagnoses of Major Depressive Disorder (MDD) and Persistent Depressive Disorder (PDD), Social Anxiety Disorder (12.6%) and Generalised Anxiety Disorder (8.7%). Group differences in frequencies are presented in Table 1, *Supplementary Materials*.

The PE group were at a significantly higher risk of meeting DSM-5 criteria for both a single lifetime psychiatric disorder (OR=3.27, CI 1.43-7.47, *p*=.005) and multi-morbid lifetime psychiatric disorders (OR=4.32, CI 1.63-11.42, *p*=.003). Two-thirds (66%) of those who reported PE met criteria for a psychiatric disorder at some stage of their lives by age 21 (range 19-24 years). Although low rates in general, there was also significant difference between the groups in terms of those currently meeting criteria for a DSM-5 psychiatric disorder (OR=4.08, CI 1.16-14.29, *p*=.03). See Table 1.

****Table 1****

Functional Outcomes
As presented in Table 2, the PE group had significantly lower scores on both the social (SF) (F=10.03, *p*=.002) and global functioning (GAF) (F=18.86, *p*=<.001) scales following adjustments. Mean GAF scores for the PE group fell within the category described as 'more than slight impairment in social, occupational or school functioning', while mean GAF scores for the control group fell within the category described as 'good functioning in all areas, interested and involved in a wide range of activities and socially effective'.

The PE group also showed significantly higher rates of functional impairments as defined by cut-off scores. For the PE group, 27% were below cut-off scores for social functioning and 17% were below cut-off scores for role functioning, whereas only 5% of the control group were below cut-off scores respectively. 46% of the PE group were below cut-off scores for global functioning in comparison to 16% of the control group. This corresponded to a significant difference in groups, where significantly more of the PE group were considered as poorly functioning on the social (SF), (χ(1)=10.17, *p*=.001) role (RF), (χ(1)=4.14, *p*=.042) and global (GAF) (χ(1)=11.05, *p*=.001) functioning scales.

****Table 2****

Neuropsychological Outcomes
Descriptions of each task, including their cognitive domain and administration instructions, is presented in Table 3. Of the 19 subtests of the neuropsychological battery, adjusted analysis revealed significant group differences on the Stroop Word task (total score) (F=7.03, *p*=.009) and the Purdue Pegboard (total score) (F=6.58, *p*=.012), where the PE group had significantly lower mean scores than the controls. The finding on the Pegboard task remained significant for both the non-dominant (F=6.95, *p*=.01) and dominant (F=3.99, *p*=.048) hands. None of the tests of the MCCB battery revealed any significant differences after adjustment. See Table 4 and Figure 1.

****Table 3****
****Table 4****
****Figure 1****

Secondary Analysis
The childhood PE group showed largely the same results. The childhood PE group were at a significantly higher risk of meeting DSM-5 criteria for a single lifetime psychiatric disorder (OR=2.51, CI 1.04-6.08, *p*=.04). They also showed poorer functioning, with significantly lower scores on the social (SF) (F=4.67, *p*=.03) and global (GAF) (F=7.92, *p*=.006) functioning scales following adjustments. There was also a significantly greater proportion of individuals in the childhood PE group below-cut off scores for social (χ(1) = 8.18, *p*=.004), role (χ(1) = 4.65, *p*=.03) and global (χ(1) = 7.09, *p*=.008) functioning compared to controls. Following adjustments, group differences on the neuropsychological task scores revealed significant differences on the Stroop Word task (total score) (F=9.42, *p*=.003) and the Purdue

Pegboard total score (F=7.40, *p*=.008), where the childhood PE group had lower scores. See Table 1, 2 and 3 *Supplementary Materials.*

Discussion

To our knowledge, the present research is the first to examine the mental health, functional and neuropsychological outcomes in early adulthood of young people who reported PE, the majority for which occurred in childhood and/or adolescence. Our findings suggest that young adults with a lifetime report of PE are not only at a significantly higher risk of a single psychiatric disorder, but also of multi-morbid psychiatric disorders. The most common DSM-5 criteria met by young people who reported PE was that of a lifetime major depressive episode. Furthermore, our analysis showed that PE is also associated with poorer social and global functioning outcomes in early adulthood. Significantly lower scores were observed on both the social and global functioning scales, with 46% of the PE group considered as globally poorly functioning at the time of assessment. In terms of neuropsychological performance, the PE group had significantly lower scores in the domains of visual attention and fine motor skill. When examining those who only reported PE in childhood, largely the same results were revealed when compared to controls, highlighting the utility of PE as an early risk marker for later outcomes into early adulthood.

