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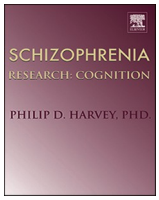

Research Paper

# Montreal Cognitive Assessment (MoCA) as a screening tool for cognitive impairment in early stages of psychosis

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ABSTRACT

*Background:* Cognitive alterations have been reported in early stages of psychosis including people with First Episode Psychosis (FEP), Clinical High-Risk Mental State (CHR), and Psychotic-Like Experience (PLE). This study aimed to compare the cognitive function in early stages of psychosis using the Montreal Cognitive Assessment (MoCA), a low-cost and brief assessment tool of cognitive functions.
*Methods:* A total of 154 individuals, including 35 with FEP, 38 CHR, 44 PLE, and 37 healthy controls (HC), were evaluated with the MoCA in Santiago, Chile. We calculated the mean total score of the MoCA and the standard deviation of the mean. Groups were assessed for a trend to lower scores in a pre-determined sequence (HC > PLE > CHR > FEP) using the Jonckheere-Terpstra test ($T_{JT}$).
*Results:* The mean total MoCA scores were 24.8 ± 3.3 in FEP, 26.4 ± 2.4 in CHR, 26.4 ± 2.3 in PLE, and 27.2 ± 1.8 in HC. The analyses revealed a significant trend ($p < 0.05$) toward lower MoCA individual domain scores and MoCA total scores in the following order: HC > PLE > CHR > FEP. The mean total scores of all groups were above the cut-off for cognitive impairment (22 points).
*Conclusions:* The MoCA describes lower scores in cognition across early stages of psychosis and may be a useful low-cost assessment instrument in early intervention centers of poorly resourced settings.

## 1. Introduction

Cognitive impairments in people with chronic psychotic disorders impact daily life activities, social functioning, and clinical aspects of the disease, and are considered one of the major predictors of quality of life, contributing to the burden of disease (Chun et al., 2020; Green et al., 2019; Mwesiga et al., 2020). They are considered a core manifestation of the pathophysiology of the disorder, and it is estimated that approximately 80 % of patients with psychosis have clinically relevant cognitive impairment (Mccleery and Nuechterlein, 2019).

The presence of neurocognitive alterations in the early stages of psychosis has robust evidence. Neurocognitive deficits in the domains of attention, verbal memory, visuospatial working memory, verbal fluency, and executive functions have been observed in first episode psychosis (FEP) (Fusar-Poli, 2014; Lee et al., 2014).FEP is defined as the first manifestation of psychotic symptoms typically presenting delusions, hallucinations, negative symptoms, cognitive deficits, and poor functioning (Breitborde et al., 2009).

The Clinical High-Risk for Psychosis (CHR) syndrome often presents before FEP. It is considered a late pre-psychotic stage with a 30 % chance

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of developing psychosis (Fusar-Poli et al., 2013). This condition is subdivided into attenuated psychosis syndrome (APS), genetic risk syndrome and functional impairment (GRD), and brief and intermittent psychotic syndrome (BIPS) (Miller et al., 2003). The cognitive deficits in CHR are not well characterized, but a recent meta-analysis indicates that cognitive functioning in CHR is lower compared to healthy controls (HC) across different cognitive domains. The largest performance differences were found in the domains of reasoning, working memory, problem-solving, and processing speed (Anda et al., 2019; Catalan et al., 2021).

Psychotic-like Experiences (PLE) are subclinical psychotic symptoms, including perception (auditive or visual) and thought abnormalities (Karcher et al., 2022). PLE are considered markers of non-specific transition to a mental health condition, including schizophrenia, affective disorders, anxiety, and substance use disorders (Healy et al., 2019). Only a few studies report the neurocognitive performance in individuals with PLE and the performance varies according to the age of the study participants. In adults, mild impairment was observed mainly in verbal functions and memory, but not in processing speed (Mollon et al., 2016). However, the symptoms and characteristics of PLE only minimally affect functionality (Van Os et al., 2009).

