Psychological Medicine (2017), **47**, 755–765. © Cambridge University Press 2016
doi:10.1017/S0033291716003044

ORIGINAL ARTICLE

Relationship of amotivation to neurocognition, self-efficacy and functioning in first-episode psychosis: a structural equation modeling approach

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Background. Better understanding of the complex interplay among key determinants of functional outcome is crucial to promoting recovery in psychotic disorders. However, this is understudied in the early course of illness. We aimed to examine the relationships among negative symptoms, neurocognition, general self-efficacy and global functioning in first-episode psychosis (FEP) patients using structural equation modeling (SEM).

Method. Three hundred and twenty-one Chinese patients aged 26–55 years presenting with FEP to an early intervention program in Hong Kong were recruited. Assessments encompassing symptom profiles, functioning, perceived general self-efficacy and a battery of neurocognitive tests were conducted. Negative symptom measurement was subdivided into amotivation and diminished expression (DE) domain scores based on the ratings in the Scale for the Assessment of Negative Symptoms.

Results. An initial SEM model showed no significant association between functioning and DE which was removed from further analysis. A final trimmed model yielded very good model fit ($\chi^2 = 15.48$, $p = 0.63$; comparative fit index = 1.00; root mean square error of approximation <0.001) and demonstrated that amotivation, neurocognition and general self-efficacy had a direct effect on global functioning. Amotivation was also found to mediate a significant indirect effect of neurocognition and general self-efficacy on functioning. Neurocognition was not significantly related to general self-efficacy.

Conclusion. Our results indicate a critical intermediary role of amotivation in linking neurocognitive impairment to functioning in FEP. General self-efficacy may represent a promising treatment target for improvement of motivational deficits and functional outcome in the early illness stage.

Received 6 September 2016; Revised 18 October 2016; Accepted 20 October 2016; First published online 21 November 2016

Key words: Diminished expression, functional outcome, general self-efficacy, motivational deficits, negative symptoms, neurocognitive impairment.

Introduction

Psychotic disorders including schizophrenia are severe mental disorders that constitute one of the leading causes of disability worldwide (Global Burden of Disease Study 2013 Collaborators, 2015). The disorders are associated with pronounced functional impairment and incur huge direct healthcare spending as well as indirect cost via loss of productivity and caregiver burden. Substantial evidence has indicated that negative symptoms and neurocognitive impairment, the core features of psychotic disorders representing independent, albeit correlated, illness dimensions (Harvey *et al.* 2006), are critically related to poor functional outcome (Green *et al.* 2000; Bowie *et al.* 2006). Recent data has further revealed that negative symptoms may mediate the relationship between neurocognition and functioning (Ventura *et al.* 2009). Of note, it is acknowledged that negative symptoms represent a multi-dimensional construct comprising two distinct symptom subdomains (Messinger *et al.* 2011), namely amotivation and diminished expression (DE). Literature has demonstrated amotivation as a robust predictor of functional outcome in chronic schizophrenia (Konstantakopoulos *et al.* 2011; Strauss *et al.* 2013; Fervaha *et al.* 2014) and early psychosis (Faerden *et al.* 2013; Fervaha *et al.* 2015; Chang *et al.* 2016*a*). Emerging evidence has also suggested that amotivation may mediate the impact of neurocognitive impairment on functioning (Gard *et al.* 2009; Nakagami *et al.* 2008). However, mixed findings were observed regarding the relationship between DE and functioning. Some studies showed that DE was associated with functioning (Evensen *et al.* 2012;

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Galderisi *et al.* 2013), while others failed to find an independent contribution of DE to functional outcome (Green *et al.* 2012; Fervaha *et al.* 2014, 2015; Chang *et al.* 2016*a*). There is a paucity of data on the relationships among DE, neurocognition and functioning.

Recently, there has been growing interest in examining the role of psychological factors on the development of negative symptoms based on the cognitive model theorized by Beck and colleagues (Rector *et al.* 2005; Beck *et al.* 2009). The model posits that negative symptoms, in particular amotivation could be developed as a consequence of maladaptive attitudinal beliefs generated via repeated unsuccessful goal attainment in real-world circumstances. Schizophrenia patients were found to display higher levels of maladaptive attitudinal beliefs including dysfunctional attitudes and negative self-efficacy when compared with the healthy populations (Grant & Beck, 2009; Ventura *et al.* 2014). Accumulating data has shown that dysfunctional attitudes, especially defeatist performance beliefs are associated with negative symptoms and poor functioning (Campellone *et al.* 2016). Conversely, relationships of self-efficacy with negative symptoms and functioning are less studied. Self-efficacy refers to an individual's perceived ability to perform a task or behavior (Bandura, 1977, 1997). Recent theoretical models have further conceptualized self-efficacy as a broader construct which is defined as a generalized and stable sense of personal competence to deal effectively with a variety of stressful situations (i.e. general self-efficacy) (Schwarzer & Jerusalem, 1995; Eccles & Wigfield, 2002). Self-efficacy has been regarded as a crucial determinant of human motivation (Bandura, 1997; Eccles & Wigfield, 2002). Extensive research has consistently demonstrated that higher self-efficacy is associated with elevated motivation, increased effort investment and better functioning across diverse domains such as career development, academic achievement, and physical and mental health (Bandura, 1997). Several previous studies on schizophrenia also indicated that higher self-efficacy was related to better rehabilitation outcomes (Choi *et al.* 2010; Suzuki *et al.* 2011). In fact, self-efficacy has been proposed as a potential therapeutic target for negative symptoms and functional enhancement in schizophrenia (Ventura *et al.* 2014).

