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A ten-year longitudinal repeated assessment study of cognitive improvement in patients with first-episode schizophrenia and healthy controls: The Oslo Schizophrenia Recovery (OSR) study

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ABSTRACT

The mapping of cognitive trajectories after a first episode of schizophrenia has been the aim in several studies, but the longitudinal course of cognitive impairments remains an important question. Due to methodological limitations, it has been challenging to pinpoint specific periods of improvement or stability in cognitive functioning over time. The objective of this study is to further clarify the longitudinal course of cognitive change after a first episode of schizophrenia through frequent repeated measurement. A total of 56 persons participated in the study (28 first episode patients and 28 healthy pairwise matched controls) with 79 % of patients retained at the 10-year follow-up.

The Oslo Schizophrenia Recovery study has a repeated measurement design and includes data from nine cognitive assessments over 10 years. Cognition was assessed with the MATRICS Consensus Cognitive Battery, which is well suited for repeated measurements. Data were analyzed with linear multilevel models. The results challenge some of the views about the course of cognitive impairment in first-episode schizophrenia patients. Using quadratic time effects in our analyses and balancing the patient group with regards to the most relevant confounding demographic variables such as age, gender, and education, we showed that cognitive deficits change and improve more than in healthy individuals until year 6, when both groups stabilize. The patient group improved on some of the most important cognitive domains associated with functional outcome with 63.5 % full recovery at 10-year follow-up.

1. Introduction

Schizophrenia is associated with wide ranging cognitive impairments (Green et al., 2019). These impairments affect a broad array of neurocognitive domains, and typically range from 0.75 to 1.5 standard deviations below healthy samples (Mesholam-Gately et al., 2009; Heinrichs and Zakzanis, 1998). Cognitive impairments occur in individuals with prolonged illness (Heinrichs and Zakzanis, 1998), in individuals at risk for psychosis (De Herdt et al., 2013) and in those with first-episode schizophrenia (FES) (Mesholam-Gately et al., 2009). However, questions remain regarding the longitudinal course of cognitive impairments. Few longitudinal studies address whether cognitive impairments change during the early illness period, and when any changes occur. It also remains unclear whether cognitive improvement is sometimes part of the long-term course after a first episode.

In a recent meta-analysis by Watson et al. (2022), they found no evidence of continued decline or improvement in the early years following psychosis onset and pointed out the need for more studies over longer follow-up periods. The early years following a first onset of psychosis have been proposed as a "critical period" (Birchwood et al., 1998) in which individuals can make the greatest improvement in social functioning as well as a window of opportunity for recovery (Torgalsbøen et al., 2018).

Due to methodological shortcomings, studies have not been able to comprehensively chart the course of cognitive functioning following the first episode of schizophrenia (Bozikas and Andreou, 2011; Zanelli et al.,

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2019). First, longitudinal studies (Barder et al.,2013, Bergh et al., 2016; Hoff et al., 2005; Rund et al., 2016; Stirling, 2003), some spanning 10 years, that report that cognitive functioning is stable - often do not include a healthy control group, or the healthy control group is not demographically matched to the patient group (Albus et al., 1997; Allott et al., 2011; Hoff et al., 2005). The lack of a healthy control group makes it impossible to determine whether the trajectory found in the psychosis group is different from normal cognitive maturation during the same age period.

Second, the longitudinal assessments are mostly completed over only two years or less. A meta-analysis by Bora and Murray (2014), which reports that the degree of overall cognitive change is similar in FES and controls, was based on studies with follow-up intervals that were generally two years or less. In a recent meta-analysis by Watson et al. (2022), there was no evidence of continued decline or improvement during a mean follow-up period of 20.76 months after psychosis onset. This time interval is useful to minimize the confounding effects of medication (Birchwood et al., 1998), but may be too short to detect meaningful changes.

Third, most studies have assessed a limited number of cognitive domains (Rund et al., 2016; Barder et al., 2013) and, as pointed out by McCleery and Nuechterlein (2019), there has been no clear consensus regarding which cognitive tests are used and which cognitive domains are assessed. Fourth, the timing of baseline cognition assessments and the time intervals between follow-ups have varied (Bozikas and Andreou, 2011). Fifth, high attrition rates are common in both the patient and control groups. Finally, another limitation is the significant variation in definitions of first-episode psychosis, making it difficult to compare results across studies (Cowman et al., 2021). All these limitations affect the interpretability of results.