There are several neurocognitive batteries to assess cognitive deficits in chronic psychosis like The Measurement and Treatment Research to Improve Cognition in Schizophrenia (MATRICS) Consensus Cognitive Battery (MCCB) (Nuechterlein et al., 2008), The Cambridge Neuropsychological Test Automated Battery (CANTAB) (Backx et al., 2020)and The Penn Computerized Neurocognitive Battery (CNB) (Gur et al., 2010, 2012). These neurocognitive batteries have been used to assess cognitive performance in patients with neuropsychiatric pathologies. However, their high cost and the need for trained personnel for their application and interpretation are negative aspects. In addition, they need considerable evaluation time (Van Rheenen and Rossell, 2014).

Conversely, screening tests and other brief scales provide a basic but reliable initial cognitive assessment of people with severe neuropsychiatric disorders like schizophrenia. Among these tests, there is the Brief Assessment of Cognition in Schizophrenia (BACS), developed for clinical trials in schizophrenia. It covers verbal memory, working memory, motor speed, attention, executive functions, and verbal fluency. The test can be applied in approximately 30 min and can be administered by health professionals (Keefe et al., 2004). The Brief Cognitive Assessment Tool for Schizophrenia B-CATS is comprised of three neuropsychological tests that provide global information on cognitive performance. It requires between 6 and 20 min to be applied and does not need to be administered by neuropsychologists (Hurford et al., 2011). Finally, The Montreal Cognitive Assessment (MoCA) is a brief cognitive test designed to assess mild cognitive impairment (MCI). The time to administer the MoCA test is approximately 10 min and has a maximum of 30 points. The test evaluates short-term memory, visuospatial skills, aspects of executive functions, attention, working memory, language, and temporospatial orientation. The MoCA has good internal consistency, with a Cronbach's alpha of 0.83 in its original version (Nasreddine et al., 2005). Furthermore, there is an adapted and validated version for Chilean population, which presents good internal consistency with a Cronbach's alpha of 0.77 (Delgado et al., 2017).

Even though the MoCA was designed to detect MCI in older patients, in recent years, the MoCA has not only been used to determine MCI, but also to assess cognition in other neurological and psychiatric disorders. The MoCA has been reported to have good construct validity in psychiatric patients and has been recommended for this population (Gierus et al., 2015). A systematic review of 12 studies concluded that the MoCA was a promising screening tool for determining neurocognitive performance in schizophrenia (Rosca et al., 2020). The usefulness of the MoCA in people with schizophrenia is also due to its ease of use and short administration time (Gil-Berrozpe et al., 2020).

This article aims to determine the usefulness of the MoCA to detect cognitive deficits in young people with early stages of schizophrenia, such as FEP, CHR, and PLE.

## 2. Materials y methods

### 2.1. Participants

$N = 154$ participants were recruited and assessed with the MoCA for this study, of which 37 were HC, 44 had PLE, 38 CHR, and 35 FEP. Participants of 14 years or older were included. Individuals with comorbid severe substance use disorders or neurological disorders were excluded. All study participants with PLE, CHR, and FEP were outpatients at the Clínica Psiquiátrica Universitaria (CPU) of the University of Chile.

The evaluations were performed by psychiatrists and psychologists trained in clinical and neurocognitive evaluations and were conducted in the Translational Psychiatry Laboratory of the University of Chile. The study was approved by the ethics committee of the Hospital Clínico de la Universidad de Chile (HCUCH), and all participants or their legal guardians provided informed consent to participate in the study.

### 2.2. Clinical and neurocognitive assessments

#### 2.2.1. The mini-international neuropsychiatric interview (MINI)

The MINI was used to diagnose FEP. This scale is a brief, structured diagnostic interview, based on the DSM-IV and ICD-10 criteria (Sheehan et al., 1998). It was used to rule out mental disorders considered exclusion criteria.

#### 2.2.2. Community Assessment of Psychotic Experiences-Positive Scale (CAPE-P15)

The CAPE-P15 was used to detect PLE. CAPE-15 is a self-report questionnaire that aims to investigate the presence of subthreshold symptoms of psychosis, such as strange or unusual thoughts or ideas, including paranoid beliefs as well as the presence of abnormal auditive or visual experiences. It is composed of 15 items. Total scores range from 15 to 75, and higher scores indicate greater severity of PLE (Capra et al., 2013; Núñez et al., 2021).