Thus far, very few studies have been conducted to investigate the relationships between negative symptoms, self-efficacy and functioning in psychotic disorders (Pratt *et al.* 2005; Cardenas *et al.* 2013; Kurtz *et al.* 2013; Ventura *et al.* 2014; Vaskinn *et al.* 2015). Among those few studies, some (Pratt *et al.* 2005; Vaskinn *et al.* 2015), but not all, found that negative symptoms mediated the effect of self-efficacy on functional outcome. One recent study further revealed that amotivation, but not DE, mediated the relationship between self-efficacy and functioning (Ventura *et al.* 2014). Nonetheless, it should be noted that most studies have examined negative symptoms as a unitary construct (Pratt *et al.* 2005; Cardenas *et al.* 2013; Kurtz *et al.* 2013; Vaskinn *et al.* 2015) which precluded delineation of potential differential relationships between negative symptom subdomains and self-efficacy. Additionally, self-efficacy assessment employed by most prior studies emphasized heavily on patients' perceived competence on symptom management (McDermott, 1995). This measurement, however, may not adequately capture patients' perception on their capabilities to perform everyday productive activities. General self-efficacy measure may thus represent a conceptually more useful construct in evaluating the impact of self-efficacy on negative symptoms and functioning.

It is well recognized that a significant proportion of first-episode psychosis (FEP) patients exhibit persistent functional impairment even in the presence of clinical remission (Chang *et al.* 2012; Verma *et al.* 2012). Better understanding of the inter-relationships among negative symptoms, neurocognition, self-efficacy and functioning in the initial stage of illness is crucial to early intervention for psychosis. This facilitates identification of treatment targets and development of effective interventions for early functional recovery. Until now, however, this has rarely been investigated in FEP populations.

To this end, we present a study conducted in a large representative cohort of adult patients presenting with FEP to a specialized early intervention program with an aim to examine the relationships among negative symptom subdomains, neurocognition, general self-efficacy and global functioning. To adequately evaluate the complex interplay among these variables, we employed structural equation modeling (SEM) which has advantages over multiple regression analysis and path analysis by being able to simultaneously examine direct and indirect relationships among a set of measured variables and latent constructs, and to explicitly model measurement errors for more accurate parameter estimation (Hoyle, 1995; Iacobucci *et al.* 2007). We hypothesized that neurocognition, amotivation and general self-efficacy would directly predict global functioning. We also predicted that amotivation would mediate the relationship between neurocognition and functioning. Given that self-efficacy has been theorized as a key determinant of motivation for goal accomplishment, we expected that amotivation would be related to and mediate the effect of general self-efficacy on functioning. Based on Beck's cognitive model of negative symptoms which postulates that competence limitation (i.e. neurocognitive

impairment) may lead to negative self-appraisal of one's ability (Rector *et al.* 2005; Beck *et al.* 2009), we hypothesized that general self-efficacy would mediate the relationship between neurocognition and amotivation. The relationships of DE with functioning, neurocognition and general self-efficacy were also investigated.

Method

Participants and setting

This study was conducted as part of the Jockey Club Early Psychosis (JCEP) project (Hui *et al.* 2014*a*), which is a territory-wide early intervention service aiming to provide phasic-specific case management to individuals aged 26–55 years presenting with first-episode DSM-IV schizophrenia, schizophreniform disorder, schizoaffective disorder, brief psychotic disorder, delusional disorder, or psychotic disorder not otherwise specified (NOS) in Hong Kong. A total of 355 patients were recruited from publicly funded generic adult psychiatric outpatient units between June 2009 and August 2011. Patients with intellectual disability, substance-induced psychosis or psychotic disorder due to general medical condition were excluded. Data of this study were derived from baseline assessments (conducted with a mean of 119.7 days after treatment initiation) of an ongoing 4-year JCEP study, and findings regarding rate and risk factors of depressive symptoms, and predictors of primary negative symptoms have been reported elsewhere (Chang *et al.* 2015*b*, 2016*b*). Of the initial cohort, 321 patients who had completed assessments were retained as the sample of the current report. The study was approved by local institutional review boards and all of the subjects gave written informed consent before participation.

