

Research Paper

Executive dysfunction in schizophrenia: Predictors of the discrepancy between subjective and objective measures

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ABSTRACT

This study aimed to investigate what characterizes individuals with schizophrenia who experience more or less subjective executive dysfunction in everyday life compared to objective executive performance on neuropsychological tests.

Sixty-six participants with broad schizophrenia spectrum disorders completed a comprehensive assessment of executive function. Discrepancies between performance on neuropsychological tests (objective) and an extensive self-report questionnaire (subjective) of central executive functions (inhibition, shifting and working memory) were calculated. Higher level of self-efficacy was the best predictor of experiencing fewer subjective cognitive complaints compared to objective performance, followed by higher levels of disorganized symptoms. Depressive symptoms did not predict discrepancy between subjective and objective executive function. Higher estimated IQ predicted greater subjective working memory difficulties in everyday life despite better objective performance.

Results may aid clinicians in the assessment and remediation of cognitive impairment. Low self-efficacy may identify individuals who are not able to utilize their potential executive functions in daily life. Interventions aimed at fostering self-efficacy ought to be included in cognitive remediation for these individuals. Disorganized symptoms could prove useful in identifying individuals who are in need of cognitive remediation for executive dysfunction, despite that they overestimate their skills. These individuals may benefit from efforts to increase insight into cognitive dysfunction.

1. Introduction

Executive functions are among the most severely impaired cognitive functions in schizophrenia (East-Richard et al., 2020; Snyder et al., 2015). Deficits on both objective and subjective measures of executive functions such as inhibition, shifting and working memory have been reported (Bulzacka et al., 2013; Forbes et al., 2009; Garlinghouse et al., 2010; Laere et al., 2018; Westerhausen et al., 2011). Executive functions are also important predictors of functional outcome (Green, 1996; McGurk and Mueser, 2006), underlining the need for assessment of these functions.

Executive functions are challenging to assess because they are considered separate, but interacting cognitive functions (Friedman and Miyake, 2017). Neuropsychological tests may therefore lack the specificity needed to isolate components of executive functions (Snyder et al.,

2015). On the other hand, executive functions are especially required during novel, complex situations. As a consequence neuropsychological tests may also fail to generalize to everyday situations because of their structured nature (Sbordone, 2014).

One way of addressing these challenges may be to combine tasks aimed at central components of executive functions with subjective assessment of real-world functioning in domains thought to reflect the same underlying components. However, diverging scores have been observed on objective (neuropsychological tests) and subjective measures (self-report questionnaires) across both healthy samples and clinical samples with neurological or psychiatric disorders (Toplak et al., 2013). One explanation for this is that despite measuring the same underlying constructs, objective measures are thought to capture skills, while subjective measures capture the application of these skills in the real-world context (Gioia et al., 2010; McAuley et al., 2010). Subjective

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measures on the other hand provide valuable information about everyday experience, but may be confounded by emotional states (Shwartz et al., 2020).

Research on the discrepancy between subjective and objective executive function in schizophrenia is limited, but studies on cognition in general have found the associations between subjective and objective measures to be weaker among individuals with schizophrenia than among healthy individuals (Medalia et al., 2008; Potvin et al., 2014). It has been suggested that co-morbid symptoms and lack of insight into cognitive impairment biases subjective cognitive assessment for a substantial portion of individuals with schizophrenia (Burton et al., 2016; Harvey and Pinkham, 2015; Raffard et al., 2020). Overestimation of cognition is problematic because it is associated with poorer functional outcomes (Gould et al., 2015). Similarly, overestimation of social cognition is related to poorer social function (Silberstein et al., 2018). Underestimation of skills is also problematic if lack of confidence leads to avoidance of activities (Silberstein and Harvey, 2019). Furthermore, subjective cognitive complaints are related to internalized stigma and poorer quality of life among persons with schizophrenia (Shin et al., 2016).

A novel method, the Stoicism-Sensitivity framework (Miskowiak et al., 2016) previously used in studies on bipolar and depressive disorders, may prove useful in quantifying the degree and direction of discrepancy between subjective and objective executive function. By comparing rankings on subjective and objective measures it is possible to view discrepancy as a bidirectional phenomenon ranging from *stoicism* (less subjective complaints relative to objective performance) to *sensitivity* (more subjective complaints relative to objective performance). Fig. 1 is an illustration of the framework where discrepancy scores fall along a scale ranging from -10 to $+10$.

Since discrepancy between subjective and objective measures have been observed in many aspects of cognition and function in schizophrenia, the Stoicism-Sensitivity framework may offer a standardized way to study discrepancy. One advantage of the Stoicism-Sensitivity framework is that it quantifies both under- and overestimation along the same dimension. By using continuous values, the framework avoids having to establish cut-off points for distinct categories. Instead, participants are assigned individual scores for degree of stoicism or sensitivity relative to the sample. In addition, the framework avoids simply using high levels of subjective complaints as a proxy for accurate self-assessment.