#### 2.2.3. Structured Interview for Psychosis-Risk Syndromes (SIPS)

The SIPS was used to establish CHR. The SIPS scale aims to identify and measure five attenuated positive symptoms, six negative symptoms, four symptoms of disorganization, and four general symptoms. It also allows evaluation of global functioning and family history, all important clinical features of prodromal stages of schizophrenia. This scale has a Kappa coefficient of = 0.81 (McGlashan et al., 2010; Miller et al., 2003).

#### 2.2.4. Montreal Cognitive Assessment (MoCA)

The MoCA was used to assess cognitive functioning. The MoCA is a brief test to assess cognition in people with MCI. The following neurocognitive domains are included in the MoCA: visuospatial/executive, naming, short-term memory through word learning, attention, verbal fluency, abstraction, delayed recall, and temporospatial orientation. This study used an adapted and validated version for the Chilean population, which presents good internal consistency with a Cronbach's alpha of 0.77 (Delgado et al., 2017).

### 2.3. Analyses

We added one point to the MoCA total scores of study participants under the age of 18 years (Pike et al., 2017).

Frequencies and descriptive statistics were used to describe the clinical and demographic characteristics of the sample.

To compare the total and individual domain scores of the MoCA between the control and the clinical groups, the Jonckheere-Terpstra test was used. It was hypothesized that the studied groups showed a significant trend toward lower MoCA individual domain scores and MoCA total scores in the following sequence: HC (1) > PLE (2) > CHR (3) > FEP (4). This hypothesis was tested in one direction only.

In addition, the sensitivity of socio-demographic subgroups to the above-mentioned trend was examined. For this purpose, the main sample was dichotomized into two subsamples by gender and duration of education. We used the median duration of education to divide the sample in those with higher and lower educational levels. In each subsample, the trend to lower MoCA total scores in the sequence HC > PLE > CHR > FEP was tested.

*P* values were considered significant when $p < 0.05$ and to be marginally significant when $0.05 < p < 0.1$.

To visualize group differences, we used box plots.

These analyses were performed with 1000 permutations using R-package "clinfun", Version 1.1.3, R software (The Comprehensive R Archive Network, R-4.2.9). The graph was generated using GraphPad Prism version 9.0.0 for Mac (GraphPad Software, San Diego, California USA, www.graphpad.com).

## 3. Results

### 3.1. Demographics

The mean age of all study participants was 21.9 years (±5.3) and the duration of education in the study population was 13.2 years (±2.8). Most of the participants were young adults who had finished their secondary education. The female-to-male ratio of all participants was 66 to 86, but this relation was more imbalanced in the FEP group. Table 1 shows the descriptive demographic data of participants, divided into 4 groups (HC, PLE, CHR, and FEP).

### 3.2. Psychometric values

Table 2 shows the MoCA total score and the individual domain scores for the four different groups. The analyses revealed a significant trend toward lower MoCA individual domain scores and MoCA total scores in the following order: HC > PLE > CHR > FEP. (Naming TJT = 3916.5, $p = 0.029$; Attention TJT = 4370.0, $p = 0.044$; Language TJT = 3572.0, $p = 0.002$; Abstraction TJT = 4132.5, $p = 0.023$; Memory TJT = 3903.0, $p = 0.034$; and Orientation TJT = 3786.0, $p = 0.001$), and in the total MoCA score (TJT = 3513.5; p = 0.002).

As in the total sample, in the subsample of men ($n = 88$), there was a significant trend (TJT = 1060.0, $p = 0.005$) to lower MoCA total scores in the sequence HC (1)- > PLE (2)- > CHR (3)- > FEP (4). However, in women ($n = 66$), the trend was only marginally significant (TJT = 614.5, $p = 0.051$).

The trend was also observed in sub-samples with different levels of education divided at the median (MED = 14 years). The trend was significant in people with fewer years of education ($n = 96$, TJT = 1396.5, $p = 0.019$) and only marginally significant in the individuals with higher educational levels ($n = 58$, TJT = 479.0, $p = 0.055$).

The distribution of the total MoCA scores in each group was visualized with box plots (see Fig. 1).

Using the cut-off score of 22 points for MCI in the Chilean population (Delgado et al., 2017), 100 % of HC subjects presented a normal performance, but all other groups had at least 1 individual with MCI according to this definition (Fig. 2).