Assessments

Best-estimate consensus diagnosis of each participant was ascertained according to DSM-IV criteria by two senior research psychiatrists using all available information including Chinese-bilingual Structured Clinical Interview for DSM-IV (CB-SCID-I/P; So *et al*. 2003) administered at intake, informant histories and medical records. Interview for Retrospective Assessment of Onset of Schizophrenia (IRAOS; Hafner *et al*. 1992) was employed to confirm the first-episode status and to determine the duration of untreated psychosis (DUP). Psychopathology was assessed using the Positive and Negative Syndrome Scale (PANSS; Kay *et al.* 1987). Negative symptoms were examined by the Scale for the Assessment of Negative Symptoms (SANS; Andreasen, 1982). As negative symptom construct is consistently shown to comprise two distinct subdomains of amotivation and DE, we thus derived amotivation and DE domain scores based on the method applied by previous research (Foussias *et al.* 2009; Chang *et al.* 2016*a*): Amotivation consisted of items of the Avolition-apathy and Anhedonia-asociality subscales (excluding global items); and DE comprised items of the Affective flattening subscale (excluding global item) and the poverty of speech item of the Alogia subscale. Patients' perceived general self-efficacy was assessed using the Chinse version of the General Self-Efficacy Scale (CGSS; Chiu & Tsang, 2004), which is a self-administered questionnaire comprising 10 items evaluating how confident the participants are regarding their abilities to cope with a broad range of stressful or demanding situations on a 4-point Likert scale (1 = not at all true; 2 = hardly true; 3 = moderately true; and 4 = exactly true) (Schwarzer & Jerusalem, 1995). The total score ranges from 10 to 40, with a higher score indicating a higher level of general self-efficacy. This is the most frequently used scale for measuring general self-efficacy and has been widely applied to research in healthy populations as well as individuals with various physical and mental disorders (Luszczynska *et al.* 2005). The CGSS has been validated in Chinese schizophrenia patients with good test–retest reliability and excellent internal consistency (Chiu & Tsang, 2004). Global functioning was measured with the Social and Occupational Functioning Assessment Scale (SOFAS; Goldman *et al.* 1992).

A brief battery of neurocognitive assessments was administered at intake to all participants, comprising digit span and digit symbol subtests of the Wechsler Adult Intelligence Scale – Revised (WAIS-R; Hong Kong Psychological Society, 1989*a*), logical memory subtest of the Wechsler Memory Scale – Revised (WMS-R; Hong Kong Psychological Society, 1989*b*), category verbal fluency and the Modified Wisconsin Card Sorting test (MWCST; Nelson, 1976). A group of healthy controls ($n = 50$), matched by age, gender and educational level, was evaluated with the same battery of neurocognitive assessments as patients. Standardized z score for each of the neurocognitive tests was computed based on performance of healthy controls.

Statistical analysis

SEM was used to examine the relationships among negative symptom subdomains, neurocognition, general self-efficacy, and global functioning. SEM evaluates multiple hypothesized relationships between latent and observed variables simultaneously by combining confirmatory factor analysis with multiple regression analysis (Hoyle, 1995). Factor loadings

https://doi.org/10.1017/S0033291716003044 Published online by Cambridge University Press

were used to specify the association between an unobserved construct (i.e. latent variable) and its theoretically related measures (i.e. indicator variables). Regression analyses determine the associations between the latent and other observed variables, and are indexed by standardized path coefficients. In SEM, both direct and indirect (i.e. mediation effect by one or more intervening variables between a predictor and a dependent variable) relationships among the variables could be estimated. In the current study, neurocognition was defined as a latent variable, indexed with five indicators including digit span, digit symbol, logical memory, verbal fluency and MWCST perseverative errors. Amotivation, DE, general self-efficacy and global functioning were each represented by a single indicator variable. Correlation analyses were performed to examine the inter-relationships between the observed variables included in the hypothesized models prior to conducting SEM.

We defined our initial SEM model based on the literature and theoretical frameworks regarding the relationships among negative symptoms, neurocognition, self-efficacy and functional outcome in psychotic disorders. Specifically, we tested the following hypotheses: first, neurocognition, amotivation and general self-efficacy would exert a direct effect on global functioning; second, neurocognition and general self-efficacy would have an indirect effect on functioning via the mediation of amotivation; third, the relationship between neurocognition and amotivation would be mediated by general self-efficacy. In addition, we examined whether DE would predict functioning, and if it was, whether it would mediate the effect of neurocognition and general self-efficacy on functioning.