Positive and negative symptoms are the most researched predictors of the discrepancy between subjective and objective cognition in schizophrenia, but results have been mixed (Homayoun et al., 2011; Potvin et al., 2014). New insight into the predictive value of psychotic symptoms could perhaps be gained by looking at a broader spectrum of psychotic symptoms. Wallwork et al.'s (2012) five factor consensus model of the Positive and Negative Syndrome Scale (PANSS) could prove optimal for this purpose. The model distinguishes between excited, disorganized and depressive symptoms in addition to positive and negative symptoms. Disorganized symptoms are particularly interesting in this regard as they share a stronger relationship with cognition

than positive symptoms (Rodriguez-Jimenez et al., 2013; Ventura et al., 2010). Furthermore, depressive symptoms have been associated with more subjective cognitive complaints among persons with schizophrenia (Burton et al., 2016; Raffard et al., 2020; Sellwood et al., 2013).

Less attention has been paid to psychological mechanisms as predictors of the relationship between subjective and objective cognition (Cella et al., 2014). One such psychological mechanism that may have predictive value for the subjective-objective cognition discrepancy is self-efficacy. Self-efficacy is beliefs in one's capability of the behaviors needed to produce a desired outcome (Bandura, 1977). Higher self-efficacy increases motivation for, and effort in, the application of skills. People high in self-efficacy tend to set goals that are more ambitious, exert more effort and be more persistent in the face of difficulty. In contrast, people low in self-efficacy make fewer attempts and give up more easily (Bandura, 1977; Bandura, 2011). Self-efficacy is increasingly being recognized as an important factor in the relationship between cognition, negative symptoms and real-world functioning in schizophrenia (Allott et al., 2020; Ventura et al., 2014). Because of self-efficacy's relationship with motivation and effort, it has potential as an explanatory variable for the gap between objectively measured capacities and subjectively reported functioning.

The aim of the current study was to investigate potential predictors of the discrepancy between subjective and objective executive dysfunction, in persons with schizophrenia. Using the abovementioned Stoicism-Sensitivity framework, the degree and direction of the discrepancy between subjective and objective executive dysfunction was quantified (Miskowiak et al., 2016; Petersen et al., 2019). We used self-efficacy and a five-factor model of psychotic symptoms as predictors. Because experience with being integrated into society has shown to improve correlations between self-assessment and function in schizophrenia, outcomes were checked against age, current participation in school or work and level of education completed (Harvey and Pinkham, 2015; Olsson et al., 2019). Other potential confounds that have been seen to influence self-assessment in other contexts were also controlled for including gender, estimated general intellectual ability, diagnosis and overall symptoms (Harvey and Pinkham, 2015; Olsson et al., 2015). We hypothesized that:

- Higher levels of self-efficacy predict *lower* subjective than objective dysfunction
- More disorganized symptoms predict *lower* subjective than objective dysfunction
- Greater depressive symptoms predict *higher* subjective than objective dysfunction

2. Methods

2.1. Participants

The sample ($n = 66$, 40 males and 26 females, aged 16–44 years, $M = 25.53$, $SD = 6.56$) consisted of individuals participating in a randomized controlled trial evaluating the effects of cognitive remediation targeting

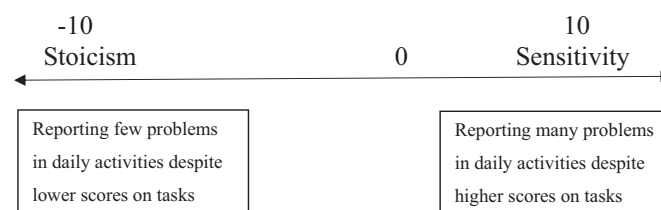


Fig. 1. The Stoicism-Sensitivity framework.

Table 1
Demographical and clinical characteristics ($n = 66$).

Participant characteristic	Frequency	Mean	SD	SE
Gender				
Female	26 (39.39%)			
Male	40 (60.61%)			
Age		25.53	6.55	0.81
Age females		25.38	5.99	1.17
Age males		25.62	6.96	1.10
Education in years		12.83	1.81	0.22
Estimated IQ ^a		99.43	13.29	1.81
Diagnosis (DSM-IV) ^b				
Schizophrenia	30 (45.50%)			
Schizoaffective disorder	14 (21.20%)			
Schizophreniform disorder	6 (9.10%)			
Psychotic disorder NOS ^c	15 (22.7%)			
Delusional disorder	1 (1.50%)			
Duration of untreated psychosis (weeks)		219.38	209.77	25.82
Hospitalizations		3.28	5.07	0.63
Months in hospital		5.75	8.15	1.01
Symptoms: Total scores ^d				
Psychosis – positive		11.97	3.37	0.42
Psychosis – negative		15.43	4.87	0.61
Psychosis – disorganized		7.15	1.85	0.23
Psychosis – depressive		10.38	2.83	0.35
Psychosis – excited		8.62	2.56	0.32
Summed		53.55	8.91	1.11
Positive, disorganized and excited		27.74	6.00	0.74
Depressive and negative		25.82	5.99	0.74
Symptoms: Mean scores				
Psychosis – positive		2.99	0.84	0.10
Psychosis – negative		2.57	0.81	0.10
Psychosis – disorganized		2.38	0.62	0.08
Psychosis – depressive		3.46	0.94	0.12
Psychosis – excited		2.15	0.64	0.08
Drug therapy	51 (77.30%)			
DDD ^e antipsychotics		0.672	0.75	0.09
DDD antidepressants		0.491	0.87	0.11
DDD mood stabilizers		0.143	0.47	0.06
DDD CNS ^f stimulants		0.025	0.15	0.02
DDD anxiolytics AH ^g		0.015	0.09	0.01
DDD anxiolytics BZ ^h		0.073	0.28	0.03
DDD sedatives AH		0.045	0.24	0.03
DDD sedatives BZ		0.131	0.38	0.05