In the Oslo Schizophrenia Recovery study (OSR) (Torgalsbøen et al., 2014, 2015; Fu et al., 2017; Fu et al., 2018), we seek to further clarify the cognitive trajectories in FES while remedying some of the limitations in previous research. We examined cognitive functioning in first-episode schizophrenia patients over a 10-year period and systematically (i.e., at similar time points throughout the 10-year period) compared them with demographically pairwise matched healthy controls using an extensive cognitive battery, the MATRICS Consensus Cognitive Battery (MCCB) (Nuechterlein and Green, 2006). This cognitive battery covers seven cognitive domains that are found to be severely impaired in schizophrenia (Nuechterlein et al., 2004).

The OSR study restricts first episode schizophrenia to participants who are referred to the study within five months of their first contact with a hospital or outpatient clinic, as this definition allows cognitive assessment to begin shortly after initial diagnosis. To fully understand the early longitudinal course of cognitive function in FES, the OSR study used a repeated assessment design that included yearly neurocognitive assessments with the MCCB during the first 4 years and thereafter every other year - totaling 9 cognitive assessments during the 10-year follow-up period. This provides the opportunity to explore several aspects of the course, such as if cognitive trajectories are flat and stable, improve gradually, or change course over time.

In a previous report (Torgalsbøen et al., 2015) from this study (the 2-year follow-up), we showed a statistically significant decline in verbal learning and improvements in reasoning/problem solving and social cognition in FES compared to demographically matched healthy controls. This indicated different trajectories for different cognitive domains while at the same time showed improvement in two cognitive domains that are considered important for functional outcome (Green and Harvey, 2014).

In the 6-year follow-up study (Fu et al., 2018), we saw cognitive performance improvements in almost every cognitive domain that is consistently impaired in FES, but gains were also present in the healthy controls. The overall non-significant tendency suggested that the cognitive difference between groups narrowed over time, but Group X Time interactions were significant for only two domains. A larger improvement in reasoning and problem solving occurred in the FES group than the healthy controls group, but improvement in working memory was smaller than in the healthy controls (Fu et al., 2018). Thus, these results suggest that cognitive functioning can improve after a first psychotic episode as it does in healthy individuals during the same age period, with some cognitive domains showing differential changes over time in the two groups.

To fully map the cognitive development of our sample and to investigate any cognitive changes over the long-term, we now extend the assessment period. To our knowledge, this is the first study using the MCCB to map the cognitive course in FES and pairwise healthy controls across 10 years. Specifically, the present study aims to answer the following research question: Over a 10-year period, how does both general and specific cognitive functioning develop in a group of well-defined first episode schizophrenia patients, compared to pairwise demographically matched healthy controls?

2. Methods

2.1. Participants

Thirty-one patients with FES were referred to this study over a period of four years (2007–2011). They were recruited from various mental health service institutions in the Oslo area, the majority coming from units specializing in early intervention and treatment of psychosis. Twenty-eight out of the 31 patients fulfilled the following inclusion criteria: age $\geq$ 18 years, the first episode of mental illness was within the spectrum of schizophrenia and psychosis according to DSM-IV (American Psychiatric Association, 1994) and referral occurred within the first five months of their first contact with mental health service institutions. Exclusion criteria were diagnosis of an affective disorder, IQ <70 and head trauma. All participants could read and write Norwegian fluently. The sample represents about 60 % of the incidence cases from the catchment area and is thus considered representative of the population of first episode schizophrenia patients in the Oslo metropolitan area.