Our research is in-line with a recent meta-analysis which suggests that PE in childhood and adolescence are associated with a 3-fold increased risk of developing any mental disorder (Healy et al., 2019). PE are considered as early transdiagnostic markers (McGorry, Hartmann, Spooner & Nelson, 2018), with even transient symptoms associated with increased risk of subsequent depressive disorders (Calkins et al., 2017). Research carried out on the Dunedin cohort found that only 15% of individuals who reported PE at age 11 were not diagnosed with a psychiatric disorder at age 38 years (Fisher et al., 2013). Results from the present research suggest that psychiatric morbidity, indeed psychiatric multi-morbidity, can be detected at an even earlier stage in early adulthood in young people who report PE. Our findings also show that PE in childhood alone is associated with adverse psychiatric and functional outcomes, replicating those of Trotta et al. (2019) who also that showed that childhood PE was associated that range of mental health problems at age 18 years in the Avon Longitudinal Study of Parents and Children (ALSPAC) study. Our findings further emulate those of a large-scale systematic study of non-clinical US youths evaluating psychosis spectrum symptoms (Calkins et al., 2014). In their study, in accordance with other population studies (Kelleher et al., 2012), higher levels of PE were reported at younger ages. The majority of the participants of the present research who reported PE did so in childhood and adolescence, with the least being reported in early adulthood, in accordance with prevalence rates in the general population (Kelleher et al., 2012). Emerging research suggests however that another peak in prevalence occurs in late adolescence (Sullivan et al., 2020). Further to this, in agreement with our results, Calkins et al. (2014) also found that being male was significantly predictive of psychosis spectrum symptoms. However, other studies have shown PE to be more common in females (Scott et al., 2008; Moriyama et al., 2019).

Our findings relating to poorer functional outcomes into adulthood for those who reported PE extend recent findings which convey that adverse functional trajectories persist to age 18 years following childhood PE (Trotta et al., 2019). A study by Brandizzi et al. (2014) found that PE, particularly perceptual abnormalities, were related to poorer social functioning in a help-seeking sample of youths. The present research demonstrates that such deterioration in

functioning is also present in non-help-seeking young people. This has been shown longitudinally throughout the ABD study both in childhood (Kelleher et al., 2015) and adolescence (Healy et al., 2018), with persistent psychotic symptoms indicative of poorest global functional outcomes. Our analysis confirms that this trend has continued into early adulthood, where those who with a lifetime report of PE are not functioning as well as their peers, particularly in aspects of social functioning. This in part may be attributable to social cognitive dysfunction, a characteristic of the psychosis spectrum. Unfortunately, impairments in overall functioning at this stage may have life-long consequences, as early adulthood is a critical period where pathways to long-term personal, interpersonal, educational and economic success are often formed (Shanahan et al., 2014).

Overall, minor neuropsychological differences were evident between groups, however a variable performance across domains for the PE group was noted. Following adjustments, two tasks revealed significantly lower scores for the PE group, the Stroop Word task which measures visual attention and response acuity, and the Purdue Pegboard Task, which measures fine motor skill and manual dexterity. Deficits in attention were identified in childhood during baseline assessments in the ABD study, where the PE group had significantly lower scores on the TMT-A task (Kelleher et al., 2012). Our results show dysfunction in attention and information processing are still evident in early adulthood. Interestingly, lower total scores were observed, however reaction time was unaffected. Trading performance accuracy for reaction time replicates previous findings in young people with PE using similar attention tasks (Calkins et al., 2014), suggesting that impairments lie in disinhibition, sustained attention and salience monitoring. Deficits in performance on the Purdue Pegboard task in participants with PE have been found consistently throughout the ABD study, during childhood (Blanchard et al., 2010), adolescence (Carey et al., 2019) and presently in early adulthood. Evidence that motor abnormalities are a stable trait marker in the psychosis spectrum is accumulating. Strik, Stegmeyer, Walther and Dierks (2017) identify 3 key brain circuits relevant to psychosis, one of which is motor circuitry. In one of the earliest studies, Cannon et al. (1999) investigated 400 children in Finland who were later diagnosed with schizophrenia in adulthood and found that, although children who later developed psychosis had performed as well as their peers in academic subjects, they had significantly worse score in sports and handicrafts abilities. Deficits particularly in fine motor functioning have been previously reported in individuals at risk for psychosis, predominantly pertaining to reduced dexterity, and velocity of hands and fingers (Gshwandtner et al., 2006). Therefore, some motor abnormalities may prove unique to the psychosis spectrum and serve a role both as observable markers and targets for intervention (Mittal & Walther, 2018). Our study highlights the need to measure both cognitive and motor abilities in tandem, as both possess specific independent effects.