^a IQ was estimated from two subtest of Wechsler Abbreviated Scale of Intelligence (WASI): Vocabulary and Matrix Reasoning. The normative mean of estimated IQ is 100 ($SD = 15$).

^b According to the criteria in the Diagnostic and statistical manual of mental disorders, DSM-IV-TR (American Psychiatric Association, 2000).

^c NOS = Not otherwise specified.

^d Summed scores for the items considered part of the five-factor consensus model (Wallwork et al., 2012). Scores on the Positive and Negative Syndrome Scale (PANSS) range from 1 “missing” to 7 “extreme,” 4 is considered psychotic threshold for delusions and hallucinations.

^e DDD = Defined daily dose.

^f CNS = central nervous system.

^g AH = antihistamines.

^h BZ = benzodiazepines.

executive dysfunction ([clinical.trials.gov: NCT03048695](https://clinicaltrials.gov/ct2/show/study/NCT03048695)). The data presented are from the baseline assessment. Participants were recruited among patients referred for treatment of psychosis at Innlandet Hospital in Norway. The inclusion criteria were age 16 to 69 years, symptoms of broad schizophrenia spectrum disorder and self-reported executive dysfunction according to The Behavior Rating Inventory of Executive Function - Adult version, BRIEF-A (Roth and Gioia, 2005). In the Norwegian cultural context healthy participants score lower than U.S. norms, so a total score $> T55$ was considered clinically relevant (Løvstad et al., 2016). Exclusion criteria included comorbid neurological conditions, ongoing alcohol or substance abuse, intellectual impairment ($IQ < 70$) and treatment for psychosis for longer than five years. The study was approved by an ethics committee (The Regional Committee for Medical and Health Research Ethics of South-Eastern Norway, application no 2015/2118) and participants gave informed consent. See Table 1 for further description of participants.

2.2. Procedure

Diagnostic assessment was conducted by a clinical psychologist according to the criteria in the Diagnostic and Statistical Manual of Mental Disorders, DSM-IV-TR (American Psychiatric Association, 2000). Cognitive assessments and symptom ratings were undertaken by the same clinical psychologist or one of two trained psychiatric nurses. Training for the clinical assessment was provided by a specialist in psychiatry and for the cognitive assessment by a specialist in neuropsychology.

2.3. Objective cognitive measures

Inhibition was assessed using the age normed scaled score for time spent on Color-Word Interference Test condition three (Color-Word 3) from the Delis-Kaplan Executive Function System (D-KEFS) (Delis et al.,

2001). The age normed *T*-score for commission errors from Conners Continuous Performance Test 3rd edition (CPT3) was converted to the same numerical scale as the other objective tests and combined with Color-Word 3 to make an inhibition domain score (Conners, 2014). **Shifting** was measured by averaging the scaled scores for time spent on condition four of the Color-Word Interference Test (Color-Word 4) and condition four of the Trail Making Test from D-KEFS (Delis et al., 2001). **Working memory** was assessed by averaging the age normed scaled scores from the Digit Span and Letter-Number Sequencing subtests in the Wechsler Adult Intelligence Scale – 4th edition, WAIS-IV (Wechsler, 2008). The domain scores were combined to create a mean score for objective executive function in concordance with current models of separate, but interacting executive components (Friedman and Miyake, 2017).

2.4. Subjective cognitive measures

Subjective executive function was measured with the 75-item questionnaire Behavior Rating Inventory of Executive Function - Adult version, BRIEF-A, (Roth and Gioia, 2005). The subscales Inhibit, Working Memory and Shift were selected because of their theorized conceptual overlap with the corresponding neuropsychological tests. The subscales had adequate Cronbach’s Alpha scores showing good internal consistency: Inhibit (α .79), Shift (α .71) and Working Memory (α .71). The *T*-scores on the three subscales were averaged to create a total subjective executive functioning measure.