The hypothesized SEM models were estimated using Mplus, v. 7.4 (Muthén & Muthén, 2015). Data distributions were checked for normality. Model fit, i.e. the degree to which a SEM fits the sample data, was evaluated with the χ^2 test, the comparative fit index (CFI) and the root mean square error of approximation (RMSEA) (Hoyle, 1995; Hu & Bentler, 1999). A non-significant χ^2 test, CFI value >0.90 and RMSEA value <0.05 indicate a good model fit. The models were compared using Akaike's Information Criterion (AIC), with a lower AIC indicating better model fit (Akaike, 1973).

To determine an adequate sample size for SEM analysis, it is recommended that the minimum sample size required must be greater than the minimum ratio of at least 10 participants per estimated parameter of the model (Jackson, 2003). Another recommendation indicates that at least 15 participants for each observed variable are needed (Bentler & Chou, 1987). A minimum sample size of 200 has also been suggested by some experts (Kline, 2011). Given that our model comprised 23 estimated parameters (and nine observed variables), a sample size of 321 participants was thus considered to be sufficient for SEM analysis.

Results

Characteristics of the sample

Of the 321 participants in the study, 44.2% were male. The mean age of the sample was 38.3 years (S.D. = 8.4) and the median DUP was 93 days. The majority (62.6%) were diagnosed with schizophrenia spectrum disorder (schizophrenia: $n = 140$; schizophreniform disorder: $n = 58$; schizoaffective disorder: $n = 3$). For other non-affective psychoses, 12.8% ($n = 41$) of the cohort had brief psychotic disorder, 19.0% ($n = 61$) had delusional disorder and 5.6% ($n = 18$) had psychotic disorder NOS. Data on demographics, baseline clinical characteristics, neurocognitive performance and functioning of the sample are summarized in Table 1, and the bivariate inter-correlations among the variables are shown in Table 2.

Initial model

The initial SEM model is shown in Fig. 1. Confirmatory factor analysis for neurocognition revealed good model fit ($\chi^2 = 2.10$, $p = 0.84$, CFI = 1.00, RMSEA<0.001) with all indicators showing significant moderate to high factor loadings ($\beta = 0.49$–0.72, $p < 0.001$), indicating that the latent variable and the indicators were strongly associated. Neurocognition, amotivation and general self-efficacy were proved to have significant direct effects on global functioning, while DE showed no significant effect on functioning. Neurocognition and general self-efficacy also demonstrated significant indirect effects on functioning via the mediation of amotivation. Significant association between neurocognition and DE was observed. There were no significant associations between neurocognition and self-efficacy, and between self-efficacy and DE. Model fit was good ($\chi^2 = 19.05$, $p = 0.58$, CFI = 1.00, RMSEA < 0.001). The model explained 30.4% of the variance on SOFAS score.

Final model

The initial model was modified based on statistical and conceptual considerations. We removed DE from the model as it was not associated with functioning. Non-significant path (i.e. a path between neurocognition and general self-efficacy) was also eliminated. After the modifications, the resulting model (Fig. 2) provided a very good fit for the data ($\chi^2 = 15.48$, $p = 0.63$, CFI = 1.00, RMSEA < 0.001). This model was more parsimonious and had a lower AIC index

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Table 1. *Demographics, baseline clinical characteristics and cognitive functions of patients with first-episode psychosis*

Variables of interest	Mean (S.D.)/*N* (%)
Demographics	
Age at entry	38.31 (8.42)
Male gender	142 (44.20)
Single marital status	161 (50.20)
Years of education	10.83 (3.81)
Clinical characteristics	
Age at onset of psychosis	36.56 (8.67)
DUP[a], days	531.77 (1110.66)
Psychiatric diagnosis	
Schizophrenia-spectrum disorder[b]	201 (62.60)
Other non-affective psychoses[c]	120 (37.38)
PANSS positive symptom score	9.10 (3.55)
PANSS negative symptom score	10.15 (4.34)
PANSS general psychopathology score	22.84 (6.98)
SANS total score	6.22 (9.26)
SOFAS score	59.98 (13.62)
CGSS total score	23.13 (6.61)
Cognitive functions[d]	
Digit span	−0.30 (0.22)
Digit symbol	−0.20 (1.13)
Logical memory	−0.06 (1.01)
Category verbal fluency	−0.80 (0.98)
MWCST perseverative errors	−0.39 (1.52)

CGSS, Chinese General Self-Efficacy Scale; DUP, duration of untreated psychosis; MWCST, Modified Wisconsin Card Sorting Test; PANSS, Positive and Negative Syndrome Scale; SANS, Scale for Assessment of Negative Symptoms; SOFAS, Social and Occupational Functioning Assessment Scale.