Strengths of our research include the enrolment and re-recruitment of a general population cohort of young people, a proportion of which have reported PE, and clinically assessing their outcomes 10 years later following baseline clinical assessments. Further to this, our study is also the first to employ such an extensive neuropsychological assessment battery, using standardized neuropsychological measures spanning all major cognitive domains, to investigate neuropsychological performance in young adults who have reported PE. However, the limitations of the present study should also be considered. Firstly, as part of the ABD study, all 211 participants who took part at baseline in childhood were invited to take part in early adulthood, of which 49% returned. This yielded a relatively small sample size for the present research, and may have raised issues with statistical power for analyses, as well as issues surrounding the prevalence of psychiatric disorders. That said, Saiepour et al.

(2019) showed that differential loss to follow-up rarely affects estimates of associations. Our attrition analysis attempted to reconcile this, and showed that those who had returned were not demographically or clinically different from those who had not. Secondly, of those who had returned, 41 (40%) had a lifetime report of PE. This is over-representative based on global lifetime prevalence rates and we can only speculate that the high levels returning reflected potentially help-seeking related behaviour. Thirdly, in terms of the findings from the neuropsychological assessments, results on the Stroop Word task may have been driven by a ceiling effect. Scores on the task fell within a range of four for all participants, and we recommend that future research employs more trials on this task to see if our finding can be replicated. We would argue however that a significantly lower score on such a simple task remains insightful. Finally, to our knowledge, at the time of assessment all participants were naïve to anti-psychotic medication.

Suggestions for future research include delving further into understanding the reduction of functioning associated with PE, as extracting the principal influences on functional outcomes is crucial in designing effective interventions. Our results would indicate that although a variable neuropsychological performance is observed, many of the early cognitive deficits associated with PE have resolved by early adulthood. What remains to be seen however, is if differing outcomes emerge for those with transient or recurring symptoms.

Finally, the findings from our study endorse the importance of routine screening for PE in clinical practice, particularly in children and young adolescents. Evidence for PE as an early marker of later, ongoing mental distress and poorer functioning is mounting.

Acknowledgements

The authors report no conflicts of interest in relation to this study. The authors also thank all participants who have taken part in this study and their families, and for their continued participation in the research.

Financial Support

The research has been funded by a European Research Council Consolidator Award to M Cannon (724809 iHEAR) (EC, DC, CH, AO'N, MC). HC was funded by a Health Professionals Fellowship from the Health Research Board. ND is funded by an RCSI StAR studentship. MC is funded by a HRB Health Research Award and Irish Research Council COALESCE Award. IK was funded by an RCSI StAR lectureship.

Conflicts of Interest

None

Ethical Standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

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Table 1. Participants' demographic information and rates of DSM-5 psychiatric disorders in groups and associated risk.

	Descriptive Statistics		Analysis			
	PE Group	**Control Group**	**χ^2 or *t***	***P*-value**		
Demographic Variable	***n*=41**	***n*=62**				
Age in years, mean(SD), range	20.7 (1.2), [19-24]	21 (1.4), [19-25]	-1.21	0.23		
Gender, *n* (%)			8.17	**0.00**		
Males	27 (66%)	23 (37%)				
Females	14 (34%)	39 (63%)				
Handedness, *n* (%)						
Right	40 (98%)	54 (87%)				
Left	1 (2%)	8 (13%)				
Socio-Economic Status (SES)	2.60	2.18	2.28	0.14		
Mental Health Outcomes			**Wald χ^2**	***P*-value**	**OR**	**95% OR CI**
Met DSM-5 criteria (current)	9 (22%)	4 (6.5%)	4.82	**0.03**	**4.08**	[1.16-14.29]
Met DSM-5 criteria (lifetime)	27 (66%)	23 (37%)	7.91	**0.005**	**3.27**	[1.43-7.47]
Multi-morbidity (diagnoses - lifetime) 1+	15 (37%)	7 (11%)	8.70	**0.003**	**4.32**	[1.63-11.42]

Note: (SD), Standard Deviation; OR, Odds Ratio; CI, Confidence Intervals; Results of unadjusted logistic regressions. Statistically significant results ($p<.05$) are presented in bold text.