2.5. Predictor variables

Self-efficacy was assessed with the ten-item questionnaire General Perceived Self-Efficacy Scale (Schwarzer and Jerusalem, 1995). The scale’s unidimensional factor structure, test-retest reliability and correlations with theoretically related concepts have been confirmed across cultures (Luszczynska et al., 2005; Scholz et al., 2002). High test-retest reliability and good internal consistency has also been found when employing the scale in schizophrenia (Chiu and Tsang, 2004). In the current study, the Cronbach α coefficient for the scale was α .85, indicating good internal consistency.

Symptoms of psychosis at the time of testing were assessed with the Structured Clinical Interview for the Positive and Negative Syndrome Scale for Schizophrenia, the SCI-PANSS (Kay et al., 1987). We grouped the symptoms according to a five-factor consensus model yielding a total score for positive, negative, disorganized, depressive and expressive symptoms (Wallwork et al., 2012). In the current study, the Cronbach alpha coefficients were α .65 for the positive symptoms subscale, α .86 for the negative symptoms subscale, α .59 for the disorganized symptoms subscale, α .54 for the depressive symptoms subscale and α .68 for the expressive symptoms subscale.

2.6. Variables controlled for

Significant predictors were checked against the effects of gender and general intellectual ability (IQ). IQ was estimated with Vocabulary and Matrix Reasoning from Wechsler Abbreviated Scale of Intelligence (WASI) (Wechsler, 1999). To assess the influence of amount of life-experience with challenging situations we used the variables age, years of education, education level completed (0 - not completed elementary school, 1 - completed elementary school, 2 - started secondary school, 3 - completed secondary school, 4 - started higher education, 5 - completed higher education) and occupational status. Occupational status was scored using the same criteria as the Social Functioning Scale (Birchwood et al., 1990): ranging from 10 for full-time work or study, via part-time and supported work placements to 0 if the participant had not worked in more than two years, was not actively job seeking and considered that working would be impossible. To check for the influence of remission status we entered summed

symptoms on all five symptom groups from PANSS, as well as summed scores for positive, disorganized and excited symptoms and summed scores for depressive and negative symptoms (Wallwork et al., 2012). The other clinical variables controlled for were diagnosis, duration of untreated psychosis, number of hospitalizations, months spent in hospital and antipsychotic drug treatment.

2.7. Data analysis

We applied the Stoicism-Sensitivity framework previously used in studies on affective disorders (Miskowiak et al., 2016; Petersen et al., 2019). Assuming that accurate assessment would lead to a similar ranking on both measures, the objective rank was subtracted from the subjective rank in the inhibition, shifting and working memory domains, as well as for the combined total executive functioning score. The differences in ranking were then transformed into a stoicism-sensitivity score by using the following formula:

$$\frac{(New_{max} - New_{min})}{(Old_{max} - Old_{min})} * (X - Old_{max}) + New_{max}$$

The scores fell along a scale ranging from -10 (maximum **stoicism**: least subjective complaints relative to objective performance) to 10 (maximum **sensitivity**: most subjective complaints relative to objective performance).

Multiple linear regression analysis was used to investigate predictors of sensitivity and stoicism. Analyses were performed using SPSS Statistics, version 26. Data were assumed to be missing at random and dealt with in a pairwise fashion. The Kolmogorov-Smirnov test was significant for disorganized symptoms $D(65) = 0.149, p = .001$, depressive symptoms $D(65) = 0.147, p = .001$ and self-efficacy $D(56) = 0.152, p = .003$, indicating deviation from the normal distribution of scores. Bias-corrected and accelerated bootstrapping was performed to ensure a robust analysis. Significant predictors were retained and separate linear regressions were run with each control variable to check for potential influence.

Table 2
Scores on measures of executive function.

Variable	Mean	SD	SE	r	Sig.
Total objective executive functioning ^a	8.37	2.06	0.26		
Total subjective executive functioning ^b	62.27	9.37	1.22	-.10	.480
Objective inhibition					
Color-Word 3 inhibition	7.76	3.35	0.42		
CPT3 commissions	57.15	10.91	1.35		
Subjective inhibition				-.35	.009
BRIEF-A inhibit subscale	56.68	12.16	1.61		
Objective shifting	7.21	3.55	0.44		
Trail making test 4	6.53	3.98	0.52		
Color-Word 4 switching	7.60	3.74	0.47		
Subjective shifting				-.13	.337
BRIEF-A shift subscale	62.64	11.33	1.49		
Objective working memory	9.72	2.35	0.29		
Digit span	9.79	2.58	0.33		
Letter-number sequencing	9.69	2.75	0.35		
Subjective working memory				-.05	.724
BRIEF-A working memory subscale	67.14	10.64	1.40		

Note: Correlations are Pearson’s correlations between objective and subjective domains. **Bold** values are significant at the $p < .05$ level in a two-tailed test. The only significant correlation detected was between greater subjective complaints of inhibition and lower scores on the tasks for objective inhibition, $r = -.35, p .009$.