[a] Median DUP was 93 days.

[b] Schizophrenia spectrum disorder included schizophrenia, schizoaffective disorder and schizophreniform disorder.

[c] Other non-affective psychoses included brief psychotic disorder, delusional disorder and psychotic disorders not otherwise specified (NOS).

[d] Standardized *z* score for each of the cognitive tests was computed based on performance of healthy controls.

(8110.8 *v.* 12154.4) than the initial model, supporting the former as a better model to represent the relationships among variables. The model explained 31.0% of the variance in global functioning. Neurocognition ($\beta = 0.25$, $p < 0.001$) and general self-efficacy ($\beta = 0.15$, $p = 0.002$) showed a positive direct effect on SOFAS score, indicating that better neurocognition and higher general self-efficacy were associated with better functioning. Amotivation had a negative direct effect ($\beta = -0.39$, $p < 0.001$) on SOFAS score, indicating that more severe amotivation was associated with poorer functioning. Significant indirect effect was found between neurocognition (indirect effect: $\beta = 0.11$, $p < 0.001$) and functioning via the mediation of amotivation. The relationship between general self-efficacy (indirect effect: $\beta = 0.05$, $p = 0.01$) and functioning was also mediated by amotivation. Thus, amotivation was demonstrated to partially mediate the effects of both neurocognition and general self-efficacy on global functioning.

Discussion

In the current analysis, we sought to examine the relationships among negative symptom subdomains, neurocognition, general self-efficacy and global functioning in FEP patients using the SEM approach. Three major findings emerged from the study. First, amotivation, neurocognitive impairment and general self-efficacy exerted direct effect on functioning. Second, an indirect effect of neurocognition on functioning was mediated by amotivaiton. Third, amotivaiton also mediated the relationship between general self-efficacy and functioning.

Consistent with the literature (Fervaha *et al.* 2014; Chang *et al.* 2016*b*), our model confirms the predictive roles of amotivation and neurocognitive impairment on global functioning. Our result that amotivation mediated an indirect effect of neurocognition on functioning is in line with a recent meta-analytic review which showed that negative symptoms partially mediated the relationship between neurocognitive impairment and functional outcome in schizophrenia (Ventura *et al.* 2009). This finding also concurs with several previous studies which demonstrated motivation as a mediator between neurocognitive impairment and functioning in chronic patients using statistical modeling such as path analysis or SEM (Nakagami *et al.* 2008; Gard *et al.* 2009). In fact, this fits well with the postulation that the willingness and motivation to execute a given task represents a key intervening variable for successful translation of an individual patient's capacity (i.e. neurocognitive functioning) to perform a real-world task into actual behavior and hence desirable functional outcome. Conversely, we failed to find any significant association between DE and global functioning. This is contrary to some prior investigations showing that flat affect, a core symptom of DE, was related to functional impairment (Evensen *et al.* 2012). However, our finding accords with a growing body of evidence suggesting that DE does not predict functioning (Fervaha *et al.* 2014, 2015; Chang *et al.* 2016*b*). This is also in agreement with two recent studies using SEM in evaluating the hypothesized pathways for functional impairment in chronic schizophrenia and revealed a lack of significant contribution of DE to functional outcome prediction (Green *et al.* 2012; Galderisi *et al.* 2014). Taken together, our results confirm the accumulating

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Table 2. *Intercorrelations among measures included in the structural equation models*[a]

	SANS AA	SANS DE	CGSS	Digit span	Digit symbol	Logical memory	Verbal fluency	WCST PE
SANS AA	.–							
SANS DE	0.506***	–						
CGSS	−0.044	0.044	–					
Digit span	−0.043	0.033	0.154**	–				
Digit symbol	−0.119*	−0.077	0.623***	0.247***	–			
Logical memory	−0.132*	−0.061	0.639***	0.267***	0.857***	–		
Verbal fluency	−0.015	0.047	0.154**	0.494***	0.247***	0.266***	–	
MWCST PE	−0.033	0.028	0.595***	0.115*	0.422***	0.115*	0.115*	–
SOFAS	−0.266***	−0.266***	0.124*	0.099	0.182*	0.174**	0.052	0.086

AA, Avolition-asociality; CGSS, Chinese General Self-Efficacy Scale; DE, diminished expression; MWCST, Modified Wisconsin Card Sorting Test; PE, perseverative errors; SANS, Scale for Assessment of Negative Symptoms; SOFAS, Social and Occupational Functioning Assessment Scale.

[a] Pearson correlation analyses were performed and Pearson's correlation coefficients were presented.