A healthy control group with 28 participants was matched pairwise with the patient group on gender, age, and education level (+/- one year). The youngest participants in the control group were recruited through inquiries at junior and senior high schools in and around the Oslo metropolitan area. The older participants were recruited through electronic advertisements on the Vestre Viken Hospital Trust (VVHF) homepage. The VVHF provides state-funded healthcare to the south-eastern part of Norway and consists of rural areas as well as city centers. Healthy controls were tested at the hospitals in the vicinity of Oslo or at the University of Oslo. Exclusion criteria for the control group were a history of schizophrenia or other severe mental disorder; IQ < 70; a history of neurological disease, head injury and/or loss of consciousness for more than 10 min; current psychotropic medication; chronic somatic illness inducing significant fatigue or pain; current narcotics for pain; a history of alcohol or substance abuse; dyslexia or other significant learning difficulties; and inability to understand spoken and written Norwegian sufficiently to comprehend testing instructions. All participants were asked to refrain from drinking alcohol or taking sleeping pills the day before the testing.

After carefully describing the study and the procedures involved, written informed consent was obtained from all participants. The study was approved by the Regional Committee for Research Ethics (REK) (2017/1139).

Complete data are available for all nine neurocognitive assessment points over 10 years. The patient group was assessed at baseline, after six months and after a year. Thereafter, they were assessed every year for four consecutive years. Beginning with the 6-year follow-up, the patient group was assessed every other year. The healthy control group was assessed at baseline, after two years, six years and 10 years.

The retention rate at 10-year follow-up is high (79 %). All patients were retained during the first three assessments, while three participants

left the study during the 2-year follow-up and an additional three dropped out during the 3-year follow-up. The reasons for dropout were mainly refusal to participate due to anxiety, lack of insight into having a mental illness, or finding participation in research not useful. One participant did not provide a reason for dropout. Regarding the healthy control group, three participants were unable to participate at the 6-year follow-up. These three were replaced by pairwise matched (age, gender, and education level) participants who were picked from a pool of healthy controls that were tested at baseline, but until then not matched to the patient group. Thus, for these three participants we do not have data from the 2-year follow-up, but we have full data from baseline, 6-year, and 10-year. The participant flow is shown in Table 1.

2.2. Clinical instruments

The clinical in-person interviews and neurocognitive tests of the participants were conducted within the first five months of their admission to the hospital or outpatient clinic. The Structured Clinical Interview for DSM-IV Axis I disorder (SCID-I), modules A-D (First et al., 1995), was used to establish diagnosis. The degree of symptom severity and psychopathology was measured with the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987). Diagnoses were first made by the patients' treating clinicians, then were separately confirmed by an experienced clinical psychologist at study entry.

Everyday functioning was rated based on a semi-structured interview, measured with the Global Functioning Scale: Social (GFS: Social) and the Global Functioning Scale: Role (GFS: Role) (Cornblatt et al., 2007). These two 10-point scales separate social from work/school functioning domains, are sensitive to changes in functioning over time, and provide brief and easy-to-use clinician ratings, while taking age and phase of illness into account. The Social scale assesses the quantity and quality of peer relationships, level of peer conflict, age -appropriate intimate relationships and involvement with family members. The Role scale refers to performance in school, at work or as a homemaker. We consider these measures as suitable for prospectively following individuals with first-episode schizophrenia (Torgalsbøen et al., 2015, 2018).

Assessment of full recovery was done according to the following criteria:

Definition of symptom remission:

The symptom remission criteria for schizophrenia (Andreasen et al., 2005) are based on an evaluation of eight groups of symptoms of the PANSS: P1 (delusions), G9 (unusual thought content), P3 (hallucinatory behavior), P2 (conceptual disorganization), G5 (mannerisms and posturing), N1 (blunted affect), N4 (social and emotional withdrawal) and N6 (lack of spontaneity). The score on these items must be mild or less (<3), using the 1–7 range for each item, with a duration of six months as a minimum threshold.

Definition of full recovery

In this 10-year follow-up study, the full recovery criteria used is a combination of the symptom remission criteria (Andreasen et al., 2005), with the operational recovery criteria developed by Liberman et al. (2002). The remission criteria are based on the evaluation of the eight groups of symptoms of the PANSS. The score on these items must be mild or less (<3), with a duration of two years. In addition, the subject must fulfill the following criteria concerning psychosocial functioning: at least part-time ordinary work or school, living independently (without supervision by family), and socializing with peers at least once weekly or otherwise involved in recreational activities that are age-appropriate and independent of professional supervision. To be considered fully recovered, a score of eight (adequate social/interpersonal functioning and good role functioning) on the GFS: Social and Role scales is required.