^a Objective scores derived from normed scaled scores in the D-KEFS and WAIS-IV all have a mean of 10 ($SD = 3$). Higher scores indicate better performance. CPT3 *T*-scores have a mean of 50 ($SD = 10$). CPT3 scores were converted to the same scale as the other objective scores before combining them.

^b Subjective scores are based on normed BRIEF-A *T*-scores with a mean of 50 ($SD = 10$). Higher scores indicate greater dysfunction.

Table 3
Correlations between variables.

	Subjective executive function				Objective executive function				Self-efficacy	Symptoms of psychosis				
	Total	Inhibition	Shifting	Working memory	Total	Inhibition	Shifting	Working memory		Positive symptoms	Negative symptoms	Disorganized symptoms	Depressive symptoms	Excited symptoms
Subjective EF														
Total														
Inhibition	.78**													
Shifting	.80**	.32**												
Working memory	.87**	.55**	.62**											
Objective EF														
Total	-.06	-.18	.08	-.04										
Inhibition	-.19	-.31*	-.01	-.14	.83**									
Shifting	.05	-.05	.13	.05	.88**	.69**								
Working memory	-.07	-.14	.03	-.05	.59**	.28*	.22							
Self-efficacy	-.41**	-.21	-.47**	-.36**	-.33*	-.14	-.37**	-.16						
Symptoms of psychosis														
Positive	-.13	-.12	-.08	-.13	.01	-.03	.03	.02	.15					
Negative	-.19	-.28*	-.05	-.10	-.03	.01	.01	-.10	-.03	.10				
Disorganized	-.19	-.23	-.04	-.17	-.27*	-.25*	-.24	-.13	.24	.38**	.16			
Depressive	.17	-.08	.40**	.15	.06	.08	.03	.04	-.20	.10	.14	-.04		
Excited	.14	-.07	.19	.05	.07	-.13	.12	.14	-.14	.49**	-.07	.17	.12	
Estimated IQ	-.20	-.30*	-.13	-.08	.48**	.36**	.21	.66**	.02	-.19	-.20	-.22	.00	-.08

EF = Executive Function.

* Correlation is significant at $< p .05$.

** Correlation is significant at $< p .01$.

Table 4

Linear model of predictors of stoicism and sensitivity in executive dysfunction with 95% bias corrected and accelerated confidence intervals reported in brackets. Confidence intervals and standard errors based on 1000 bootstrap samples.

Linear models	<i>B</i>	<i>SE B</i>	β	Sig.	r^2
Total executive function					
Model 1					.27
Constant	11.55	2.97			
Self-efficacy	-0.52 [-0.73, -0.27]	0.12	-0.52	.001	
Model 2					.38
Constant	14.73	5.06			
Self-efficacy	-0.46 [-0.70, -0.19]	0.13	-0.47	.003	
Disorganized symptoms	-0.79 [-1.38, -0.16]	0.31	-0.29	.013	
Depressive symptoms	0.11 [-0.33, 0.50]	0.21	0.06	.598	
Positive symptoms	0.10 [0.68, -0.34]	0.24	0.07	.679	
Negative symptoms	-0.14 [-0.39, -0.08]	0.13	-0.14	.274	
Excited symptoms	0.11 [-0.39, 0.59]	0.24	0.06	.642	
Inhibition					
Model 1					.08
Constant	6.19	2.78			
Self-efficacy	-0.26 [-0.46, -0.03]	0.11	-0.28	.019	
Model 2					.29
Constant	16.29	5.21			
Self-efficacy	-0.23 [-0.45, 0.01]	0.12	-0.24	.057	
Disorganized symptoms	-1.07 [-1.78, -0.50]	0.35	-0.42	.007	
Depressive symptoms	-0.07 [-0.56, 0.35]	0.21	-0.05	.745	
Positive symptoms	0.17 [-0.23, 0.64]	0.22	0.13	.429	
Negative symptoms	-0.16 [-0.38, 0.07]	0.13	-0.17	.198	
Excited symptoms	-0.23 [-0.76, 0.45]	0.26	-0.13	.351	
Shifting					
Model 1					.28
Constant	12.01	2.98			
Self-efficacy	-0.53 [-0.73, -0.31]	0.12	-0.53	.001	
Model 2					.36
Constant	9.45	5.99			
Self-efficacy	-0.45 [-0.68, -0.21]	0.14	-0.46	.001	
Disorganized symptoms	-0.49 [-1.05, 0.05]	0.28	-0.19	.086	
Depressive symptoms	0.29 [-0.15, 0.65]	0.23	0.17	.188	
Positive symptoms	0.07 [-0.37, 0.54]	0.21	0.05	.751	
Negative symptoms	-0.05 [-0.32, 0.21]	0.14	-0.05	.717	
Excited symptoms	0.14 [-0.37, 0.70]	0.23	0.08	.532	
Working memory					
Model 1					.17
Constant	8.46	2.74			
Self-efficacy	-0.37 [-0.56, -0.17]	0.10	-0.43	.001	
Model 2					.24
Constant	13.45	5.03			
Self-efficacy	-0.33 [-0.57, -0.08]	0.11	-0.39	.008	
Disorganized symptoms	-0.67 [-1.19, -0.08]	0.29	-0.29	.028	
Depressive symptoms	-0.14 [-0.51, 0.25]	0.20	-0.10	.485	
Positive symptoms	-0.02 [-0.40, 0.32]	0.21	-0.01	.920	
Negative symptoms	-0.13 [-0.41, 0.16]	0.12	-0.16	.252	
Excited symptoms	0.33 [-0.10, 0.90]	0.23	0.21	.165	