*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

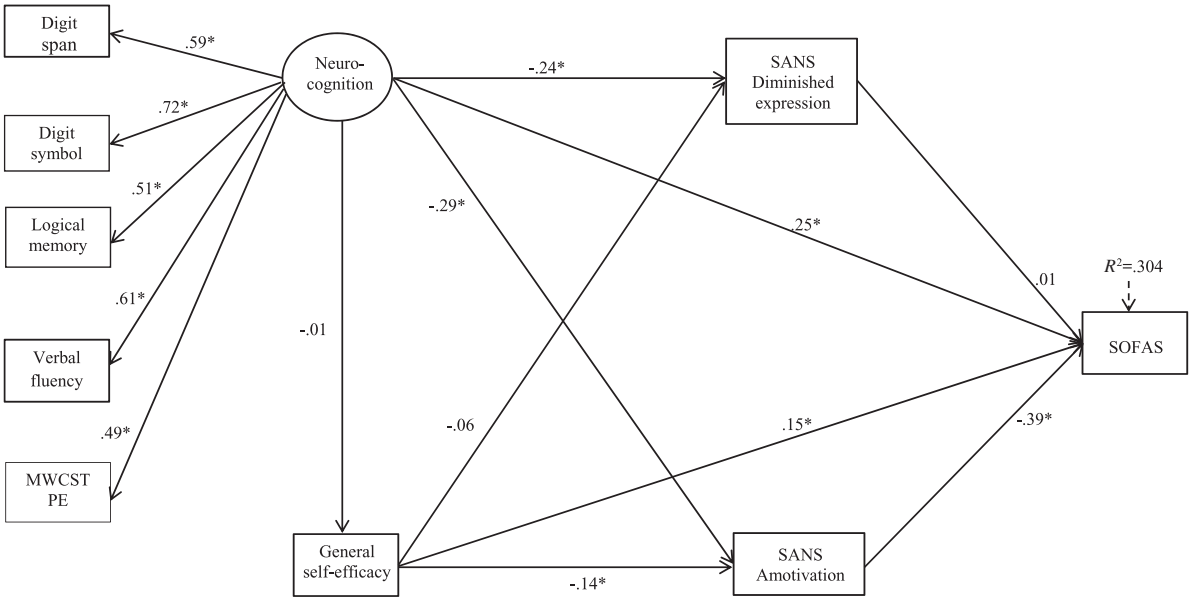

Fig. 1. Initial structural equation model. Rectangles represent observed measured variables. Circles represents an unobserved latent variables. Values are standardized path coefficients. The squared multiple correlation value (R^2) of a dependent variable, SOFAS indicates the amount of variance explained by its predictors. MWCST, Modified Wisconsin Card Sorting Test; PE, perseverative errors; SANS, Scale for Assessment of Negative Symptoms; SOFAS, Social and Occupational Functioning Assessment Scale. Significant at *$p < 0.05$.

evidence which indicates that the predictive power of negative symptoms on functional outcome is mainly attributable to deficits in motivation rather than emotional expressivity (Foussias & Remington, 2010). The study results also underscore the clinical significance of motivational deficits as a critical intermediary factor, and hence treatment target, linking neurocognitive impairment with real-world functioning.

In line with our a priori hypothesis, general self-efficacy was shown to independently predict functioning. Furthermore, we demonstrated differential relationships between negative symptom subdomains and general self-efficacy. Our SEM analysis indicated that amotivation, but not DE, was related to and mediated the effect of general self-efficacy on functioning. This is in keeping with the only published report so far which has investigated the relationships of two negative symptom subdomains (as opposed to a single composite symptom score) with self-efficacy and functioning (Ventura *et al.* 2014). This study