**Table 1**
Descriptive demographic data of participants.

| Parameter | Groups | | | |
|---|---|---|---|---|
| | HC ($n = 37$) | PLE (n = 44) | CHR (n = 38) | FEP (n = 35) |
| Age (years) ± SD | 23.7 ± 4.6 | 22.2 ± 5.3 | 19.2 ± 5.0 | 22.5 ± 5.5 |
| Education (years) ± SD | 15.2 ± 2.1 | 13.5 ± 2.5 | 11.8 ± 3.2 | 12.7 ± 2.5 |
| Sex | 25F:12M | 23F:21M | 14F:24M | 4F:31M |

Abbreviations: HC, Healthy controls; PLE, psychotic-like experience; CHR, clinical high-risk; FEP, first-episode psychosis; SD, standard deviation; F, female; M, male.

**Table 2**
MoCA total and individual domain scores by group.

| Parameter | Mean ± SD | | | | Statistic $T_{JT}$ | P value |
|---|---|---|---|---|---|---|
| MoCA domains | HC ($n = 37$) | PLE ($n = 44$) | CHR ($n = 38$) | FEP ($n = 35$) | | |
| Visuospatial/ executive | 4.54 ± 0.65 | 4.27 ± 0.85 | 4.26 ± 0.89 | 4.11 ± 0.96 | 3916.5 | 0.029 |
| Naming | 2.97 ± 0.16 | 2.98 ± 0.15 | 3.00 ± 0.40 | 2.94 ± 0.24 | 4370.0 | 0.300 |
| Attention | 5.41 ± 0.83 | 5.16 ± 1.06 | 5.37 ± 1.05 | 4.80 ± 1.18 | 3947.0 | 0.044 |
| Language | 2.57 ± 0.73 | 2.68 ± 0.56 | 2.13 ± 0.91 | 2.09 ± 1.04 | 3572.0 | 0.002 |
| Abstraction | 1.97 ± 0.16 | 1.91 ± 0.29 | 1.89 ± 0.39 | 1.77 ± 0.55 | 4132.5 | 0.023 |
| Memory | 3.65 ± 1.21 | 3.27 ± 1.48 | 3.45 ± 1.33 | 2.97 ± 1.48 | 3903.0 | 0.034 |
| Orientation | 6.00 ± 0.00 | 5.91 ± 0.29 | 5.68 ± 0.66 | 5.69 ± 0.58 | 3786.0 | 0.001 |
| Total score | 27.18 ± 1.77 | 26.43 ± 2.25 | 26.39 ± 2.44 | 24.82 ± 3.33 | 3513.5 | 0.002 |

Abbreviations: HC, healthy controls; PLE, psychotic-like experience; CHR, clinical high-risk; FEP, first-episode psychosis; MoCA, Montreal Cognitive assessment; $T_{JT}$, Jonckheere-Terpstra test.

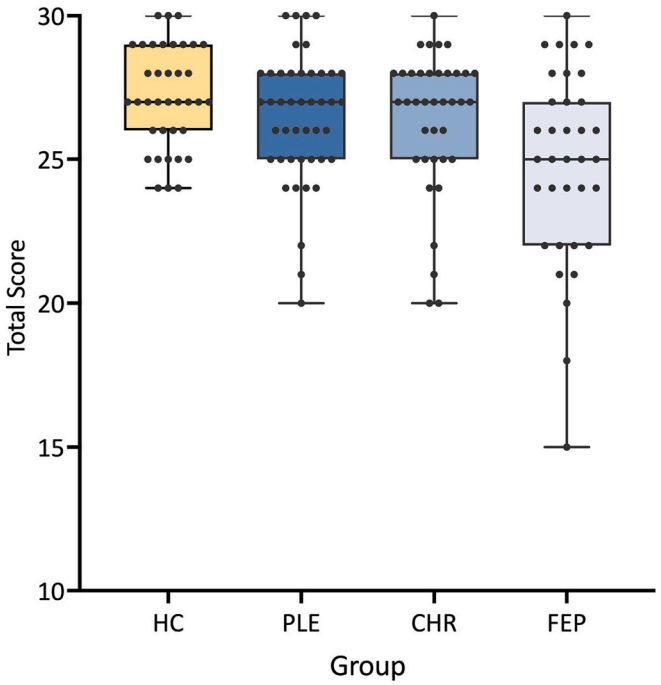


**Fig. 1.** Group comparisons of total MoCA scores using Box Plots.
HC = healthy controls; PLE = psychosis-like experience; CHR = clinical high risk; FEP = first episode psychosis.