Note: Significant predictors have *p*-values in **bold**. Model 1 was considered the better fit as there was no significant *F*-change for model 2 for Total Executive function *p* .182, Shifting, *p* .438 and Working Memory, *p* .110. Model 2 was considered the better fit for Inhibition.

3. Results

3.1. Executive function

Mean total objective executive function score in the sample was significantly lower than the normative mean scaled score of 10 in a one-sample *t*-test: *M* 8.27, *SD* 2.16, *SE* 0.27, *t* (1, 64) = -6.439, *p* .000. Also, total subjective complaints, *M* 62.03, *SD* 9.23, *SE* 1.21, were significantly higher than the normative mean *T*-score of 50, *t* (1,57) = 9.93, *p* .000. See Table 2 for scores on measures of executive function and Table 3 for correlations between variables.

3.2. Stoicism and sensitivity

The distribution of stoicism and sensitivity scores for total executive function, *M* -1.19, *SD* 5.05, *SE* 0.67, showed a slight overrepresentation

of stoicism. Thirty-two participants, 48.5%, ranked lower on total subjective complaints than objective measures (stoicism) and 26 participants, 39.4%, ranked higher on total subjective complaints than objective measures (sensitivity). Eight participants, 12.1%, had missing scores on at least one measure.

3.3. Predictors of stoicism and sensitivity

For total executive functioning, the strongest predictor of greater stoicism (fewer subjective complaints relative to objective performance) was higher self-efficacy, accounting for 27% of the variation, *F* (1, 51) = 19.21, *p* = .001, r^2 = .27. See Table 4 for results of the regression analysis.

Separate analysis of the executive function domains found that greater self-efficacy was the strongest predictor of greater stoicism in shifting, Model 1: *F* (1, 50) = 19.85, *p* .000, r^2 = .27, and working

Table 5
Influence of demographic and clinical variables.

Linear regression controlling for:	Total executive function			Inhibition			Shifting			Working memory		
	F change	Sig.	Δr^2	F change	Sig.	Δr^2	F change	Sig.	Δr^2	F change	Sig.	Δr^2
Gender	0.05	.833	.00	0.22	.645	.00	0.02	.900	.02	0.11	.740	.00
Age	1.97	.167	.03	0.03	.866	.00	1.43	.238	.02	0.91	.346	.02
Estimated IQ ^a	1.44	.237	.02	0.79	.379	.01	0.42	.521	.00	12.03	.001	.15
Diagnosis	0.52	.476	.01	0.07	.796	.00	0.24	.628	.00	0.00	.972	.00
DUP ^b	1.66	.204	.02	1.91	.173	.03	1.15	.290	.02	0.21	.652	.00
Total symptoms	0.02	.894	.00	0.79	.378	.01	1.09	.302	.02	0.22	.642	.00
Positive, disorganized & excited symptoms	1.09	.301	.01	0.00	.971	.00	1.23	.274	.02	1.36	.250	.02
Negative and depressed symptoms	0.48	.492	.01	1.39	.245	.02	0.19	.994	.00	2.71	.106	.04
Drug therapy (yes/no)	0.43	.513	.01	0.40	.533	.01	0.76	.388	.01	0.35	.556	.01
DDD ^c antipsychotics	0.00	.991	.00	0.86	.357	.02	0.09	.761	.00	0.08	.775	.00
Hospitalizations	0.26	.611	.00	0.52	.474	.01	0.25	.622	.00	0.32	.572	.01
Months in hospital	2.23	.142	.03	0.39	.534	.01	2.16	.148	.03	0.10	.757	.00
Occupational status ^d	0.35	.558	.01	0.08	.778	.00	0.18	.676	.00	0.49	.487	.01
Years of education	0.15	.705	.00	0.54	.465	.01	0.13	.717	.00	0.39	.538	.01
Education completed ^e	0.06	.807	.00	1.20	.280	.02	0.15	.705	.00	0.37	.546	.01

Note: Significant predictors identified in the main analysis were retained (self-efficacy and disorganized symptoms) and controlling variables were added to the linear regression model one-by-one. Bootstrapping was performed ($n = 1000$) similar to main analysis. Values in **bold** are significant.