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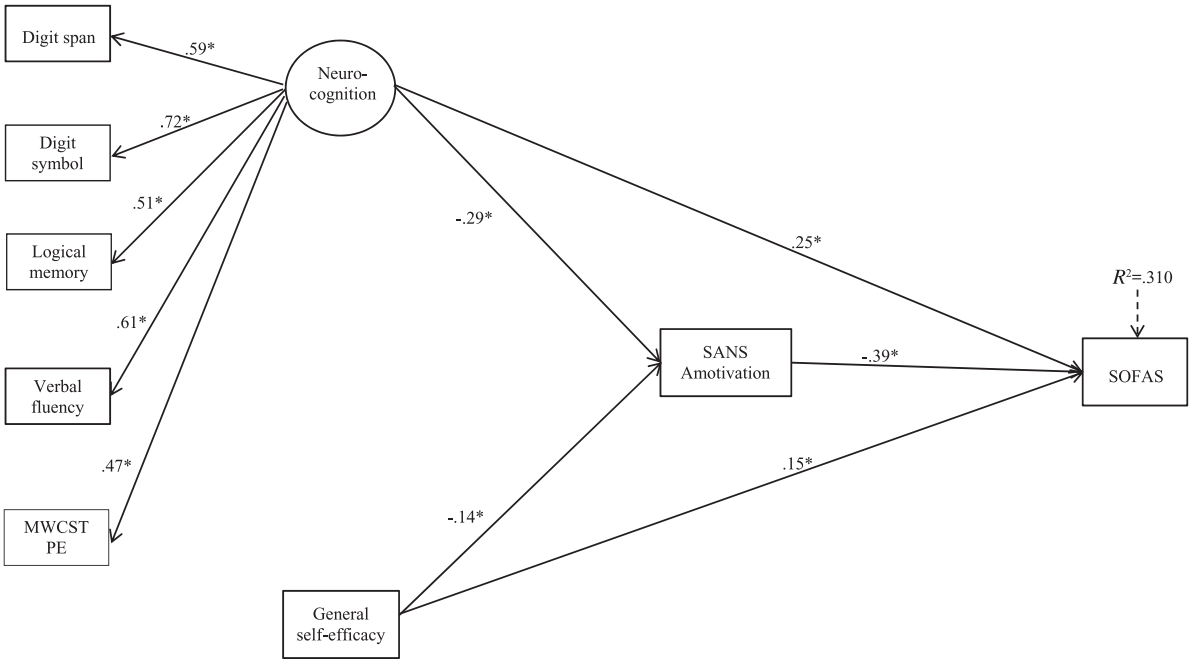

Fig. 2. Final structural equation model. Neurocognition is a latent variable (with arrows pointing to its respective indicators). SANS Avolition, Neurocognition and General self-efficacy are independent predictors. SANS Avolition is a mediator, and SOFAS is a dependent variable. Values are standardized path coefficients. The squared multiple correlation value (R^2) of a dependent variable indicates the amount of variance explained by its predictors. MWCST, Modified Wisconsin Card Sorting Test; PE, perseverative errors; SANS, Scale for Assessment of Negative Symptoms; SOFAS, Social and Occupational Functioning Assessment Scale. *Significant at $p < 0.05$.

found that motivational component rather than DE of negative symptoms mediated the impact of self-efficacy on functioning in recent-onset schizophrenia (Ventura *et al.* 2014). Our result also concurs with a recent study which revealed that negative expectancy appraisal, a construct that is closely linked to self-efficacy, was associated with amotivation rather than DE (Couture *et al.* 2011). Hence, our finding provides empirical support to the cognitive model of negative symptoms (Rector *et al.* 2005; Beck *et al.* 2009) which theorizes that overgeneralized, self-defeating attitudinal beliefs including low self-efficacy contribute to negative symptom development, particularly motivation decrement which in turn results in diminished engagement in constructive activities, and thereby functional deterioration. This finding also corresponds well with two major theories of human motivation, namely expectancy-value theory (Wigfield & Eccles, 2000) and self-determination theory (Ryan & Deci, 2000). Expectancy-value theory posits that high self-efficacy will lead to positive expectancy to success which will enhance motivation for initiation and maintenance of goal-directed behavior (Wigfield & Eccles, 2000), while self-determination theory identifies sense of competence as one of the three basic psychological needs for promoting intrinsic motivation (Ryan & Deci, 2000). Thus, our results indicate an important role of general self-efficacy in determining motivation in FEP patients.

Our model revealed that neurocognition was not associated with general self-efficacy. This is contrary to the proposition formulated by Beck's cognitive model that capacity limitation imposed by neurocognitive impairment may contribute to the formation of dysfunctional attitudes and negative self-efficacy (Rector *et al.* 2005; Beck *et al.* 2009). Our result, however, was consistent with most of those few studies which examined the relationship between self-efficacy and neurocognition in schizophrenia and revealed no significant association between these two variables (Pratt *et al.* 2005; Kurtz *et al.* 2013; Vaskinn *et al.* 2015). Alternatively, the negative finding might be attributable to an inherent difference between 'objective' neurocognitive function assessed by standardized battery conducted in laboratory setting and 'subjective' perception of self-competence stemming from everyday activities within the context of unstructured real-world circumstances. In fact, literature has also demonstrated minimal or even lack of concurrence between objective and subjective measures of neurocognition in schizophrenia patients (Sellwood *et al.* 2013; Chang *et al.* 2015*a*). Owing to the scarcity of

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existing data, further research is needed to verify our finding of a lack of significant relationship between neurocognition and self-efficacy in first-episode populations.