Table 2. Mean functioning scores with group differences (adjusting) on all functioning scales and percentage of participants below cut-off scores with group differences.

Functioning	**PE Group**	**Controls**	**Group Differences** ***(unadjusted)***	**Group Differences** ***(adjusted for gender and current DSM-5 diagnoses)***
	Mean(SD)	Mean(SD)	*F*(*p*-value)	*F*(*p*-value)
Social (SF)	7.9 (1.3)	8.7 (0.7)	13.36 **(.000)**	10.03 **(.002)**
Role (RF)	8.0 (0.7)	8.5 (0.7)	5.03 **(.003)**	4.14 (.05)
Global (GAF)	72.8 (10.9)	81.5 (8.7)	19.93 **(.000)**	18.86 **(.000)**
Frequency of participants with poor functioning *(below cut-off scores)*			**X^2(p-value)**	
Social (SF)	11 (27%)	3 (5%)	10.17 **(.001)**	
Role (RF)	7 (17%)	3 (5%)	4.14 **(.042)**	
Global (GAF)	19 (46%)	10 (16%)	11.05 **(.001)**	

Note: (SD), Standard Deviation Statistically significant results ($p<.05$) are presented in bold text. SF; Social Functioning Scale, RF; Role Functioning Scale, GAF; Global Assessment of Functioning Scale.

Table 3. Neuropsychological assessment battery completed by all participants, cognitive domains, individual subtests and instructions for administration

Battery	Cognitive Tests	Description of Tests	Cognitive Domain
MCCB	Trail Making Test (TMT) Part A	The test requires attention and speed of processing to track numbers. Measured in time.	**Processing Speed**
	Brief Assessment of Cognition Symbol-Coding: Digit SC	The test requires psychomotor abilities to convert symbols to numbers. Measured in total score in 90 seconds.	**Processing Speed**
	Delis-Kaplan Executive Function System (DKEFS) Category Fluency	The test requires the verbal production of animal words and speed of processing abilities. Measured in total score in 1 minute.	**Processing Speed**
	Wechsler Memory Scale (WMS-III): Spatial Span forward and backward (WMS-SS)	The test measures non-verbal working memory abilities and requires visuospatial processing and manipulation. Measured in total score.	**Working Memory (non-verbal)**
	Letter-Number Sequencing (LNS)	The test requires the short-term memory storage of chunks of letters and numbers and their verbal manipulation. Measured in total score.	**Working Memory (verbal)**
	Hopkins Verbal Learning Test (HVLT)	The test requires verbal memory and strategies, for both short and long-term storage. Measured in total score.	**Verbal Learning**
	Brief Visuospatial Memory Test- Revised (BVMT)	The test requires visuospatial memory and visuospatial reproduction. Measured in total score.	**Visual Learning**
Stroop	Stroop Task (including Stroop Word, Stroop Colour-Word and Stroop Interference tasks)	The test requires word and colour recognition for the first 2 while the 3rd trial requires inhibition processes as the word and colour stimuli are incongruent. Completed on the computer- 40 trials per condition. Mean total scores and mean reaction times for the 3 tasks are recorded (3 x 40 trials). The test relies on speed of processing.	**Executive Functions**
Additional non-MCCB	Wechsler Abbreviated Scale of Intelligence (WASI-II) Vocabulary (VC)	The test requires word knowledge and verbal concept formation. Measured in total score.	**Proxy IQ**

	Wechsler Abbreviated Scale of Intelligence (WASI-II) Matrix Reasoning (MR)	The test requires fluid intelligence, broad visual intelligence, classification and spatial ability, knowledge of part–whole relationships and perceptual organization. Measured in total score.	**Proxy IQ**
	Trail Making Test (TMT) Part B	The test requires attention, mental flexibility to track of numbers and letters. Measured in time.	**Executive Functions**
	Delis-Kaplan Executive Function System (DKEFS) Category Switching	The test requires the verbal production of words alternating between 2 categories, fruit and furniture, and requires set-shifting and mental flexibility abilities. Measured in total score in 1 minute.	**Executive Functions**
	Logical Memory (WMS-III): Story	The test also requires verbal memory for both long and short-term storage, it also requires that information is stored in a chronological order. Immediate recall and delay following 20 minutes. Measured in total score.	**Verbal Memory**
Motor	The Purdue Pegboard	The test requires manual dexterity and co-ordination. Measured in total score.	**Fine Motor Skill**

Note: For all measures, with the exception of timed tasks, a higher score represents a better performance. For timed tasks, a lower score represents a better performance.