^a IQ was estimated from two subtest of Wechsler Abbreviated Scale of Intelligence (WASI): Vocabulary and Matrix Reasoning.

^b Duration of untreated psychosis.

^c DDD = Defined daily dose.

^d Occupational status was coded the same way as in the Social Functioning Scale (Birchwood et al., 1990).

^e Level of education completed was coded 0 - not completed elementary school, 1 - completed elementary school, 2 - started secondary school, 3 - completed secondary school, 4 - started higher education, 5 - completed higher education.

memory, $F(1, 49) = 11.19$, $p = .002$, $r^2 = .19$. However, in the inhibition domain more disorganized symptoms were a stronger predictor of stoicism than self-efficacy, Model 2: $F(6, 44) = 3.01$, $p = .015$, $\Delta r^2 = .22$. Depressive, positive and negative symptoms were not significant predictors of stoicism and sensitivity in any domain.

3.4. Controlling for demography and clinical variables

Gender did not change the significance of the predictive value of self-efficacy and disorganized symptoms on stoicism-sensitivity. Nor did experience from daily life measured by age, occupational status, years of education, level of education completed or estimated IQ. However, higher estimated IQ independently predicted greater sensitivity (greater subjective complaints despite better performance on tests) in the working memory domain only, $F(3, 37) = 13.76$, $p = .000$, $\Delta r^2 = .15$. The clinical variables, diagnosis, symptoms, duration of untreated psychosis and treatment had no significant bearing on the results. See Table 5 for details.

4. Discussion

The present study investigated potential predictors of discrepancy between subjective and objective executive function among persons with schizophrenia. The discrepancy was quantified using a novel framework creating a scale ranging from sensitivity (greater subjective complaints than objective dysfunction) to stoicism (fewer subjective complaints than objective dysfunction) (Miskowiak et al., 2016). We found that participants were characterized by both sensitivity and stoicism, which is in line with studies finding both over- and underestimation of cognition and social cognition (Burton et al., 2016; Silberstein et al., 2018). Stoicism and sensitivity scores were normally distributed, but there was slightly higher occurrence of stoicism in the sample in total executive function. This might seem surprising considering that subjective executive complaints were an inclusion criterion. However, this only shows that despite increased subjective complaints in the group as a whole compared to the normative mean in a healthy population, there are still individual variations in how well subjective complaints align with objective performance within the sample.

As expected, greater self-efficacy was associated with greater

stoicism and lower self-efficacy was associated with greater sensitivity in all domains explaining a substantial amount of the variance in discrepancy in working memory, shifting and total executive function. This finding emphasizes the importance of exploring psychological factors as explanations for discrepancy between subjective and objective cognitive assessment (Cella et al., 2014). The effect of self-efficacy on stoicism-sensitivity was not better explained by gender, diagnosis, total symptoms, age, intellectual abilities, occupational status or having longer experience within the educational system. Nevertheless, we found that higher estimated IQ independent of self-efficacy, predicted greater sensitivity in the working memory domain alone. It is not clear whether this is due to an association between intellectual capacity and the ability to self-monitor working memory performance, or whether those who perform well on tasks measuring intellectual ability expect more from their working memory.

Our second hypothesis was partially supported. We expected higher levels of disorganized symptoms to predict greater stoicism, and found that it was the superior predictor of stoicism in the inhibition domain. The mechanism is not known, but perhaps disorganized symptoms interfere with attention so that subjective experiences of problems with inhibition to a greater degree go unnoticed. Disorganized symptoms appear to be fairly unexplored as a predictor of the subjective-objective cognition discrepancy, although one study found an association between a single item for disorientation and lower subjective cognitive complaints (Baliga et al., 2020).

Our third hypothesis was not supported. Higher levels of depressive symptoms did not predict greater sensitivity. Considering the consistent findings in other studies of a relationship between depressive symptoms and subjective cognitive complaints, it was surprising that depressive symptoms did not predict sensitivity in the current study (Burton et al., 2016; Durand et al., 2015; Raffard et al., 2020; Sellwood et al., 2013). One explanation for this might be that even though several participants had mild and moderate depressive symptoms, few had severe depressive symptoms. Studies with healthy individuals across cultures has shown that mild self-reported dysphoria is associated with more accurate self-assessment of capabilities - a phenomenon known as depressive realism. According to these studies, non-dysphoric individuals often overestimate their abilities (Moore and Fresco, 2012). Research on self-assessment of daily function in schizophrenia has also shown that

depression was associated with accuracy rather than underestimation (Harvey et al., 2017). In addition, we used a clinician rating for depressive symptoms, whereas some of the previous studies have used self-reported depression scales which may have resulted in lower scores (Moore and Fresco, 2012).