Our results have several clinical implications. First, given that motivational impairment is prevalent in the early course of illness (Fervaha *et al.* 2015; Norman *et al.* 2015) and has been affirmed to play a central role in determining functional outcome in FEP patients, more intensive monitoring with detailed assessment of diminished motivation should be conducted on a regular basis to ensure early identification and prompt management. Second, it is known that negative symptoms including amotivation show limited response to current pharmacological and psychosocial interventions (Fusar-Poli *et al.* 2015). Our finding that patients' perceived general self-efficacy influenced their motivational levels indicate that general self-efficacy may represent a promising therapeutic target for treatment of negative symptoms and promotion of early functional recovery in FEP patients. This is in fact congruent with emerging evidence demonstrating that cognitive therapy targeting at modifying maladaptive attitudinal beliefs including negative self-efficacy in conjunction with the use of goal-directed treatment framework was effective in improving motivation and functioning in schizophrenia patients (Grant *et al.* 2012).

Several methodological limitations warrant consideration in interpreting the study results. First, although we used SEM analysis to examine theoretically-driven relationships among variables, the cross-sectional nature of our study cannot confirm causality. Prospective investigation is required to verify the longitudinal relationship and hence the directionality among the investigated variables. Second, evaluation of amotivation by SANS items relies primarily on reports of self-care, occupational performance and interpersonal relationships which overlap with functional outcome measure. Differential relationship of functioning with amotivation and DE might thus be partly attributable to this measurement overlap. Adoption of the recently developed negative symptom rating instruments that incorporate items to assess internal experience of motivation (Kirkpatrick *et al.* 2011; Kring *et al.* 2013) could minimize such measurement bias and the potential inflated associations. Third, although the use of a latent variable in our SEM analysis, which allows a number of observed variables (individual neurocognitive measures) to map onto a theoretical construct (neurocognition), can reduce the measurement error in estimating the predictive value of global neurocognition on functional status, this might obscure the potential differential relationships between functioning and specific neurocognitive domains. Fourth, a larger sample size is required to ensure our SEM analysis to have adequate statistical power to include other symptom dimensions such as positive symptoms, disorganization and depression in the modeling so as to derive a more comprehensive prediction model for functional outcome. Fifth, other variables which have been found to be associated with negative symptoms, neurocognition, and/or functioning including social cognition, dysfunctional attitudes and functional capacity (Bowie *et al.* 2006; Grant & Beck 2009; Fett *et al.* 2011) were not measured in this study. A model (with adequate sample size) incorporating additional candidate variables would likely yield better model fit for the observed data and would enhance explained variance in functional outcome prediction. Sixth, our sample included only adult patients aged 26–55 years, while the majority of first-episode studies also included patients at younger age or focused mainly on adolescent and young adult patients. The relatively older mean age of our cohort may thus render our findings less comparable to the literature of first-episode research as there may be significant variations in illness impacts on clinical and functional outcomes between patients with a more typical age of onset (i.e. late adolescence or early adulthood) and those having their psychosis manifested at later years (Hui *et al.* 2014*b*). The relatively milder degree of neurocognitive impairment of our cohort as compared to those typical FEP samples whose neurocognitive deficits are mostly found to be 1–2 S.D. below the mean of healthy controls' performance (Mesholm-Gately *et al.* 2009; Aas *et al.* 2014) may also limit the generalizability of our results.

In conclusion, the current study extends prior research on chronic schizophrenia to FEP regarding the central role of amotivation in determining functional outcome. Using SEM analysis, our results indicate that, alongside its direct effect, amotivation mediates the influence of neurocognitive impairment and perceived self-efficacy on global functioning in FEP patients. Our findings also suggest general self-efficacy as an important treatment target for alleviating motivational deficits and hence promoting functional recovery in the early stage of psychotic illness. Future research using longitudinal follow-up design is required to clarify the temporal relationship among these key variables in predicting functional outcome in patients with FEP. In addition, further investigation is warranted to clarify the neurobiological basis underlying amotivation in psychotic disorders, for instance dysfunctional reward processing (Strauss *et al.* 2014; Chang *et al.* 2016*c*) and altered effort-cost computation (Gold *et al.* 2015), to facilitate development of effective treatments to ameliorate motivational impairment and therefore its adverse impacts on functional outcome.

https://doi.org/10.1017/S0033291716003044 Published online by Cambridge University Press

Acknowledgements

This study was funded by the Hong Kong Jockey Club Charities Trust (21009144). The funding body had no involvement in any aspect of the study or manuscript preparation. We thank all the coordinating clinicians and staff from the participating hospitals, clinics and medical records departments for their kind assistance. We are also grateful to the individuals who participated in the study.

Declaration of Interest

Author E.Y.H.C. has participated in the paid advisory board for Otsuka, has received educational grant support from Janssen-Cilag, and has received research funding from AstraZeneca, Janssen-Cilag, Eli Lilly, Sanofi-Aventis and Otsuka. E.H.M.L has been a member of the paid advisory boards for Eli Lilly and AstraZeneca. The remaining authors report no conflicts of interest.

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