Table 4. Mean raw scores of neuropsychological assessments for both groups respectively, along with unadjusted and adjusted group differences.

Battery	**Test**	**PE Group**	**Controls**	**Group Differences *(unadjusted)***	**Group Differences *(adjusted for gender and current DSM-5 diagnoses)***	**Holm-Bonferroni adjusted**
		Mean(SD)	Mean(SD)	*F*(*p*-value)	*F*(*p*-value)	(*p*-value)
MCCB	HVLT immediate	26.8 (4.5)	27.2 (3.4)	0.37 (.55)	0.01 (.98)	1.00
	TMT-A	28.1 (8.6)	24.6 (8.2)	3.80 (.05)	2.27 (.14)	0.40
	BACS- SC	63.8 (11.7)	67.3 (10.2)	2.41 (.12)	1.09 (.29)	0.84
	LNS	16.4 (2.3)	16.2 (2.3)	0.07 (.79)	0.01 (.92)	1.00
	BVMT	29.8 (5.9)	28.5 (5.9)	1.08 (.30)	1.55 (.22)	1.00
	DKEFS Category Fluency	26.7 (5.3)	27.4 (5.3)	0.29 (.59)	0.01 (.95)	1.00
	WMS-III Spatial Span Forward	9.0 (1.6)	9.3 (1.8)	0.60 (.44)	0.64 (.43)	1.00
	WMS-III Spatial Span Backward	8.3 (1.8)	8.4 (1.5)	0.00 (.95)	0.01 (.94)	1.00
Stroop	Stroop Word TS	39.0 (1.0)	39.6 (0.7)	9.43 **(.003)**	7.03 **(.009)**	**0.018**

	Stroop Word RT	0.72 (0.1)	0.73 (0.2)	0.08 (.78)	0.61 (.44)	1.00
	Stroop Colour TS	39.3 (0.8)	39.5 (0.9)	1.54 (.22)	0.92 (.34)	0.56
	Stroop Colour RT	0.78 (0.1)	0.76 (0.1)	0.40 (.53)	0.00 (.96)	1.00
	Stroop Interference TS	38.9 (1.3)	39.3 (0.8)	2.19 (.14)	1.81 (.18)	0.56
	Stroop Interference RT	0.80 (0.2)	0.79 (0.7)	2.51 (.11)	1.98 (.16)	0.55
Non-MCCB	WASI-II Vocabulary	36.4 (3.6)	35.4 (3.5)	1.98 (.16)	3.44 (.07)	0.80
	WASI-II Matrix-Reasoning	18.4 (3.2)	18.4 (2.8)	0.03 (.86)	0.00 (.96)	0.86
	TMT-B	43.9 (18.8)	40.2 (13.4)	1.21 (.27)	0.59 (.44)	0.81
	HVLT delay	9.3 (2.3)	9.9 (1.9)	1.89 (.17)	0.06 (.81)	0.80
	WMS-III Story Immediate	28.2 (6.1)	30.5 (6.2)	3.07 (.08)	0.80 (.37)	0.56
	DKEFS Category Switching	14.7 (3.2)	15.3 (3.0)	0.64 (.43)	0.21 (.64)	0.81
	WMS-III Story Delay	24.7 (6.5)	26.8 (6.4)	2.51 (.12)	0.52 (.47)	0.72
Motor	Purdue Pegboard TS	184.9 (18.4)	197.8 (19.0)	11.54 **(.001)**	6.58 **(.012)**	-

Note: (SD), Standard deviation; WASI, Wechsler Abbreviated Test of Intelligence; HVLT, Hopkins Verbal Learning Task; TMT, Trail-Making Test (Part A and Part B); BACS, Brief Assessment of Cognition in Schizophrenia; LNS, Letter-Number Sequencing; WMS, Wechsler Memory Scale; BVMT, Brief Visuospatial Memory Task; D-KEFS, Delis-Kaplan Executive Function System; TS, Total Score; RT, Reaction Time. Statistically significant results ($p<.05$) are presented in bold text.

****Supplementary Materials****