Much of the emerging research on discrepancies between subjective and objective cognition in schizophrenia has favored lack of insight into cognitive impairment as the primary explanation (Medalia et al., 2008). We may also interpret the most extreme stoicism and sensitivity scores among our participants as over- and underestimation of executive skills. However, some degree of discrepancy between subjective and objective measures of executive function was expected, and may at least partially also be explained by the problems inherent in measuring executive function. Previous research has pointed out that task measures specific enough to isolate components of executive function in the lab often have little in common with the novel, complex real-life situations where the interplay of executive functions are most required (Sbordone, 2014). When combining objective and subjective measures we must keep in mind that we are measuring theoretically assumed underlying brain functions, but at two different levels of measurement. Executive tasks in the lab aim to tap capacity, while the subjective measures aim to tap performance in real-life (Gioia et al., 2010).

There are several possible interpretations of the finding that self-efficacy predicts stoicism and sensitivity. The direction of relationships between cognition, negative symptoms, real-world function and self-efficacy or related psychological concepts has proven difficult to disentangle and are currently under debate (Beck et al., 2018; Chang et al., 2017). It is possible that adequate self-efficacy is a pre-requisite for attempting activities that lead to greater stoicism when successful (Cardenas et al., 2013). However, it is also possible that self-efficacy is better preserved among individuals who make few attempts at challenging activities due to avoidant coping strategies (Lysaker et al., 2001). In addition, since self-efficacy is a subjective measure, it is not possible to rule out that challenges to accurate self-assessment also affect this measure for some participants.

4.1. Implications

Although the number of studies exploring subjective cognition in schizophrenia is growing, there are few specifically focusing on executive functions, making conclusions tentative at this point. Still, the present study has several possible implications. The results indicate that disorganized symptoms can help identify stoic individuals. Stoic individuals may be more likely to turn down cognitive remediation (Balzan et al., 2014). When daily function indicates that stoic individuals may benefit from cognitive remediation or supportive services, interventions should include efforts to increase recognition of cognitive difficulties in everyday life (Medalia et al., 2008).

However, our results also raise ethical concerns over whether interventions aimed at increasing insight into cognitive impairment may harm self-efficacy (Cella et al., 2014; Rose et al., 2008). This could be counterproductive, considering the importance of self-efficacy to well-being in severe mental illness (Gleeson et al., 2020; Hansson, 2006). Sensitive participants may also have difficulty engaging during cognitive remediation due to low self-efficacy (Beck et al., 2018; Chang et al., 2017). To ensure that interventions are effective and ethically sound for sensitive individuals, they should be carried out in a manner that fosters self-efficacy (Allott et al., 2020; Cella and Wykes, 2019).

4.2. Strengths and limitations

The extensive test battery and questionnaire specifically tapping core components of executive function is a strength of this study. There are, however, also some limitations that warrant mentioning. Our selection of objective measures allow for comparison with previous research, although the specificity of these measures has been drawn into question

(Barch et al., 2009; Miyake et al., 2000). We chose to focus on components of executive functions that aligned with the subscales of the BRIEF-A questionnaire. Tasks that are more complex may be subject to task impurity (Donohoe and Robertson, 2003; Roca et al., 2014). However, we acknowledge that the inclusion of more complex executive tasks such as Wisconsin Card Sorting Test which has been shown to predict function (McGurk and Meltzer, 2000) may have been beneficial. Subjective executive complaints were part of the inclusion criteria, but we assume our sample to be representative of persons with schizophrenia in this regard since scores were similar to other studies (Bulzacka et al., 2013; Garlinghouse et al., 2010).

Importantly, the analyses were correlational and thus cannot establish causal relationships between the variables. Because the study is part of a cognitive remediation trial, we did not include a healthy control group and scores were instead standardized using norms. Precautions should be taken in the generalization of findings because the sample in the study is somewhat heterogeneous and small. Specifically, the sample has a young mean age and excluded anyone who had received treatment for longer than five years. Therefore, we do not know if the results will generalize to individuals who have been living with schizophrenia spectrum disorders for longer. A longer duration in stable remission from psychotic symptoms is related to higher correlations between self-assessment and daily function (Harvey et al., 2019; Olsson et al., 2015). For the youngest participants in the present study variables such as level of education and occupational status are likely to change since some are currently still in secondary school.

Not all potential predictors of discrepancy were accounted for. For example, the present study could have benefitted from the inclusion of more proximal measures of functioning in daily life. Experience with everyday situations has previously shown to be associated with more accurate assessment in other areas (Harvey and Pinkham, 2015). This could be interesting directions for future research, in addition to longitudinal studies of discrepancy over time.

CRedit authorship contribution statement

Ingvild Haugen: Investigation, formal analysis and writing – original draft, **Jan Stubberud:** Conceptualization, Supervision and writing – review and editing, **Torill Ueland:** Writing – review and editing, **Elisabeth Haug:** Conceptualization, supervision and writing – review and editing, **Merete Glenne Øie:** Conceptualization, funding acquisition, project administration, supervision and writing – review and editing.

Declaration of competing interest

The authors have no conflicting interests to declare.

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