Follow up assessments were completed by an experienced clinical psychologist trained in PANSS ratings. To establish accuracy of remission and full recovery judgements, we completed an inter-rater reliability assessment, which yielded satisfactory agreement between raters (Torgalsbøen et al., 2018).

2.3. Neurocognitive measures

IQ was estimated by using the following subtests from the Wechsler Abbreviated Scale of Intelligence (WASI): Vocabulary, Similarities, Block Design and Matrix Reasoning (Wechsler, 1999.

The Norwegian academic translation version of the MATRICS Consensus Cognitive Battery (MCCB) (Mohn et al., 2012; Nuechterlein and Green, 2006) was used to assess the neuropsychological functioning both at baseline and at the various follow-up points. The subtests of the MCCB were selected mainly for their sensitivity to cognitive changes and high test-retest reliability, their suitability for repeated measurement, their relationship to self-reported functional outcome, practicality for the test administrator and tolerability for the participant (Nuechterlein et al., 2008). The assessment at baseline and follow-up was performed by graduate students in clinical psychology, trained in neuropsychological assessment.

The MCCB consists of the following 10 tests measuring 7 different cognitive domains: Speed of processing: *Trail Making Test A (TMT-A)*, *Symbol Coding (Brief Assessment of Cognition in Schizophrenia, BACS)*, *Category Fluency*; Attention/Vigilance: *Continuous Performance Test – Identical Pairs (CPT-IP)*; Working memory: *Spatial Span (Wechsler Memory Scale, SS-WMS)*, *University of Maryland Letter Number Span test (LNS)*; Verbal learning: *The revised Hopkins Verbal Learning Test (HVLT-R) Alternate forms*; Visual learning: *The revised Brief Visuospatial Memory Test (BVMT-R) Alternate forms;* Reasoning/Problem solving: *Mazes from the Neuropsychological Assessment Battery (NAB Mazes) Alternate forms*; and Social Cognition: *Managing Emotions Branch of the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT ME)*. The schedule of Alternate forms was that we presented form 1–5 (HVTL-R) consequently until assessment point 5, then we started to use form 1–5 consequently again. We followed the same schedule for the alternate forms of BVMT-R and the NAB Mazes.

The MCCB Computer Scoring Program was used to calculate T scores for each cognitive domain and to calculate an Overall Composite score

Table 1
Participant flow and neurocognitive assessments across 10 years.

	Patients	Controls	Lost to follow-up (patients) ($n = 6$)	Completed neurocognitive assessments with MCCB
Baseline	$N = 28$	N = 28		$N = 56$
6.months	N = 28			N = 28
Year 1	N = 28			N = 28
Year 2	$N = 25$	N = 28	$N = 3$	$N = 53$
Year 3	$N = 22$		N = 3	N = 22
Year 4	N = 22			N = 22
Year 5				
Year 6	N = 22	N = 28		$N = 50$
Year 7				
Year 8	N = 22			N = 22
Year 9				
Year 10	N = 22	N = 28		N = 50

based on all seven domains, using the North American norms (Nuechterlein and Green, 2006), which are suitable for Europe. We have used the age- and gender corrected method. These norms are valid for individuals 20 years of age and older (Nuechterlein and Green, 2006). However, as some of our participants are younger than 20 years, we present baseline raw scores to facilitate comparison (see Table 6).

2.4. Statistics

All statistical analyses were performed using IBM SPSS for Windows version 27 and R version 3.5.3, the Tidyverse package. Like our previous strategy for analyzing six-year follow-up data (Fu et al., 2018), a series of multilevel growth curve models were fitted for each MCCB domain and for the Overall Composite T-score to estimate initial level and changes across time. The baseline model included a fixed and random intercept (Model 1). Fixed and random effect of time was added in models 2 and 3 respectively, while models 4 and 5 similarly included fixed and random quadratic effects of time. Model 6 further included a group indicator variable (controls 0, patients 1). Finally, in model 7, an interaction term between group and time with both linear and quadratic time was included (Table 2).

Effect sizes are given as partial eta squared with the following rule of thumb as to magnitude: $n^2 = 0.01$ indicates a small effect, $n^2 = 0.06$ indicates a medium effect, and $n^2 = 0.14$ indicates a large effect.