## 4. Discussion

Information on cognitive performance is critical for clinicians to make decisions about how to proceed with treatment or schedule future assessments (Rose et al., 2021). While specific neurocognitive batteries require time and specialized resources, brief neuropsychological screening tests such as the MoCA are useful for poorly resourced care settings (Yang et al., 2018).

Our results indicate that there are significant differences in total and individual domain scores of the MoCA in individuals with FEP compared

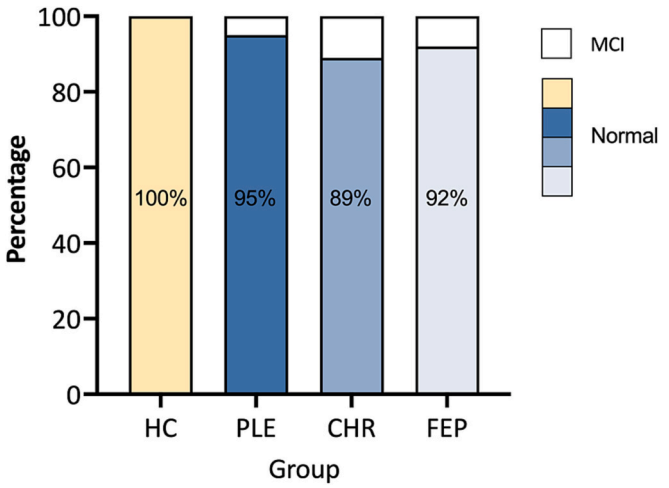


**Fig. 2.** Percentage of study participants without mild cognitive impairment. HC = healthy controls; PLE = psychosis-like experience; CHR = clinical high risk; FEP = first episode psychosis; MCI = mild cognitive impairment.

to HC. This result is consistent with previous reports using the MoCA to assess cognition in early schizophrenia (Haddad et al., 2022; Wu et al., 2014; Yang et al., 2018). Our study also supports the idea that memory and attention are often affected in FEP (Bozikas and Andreou, 2011).

There were also group differences of the total MoCA scores between CHR, and PLE vs FEP, as it has been previously described with other neurocognitive batteries such as the MCCB (Catalan et al., 2021).

The literature supports cognitive abnormalities in verbal learning, visual memory, processing speed, attention and general intelligence in CHR populations (Catalan et al., 2021), but few studies have described cognitive abnormalities in PLE. One example is a recent paper that shows evidence of working memory deficits and its association with negative and disorganization symptoms (Chun et al., 2020).

When we compared total MoCA or individual domain scores in the groups with CHR or PLE with HC, we did not find significant differences. However, several individuals in the groups with early psychotic states scored positive for MCI (using the cut-off established in Chile). About 10 % of the participants with CHR and PLE had below-normal performance.

This study has several limitations. We did not match the age and educational levels of the individuals between the different groups. We included participants over 14 years old, which is a population little studied with this instrument. The MoCA has been validated in young people between the age of 14 and 21 with congenital heart disease (Pike et al., 2017), and it is reliable in the general population including adolescents (Krist et al., 2019). Finally, we did not compare the MoCA scores with specific batteries for the evaluation of psychotic patients, such as the MCCB.

In conclusion, the MoCA showed significant cognitive alterations in FEP when compared to HC, CHR, and PLE. There was a trend to lower cognitive scores in the expected and pre-determined sequence HC (1) > PLE (2) > CHR (3) > FEP (4) indicating that the MoCA may be a useful instrument for poorly resourced settings to assess cognition in early stages of psychosis.

Future research may compare the total scores and individual domain scores of the MoCA with other neuropsychological assessment instruments in psychosis risk states and early psychosis.

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## CRediT authorship contribution statement

**Sebastian Corral:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Pablo Gaspar:** Writing – review & editing, Writing – original draft, Resources, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Rolando Castillo:** Writing – original draft, Supervision, Conceptualization. **Rocio Mayol:** Writing – review & editing, Writing – original draft, Supervision, Investigation, Conceptualization. **Adrian P. Mundt:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Yuriy Ignatyev:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Rodrigo R. Nieto:** Investigation. **Alicia Figueroa-Muñoz:** Investigation, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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