While the MCCB is only normed to the age of 20, it is still important to include participants who are younger in age since psychosis can occur in individuals from an early age on. Although these scores are statistical estimates, we argue that our statistical method accounts for that since we have multiple measurement points. Also, multilevel models provide estimates on intercept which are based on baseline scores, but we allow for random effects for both intercept and slope to obtain the best fitting model.

3. Results

Demographic and clinical characteristics of the participants at baseline and at the 10-year follow up are presented in Table 3. Cognitive performance at baseline for each group is presented in Table 4. At baseline, the FES patients performed significantly lower on each cognitive domain except working memory, for which the groups did not differ significantly.

The best fitting multilevel model for the Overall Composite score and

Table 3
Demographic and clinical characteristics.

	Patients ($n = 28$)	Controls (n = 28)
Age	21.0 (2.6) 18–27	21.1 (2.7) 17–27
Gender		
Women	39.3 % ($n = 11$)	39.3 % ($n = 11$)
Men	60.7 % (n = 17)	60.7 % ($n = 17$)
Level of education		
Elementary school	39.3 % (n = 11)	32.1 % ($n = 9$)
High school	28.6 % ($n = 8$)	57.1 % ($n = 16$)
Some college	25.5 % ($n = 7$)	7.1 % (n = 2)
BA or higher	7.2 % (n = 2)	3.6 % (n = 1)

	Baseline	10-year follow-up (n = 22)
Duration of untreated psychosis	15.9 (15.4) months 1–60 months	
On medication	92.8 % ($n = 26$)	68.2 % ($n = 15$)
Substance abuse, current	3.6 % (n = 1)	9.1 % (n = 2)
Substance abuse, previous	64.3 % ($n = 18$)	
SCI-PANSS		
Positive	18.3 (5.4) 8–30	8.1 (2.3) 7–16
Negative	20.7 (4.3) 13–31	8.6 (2.1) 7–13
General	40.2 (9.3) 22–54	19.9 (3.9) 16–30
Global function		
Social	6.1 (1.2) 3–8	7.1 (1.2) 4–9
Role	4.1 (1.9) 2–7	6.8 (1.4) 4–8
Hospitalized	57.0 % (n = 16)	
Outpatient	43.0 % ($n = 12$)	
Fully recovered	None	63.6 % ($n = 14$)

Numbers in mean (SD) unless otherwise specified. Second line of cell is min-max scores. Medication: antipsychotic, mood stabilizing, and/or antidepressants.

Table 2
Growth models of the MCCB overall composite score.

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Predictors	Estimates	Estimates	Estimates	Estimates	Estimates	Estimates	Estimates
(Intercept)	44.92***	41.62***	41.67***	40.03***	40.07***	46.97***	47.37***
Time		0.90***	0.88***	2.48***	2.44***	2.39***	1.97***
Time squared				−0.16***	−0.16***	−0.15***	−0.12*
Group[a]						−12.93***	−13.45***
Group*time							0.67
Group*time squared							−0.05
Random effects							
Residual	37.32	26.62	23.81	20.84	20.22	20.14	19.81
Intercept variance	108.41	99.95	98.19	96.46	93.58	51.86	55.56
Linear term variance			0.19	0.21	1.49	1.53	1.56
Quadratic term variance					0.01	0.01	0.01
Intercept – linear correlation			0.00	0.08	−0.10	0.15	0.09
Intercept – quadratic correlation					0.13	−0.15	−0.08
AIC	2149.879	2060.463	2057.787	2029.532	2029.556	2005.339	2008.069

Note. All models were fitted using maximum likelihood and an unstructured covariance structure. Akaike Information Criterion (AIC) was used to determine the best fitting models (Akaike, 1974).

* $p < .05$.

*** $p < .001$.

[a] Controls coded 0, patients coded 1.

Table 4
Cognitive function in FES and healthy controls at baseline (T scores).

Cognitive domains	Patients (n = 28) Mean (SD) Min-max	Controls (n = 28) Mean (SD) Min-max	F	η^2
Composite score	32.2 (9.8) 20–49	47.6 (8.8) 24–59	34.14***	0.42
Speed of processing	32.9 (8.4) 20–56	50.9 (7.8) 32–64	61.25***	0.56
Attention/vigilance	33.7 (8.8) 20–49	44.1 (6.7) 31–56	22.20***	0.32
Working memory	42.7 (12.8) 20–78	47.4 (11.3) 24–70	1.84ns	0.04
Verbal learning	41.9 (7.4) 27–55	48.8 (10.2) 31–63	7.45**	0.13
Visual learning	37.8 (10.8) 20–54	50.3 (8.7) 29–61	20.34***	0.30
Reasoning/problem solving	40.2 (9.6) 24–54	49.7 (10.8) 27–61	10.58**	0.18
Social cognition	39.9 (12.5) 20–67	47.9 (10.3) 30–70	6.12*	0.11
Estimated IQ	102.1 (14.7) 78–143	112.1 (8.6) 90–124	9.11**	0.15

F: Between group significance test. η^2: effect size. ***: p < .001, **: $p < .01$, *: p < .05, ns: non-significant.

nearly all domains was Model 6. Table 2 provides the effects for the Overall Composite T score, while the Supplementary Tables show the growth curve effects for each of the cognitive domains. In general, there was a significant effect of time, in that changes in cognition occurred across several time waves, during the entire 10-year assessment period. However, for working memory and verbal learning, there was no significant change over time. The introduction of quadratic time as a parameter revealed that the cognitive change was largest at the earliest measurement points for all domains except for working memory, verbal learning, and social cognition, and then stabilized (see Supplementary tables). Moreover, there was a significant main effect of group, in that the cognitive performance of the patient group was lower throughout the assessment period compared to that of the healthy controls. The one exception was social cognition, where there was no statistically significant group effect in Model 6. However, when a group x time effect was included (Model 7), a significant group effect did emerge for social cognition. Finally, for most cognitive domains, the Group X Time interaction terms did not improve model fit. The exception was the reasoning and problem-solving domain, for which both linear and quadratic time significantly interacted with the group variable.

Table 5 provides the means and SDs for each group over time for the Overall Composite score, working memory, and reasoning and problem solving. The greater improvement in reasoning and problem solving in FES patients, relative to healthy controls, is evident, as the FES group improves by 15.6 T scores while the healthy controls improve 9.0 T scores over 10 years.

Table 6
Neuropsychological test results of the participants at baseline (raw scores).

Subtests	Patients (n = 28) Mean (SD) Min-max	Controls (n = 28) Mean (SD) Min-max	F	η^2
TMT-A #	35.2 (13.9) 17–71	23.8 (6.7) 16–45	15.08***	0.22
Symbol coding	45.5 (10.1) 23–63	61.6 (8.9) 40–76	40.05***	0.43
Fluency	21.3 (4.5) 9–38	26.6 (4.5) 20–39	13.94***	0.21
CPT-IP	2.0 (0.6) 0.9–3.1	2.8 (0.5) 1.8–3.5	28.28***	0.34
Letter-number span	12.5 (2.6) 9–25	15.3 (2.9) 10–25	14.78***	0.22
Spatial span	17.3 (3.6) 7–20	18.0 (3.5) 11–21	0.63ns	0.01
HVLT-R	24.8 (4.1) 16–31	27.9 (4.2) 18–35	7.57**	0.12
BVMT-R	22.3 (7.1) 0–32	29.9 (4.6) 18–36	22.91***	0.30
Mazes	18.5 (5.9) 4–25	22.5 (5.2) 9–26	7.04**	0.12
MSCEIT	86.2 (10.4) 68–108	92.7 (9.1) 77–111	6.10*	0.10

Lower TMT-A scores denote higher function. F: Between group significance test. η^2: effect size. ***: p < .001, **: p < .01, *: p < .05, ns: non-significant.

4. Discussion

Using a repeated assessment prospective design on a well-defined first-episode schizophrenia sample compared with pairwise matched healthy controls with a low dropout rate over 10 years, we found that cognitive performance in FES changes and improves at generally the same rate as in healthy individuals until year 6, after which both groups stabilize. These findings challenge some views about the course of cognitive impairments in schizophrenia. First, the results indicate both initial improvement and then stability in the developmental course of cognition. There seems to be normative age-associated changes in cognitive functioning in both groups, which is expected given the young age of the sample at baseline. Furthermore, the development of cognitive functioning in the two groups over 10 years modifies what was observed during the first 6 years. The significant quadratic time effect in our analyses shows that the improvement in both groups early in the course is stabilizing from year 6 onward, with no further improvement.

Previous studies have mainly reported on stability in the cognitive course of schizophrenia and related psychoses (Bergh et al., 2016; Rund et al., 2016; Zanelli et al., 2019; Flaaten Bärthel et al., 2022). Comparisons with these studies are difficult primarily due to sampling methods and difference in cognitive measures. Furthermore, the subjects were older at intake; mean age 26, 28.1, 29.6 and 26.04 years respectively. Our patients were younger at baseline (mean age 21). An alternative explanation for the reported stability in previous studies might be that

Table 5
Means and SD for FES and controls for the overall composite score, working memory and reasoning and problem solving.

	Composite score		Working memory		Reasoning/problem solving	
	Schizophrenia	Controls	Schizophrenia	Controls	Schizophrenia	Controls
Baseline	32.2 (9.8)	47.6 (8.8)	42.7 (12.8)	47.4 (11.3)	40.2 (9.6)	49.7 (10.8)
6 months	37.1 (10.2)		43.8 (12.1)		44.8 (11.2)	
Year 1	36.5 (10.9)		40.6 (11.5)		43.9 (10.7)	
Year 2	38.6 (10.7)	50.3 (8.1)	41.0 (11.3)	50.5 (7.4)	49.5 (8.4)	51.2 (9.8)
Year 3	42.2 (10.4)		43.8 (11.9)		50.3 (9.7)	
Year 4	43.2 (10.9)		44.3 (9.7)		51.6 (8.9)	
Year 6	45.3 (11.4)	54.0 (7.3)	47.4 (10.1)	52.5 (13.2)	53.3 (9.4)	53.3 (10.6)
Year 8	46.0 (11.3)		46.8 (8.8)		54.7 (10.2)	
Year 10	45.2 (11.9)	54.7 (7.8)	46.8 (12.8)	53.9 (8.2)	55.8 (8.2)	58.7 (7.9)

Numbers in mean (SD) T scores.

no large change in cognitive development is taking place after the age of 30 years (Fett et al., 2022). Further, contrasting results might also be due to large gaps between the assessments and differences in test batteries and cognitive domains assessed (and not using the MCCB) during the 10-year follow-up, making it difficult to pinpoint specific periods of decline or improvement in cognitive functioning. When a healthy control group was included (Zanelli et al., 2019; Flaaten Bärthel et al., 2022), it was not matched to the patient group with regards to the most relevant confounding demographic variables, such as age, gender, and education (Albus et al., 1997).

The present results are mostly consistent with our previous reports at the 2-year (Torgalsbøen et al., 2015) and 6-year follow-up studies (Fu et al., 2018), in that the cognitive functioning improved or remained at the same level for both groups, and that the cognitive functioning of the patient group was generally significantly lower than that of the control group across the entire follow-up period. However, there are some notable differences. At the 2-year follow-up assessment, the two groups displayed significantly different cognitive trajectories, as the verbal learning score of the patients declined and the reasoning/problem solving and social cognition scores increased, while the same functions remained unaltered in the control group (Torgalsbøen et al., 2015). Moreover, analyses across 6 years showed a general improvement in cognitive function, except for visual learning, for both groups (Fu et al., 2018). Fnally, Fu et al.'s finding (2018) of a statistically significant Group x Time interaction in working memory was not replicated in the current study. However, we found significant Group X Time linear and quadratic interactions for reasoning and problem solving, demonstrating that the performance in this domain improved more for the FES group than for the control group, particularly for the first two years of follow-up. Thus, for this specific domain, there was a narrowing gap between the groups across time.

While the overall tendency at the 6-year follow-up was that FES and healthy controls tended to improve over time, two cognitive domains developed differently during the 10-year course. No significant change over time occurred for working memory and verbal learning, indicating stability for these domains. The implication is that the extent and timing of the most severe declines, improvements, or stability may differ between cognitive domains (Fett et al., 2022).

It is worth noting that we found no statistically significant group effect for social cognition. In a meta-analysis (Savla et al., 2013), impairments on multiple social cognitive domains were shown in schizophrenia compared to controls. However, this deficit was associated with inpatient status and longer illness duration. Emotion processing is one of five relevant domains in social cognition and is measured by the MSCEIT Managing Emotions Branch in the present study. Social cognition is known to be strongly related to community functioning (Fett et al., 2011), so the positive outcome at 10- year follow-up for most FES patients parallels their relatively intact social cognition.

The differentially greater improvement in the reasoning and problem-solving domain for the FES group shows that the ability to apply and shift strategies effectively to find optimal solutions to problems (Green et al., 2019) is recovering in the FES group. This cognitive domain has shown a strong association with social functioning (Fett et al., 2011; Torgalsbøen et al., 2015), and might have contributed to the high psychosocial functioning in the FES group at follow up. The increased performance in problem solving and reasoning also suggests that some aspects of the cognitive deficit may be partly modifiable with treatment. Another, more cautious interpretation is that the differential change in reasoning and problem solving could be a combination of practice effects in the patient group and ceiling effects in the healthy controls.

It is noteworthy that most participants, 63.5 %, were fully recovered (full participation in social and work functioning and independent living) (Table 3) at the 10-year follow-up point. Signs of full recovery appeared as early as during the two first years (16 %) (Torgalsbøen et al., 2015). The improvements in overall functional recovery in the first two years may be linked to cognitive improvements in that period. It is worth noting that our recovery rates are higher compared to a recent 10-year follow-up study from Norway (Åsbø et al., 2022) reporting a high attrition rate. It has been pointed out that individuals with good recoveries may have greater potential for being lost to follow-up (Lally et al., 2017; Ajnakina et al., 2021). The high retention rate in our study may contribute to our high percentage of fully recovered patients, as they may be more likely to be included in the 10-year follow-up than in studies with lower retention of participants. Another contributing factor may be attributed to the Norwegian health care system, which provides universal coverage and equal access to mental illness treatment for all regardless of socioeconomic status, ethnicity, and area of residence. Thus, our rates of full recovery show what outcome can be expected when comprehensive treatment for first-episode patients is provided.

The cognitive improvement shown in this study for the FES patients might also be influenced by environmental factors such as the access to vocational and social participation in Norway, which provide possibilities for cognitive practice that allow age-appropriate cognitive gains. In contrast, failing to show normative gains in some environments has been raised as a potential explanation (Panayiotou et al., 2020) for results of a study showing significant decline in crystallized cognitive abilities a decade after psychosis onset (Zanelli et al., 2019).

The small sample size, the young age of the sample and the potential contribution of the Norwegian health care system and other context-dependent factors, suggests a limitation to the extent to which the cognitive findings may be generalized to FES patients in other countries. Another potential limitation is the possibility of medication effects on cognition. However, we did not find any significant correlations between daily doses of medication and cognitive scores.

The dropout rates from both groups were low, and we were able to analyze all available data with multi-level analyses, thereby strengthening our findings. Out of 56 participants, 84 % completed every assessment over the 10-year period. Thus, we were able to study the cognitive trajectories in the same individuals over a long period. The MCCB permits standardized comparisons across studies, enabling other researchers to replicate our results in a larger sample of FES.

It has been argued based on meta-analyses that improvements in cognition are mostly accounted for by practice effects in samples of patients with schizophrenia (Szöke et al., 2008) and in first episode samples in the years following a first episode of psychosis (Watson et al., 2022). However, meta-analyses are not sensitive to design features and cognitive measures used in each study. The MCCB is a consensus cognitive battery that has shown relatively small practice effects in validation studies with test-retest periods as brief as 15 days (Keefe et al., 2011; Nuechterlein et al., 2008). In addition, repetition of the MCCB nine times will decrease practice effects (Keefe et al., 2011). Furthermore, two domains showed no change even with multiple administrations. Thus, we argue that the overall changes over time in our study are mainly due to genuine improvements in cognition rather than being fully accounted for by any practice effects.

The main clinical implication from this study is that clinicians should be aware of the possibility of cognitive improvement and recovery in FES, thus contributing to a hopeful attitude in their patients.

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Declaration of competing interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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