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Schizophrenia Research 80 (2005) 213–225

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Biosocial pathways to functional outcome in schizophrenia

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Received 27 February 2005; received in revised form 18 July 2005; accepted 22 July 2005

Available online 30 August 2005

Abstract

Biosocial models are preeminent in the study of schizophrenia, yet there has been little empirical testing of these models. *Objective:* This study provided the first test of a biosocial causal model of functional outcome in schizophrenia, using neurocognition, social cognition, social competence and social support as predictors of both global and specific domains of functional outcome.

Method: The design used baseline variables to predict both concurrent functional status and prospective 12-month functional outcome. Subjects were recruited upon admission to outpatient community-based psychosocial rehabilitation programs shown in previous studies to be effective in improving functional outcomes. 139 individuals diagnosed with schizophrenia or schizoaffective disorder participated in the study; 100 participants completed the 12-month assessments. Face-to-face interviews assessed neurocognitive functioning (with five neuropsychological measures), social cognition (as perception of emotion), social competence, social support, and functional outcome which consisted of items covering the domains of social, independent living, and work functioning.

Results: Path analysis modeling showed that the proposed biosocial models had strong fit with the data, for both concurrent and 12-month global functional outcomes, with fit indices ranging from .95 to .98. The model explained 21% of the variance in concurrent global functional outcome, and 14% of the variance in 12-month prospective outcome.

Conclusions: The support for this model was strong, and it has implications for understanding the causal factors related to functional outcome, as well as for intervention strategies for improving functional outcomes in schizophrenia.

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Biosocial models are receiving increasing attention in the study of schizophrenia and other disorders (Cacioppo et al., 2002; National Advisory Mental

Health Council, 2000). Consistent with a biosocial theory of schizophrenia, outcome phenomena are conceptualized as resulting, in part, from neural abnormalities attributable to biological and environmental influences and their interactions (Anderson, 2002; Andreasen, 1999; Cannon and Murray, 1998; Cannon

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et al., 2002; Gottesman, 1994; Tsuang et al., 2001). Untangling these linkages is a challenge that has produced several models of etiologic pathways (Gottesman, 1994; Green et al., 2000; Weickert and Weinberger, 1998). Understanding the causal pathways to functional outcomes is critical to establishing biosocial models in schizophrenia, and is fundamental to improving psychosocial interventions for persons with schizophrenia. Previous work has suggested the importance of basic cognitive processes for understanding community outcomes in schizophrenia (Brenner et al., 1992; Nuechterlein et al., 1992; Spaulding et al., 1994). Recently, Green et al. (2005) reviewed literature which suggested that a combination of neurocognition, social cognition, and psychosocial variables has promise for furthering the causal understanding of functional outcome in schizophrenia. To date, however, there has been no empirical testing of these multivariate causal propositions.

In this paper we present a biosocial model of functional outcome in schizophrenia, utilizing factors previously associated with functional outcome, including neurocognition, social cognition, social competence, and social support (see Fig. 1). Our purpose was: (i) to test a causal organization of these variables to explain variations in global psychosocial outcome; and (ii) to examine the generalizability of the model in predicting the distinct functional domains of independent living, social, and work functioning in schizophrenia.

1. Neurocognition

A growing body of research has shown that neurocognitive variables are related to functional outcomes (Green, 1996; Green et al., 2000). Meta-analyses have indicated that secondary and immediate verbal mem-

ory, executive functioning, and sustained attention may each be separately predictive of functional outcome in schizophrenia (Green et al., 2000). Composite neurocognitive measures may reveal larger relationships with functional outcomes than do individual neurocognitive constructs (Green et al., 2000). The mechanisms of association between neurocognitive variables and functional outcome are not yet understood, and various types of mediators have been suggested, including social cognition (Green and Nuechterlein, 1999; Kee et al., 1998). In our model, neurocognition is a primary causal variable and it is proposed to have both direct and indirect effects on functional outcome.

2. Social cognition

Social cognition, defined as the “cognitive processes involved in how [people] think about themselves, other people, social situations, and interactions” (Penn et al., 1997a, p. 114), is differentiated from, but not orthogonal to, nonsocial cognition. While both are impaired in schizophrenia, the stimuli in social cognition studies tend to be personally relevant, changeable, interactive, and complex compared to the stimuli in nonsocial cognition studies, which use words, tones, numbers, and other affectively neutral objects. Various types of social cognition tasks have been used in the study of schizophrenia including measures of emotion perception, theory of mind, social perception, and attributional bias (Bryson et al., 1997; Kee et al., 2003; Mueser et al., 1998, 1996; Penn et al., 1997a,b; Pinkham et al., 2003; Schneider et al., 1995). Emotion perception has received a relatively large amount of the attention in this area, and this was the domain of social cognition that was used in this study. Emotion perception has shown promise as a construct of social cognition that

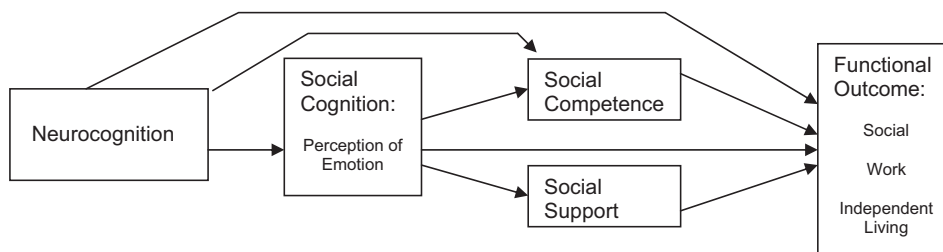


Fig. 1. Proposed model.

may mediate the relationship between neurocognition and functional outcomes. Deficits in perception of emotion have been linked to basic neurocognitive abilities (Bryson et al., 1997; Kee et al., 1998; Schneider et al., 1995) as well as to work functioning in schizophrenia (Kee et al., 2003).

In this model, perception of emotion is proposed to have both direct and indirect influence on functional outcome. It is hypothesized to mediate some of the influence of neurocognition on functional outcome, and its effects will also be partially mediated by social competence and social support.

2.1. Social competence

Social skills may be defined as a “specific set of abilities, including cognition, verbal, and nonverbal behaviors that are needed for effective interpersonal performance” (Mueser et al., 1998). There is evidence that neurocognitive capacity is related to social skill acquisition (Green and Nuechterlein, 1999). Competence in social skill may also mediate the relationship between ability to perceive affect and functional outcome (Mueser et al., 1996). Studies have found that persons with schizophrenia have generally poorer social skills performance than controls, and that it is associated with symptom profiles (Hoffman et al., 1998; Mueser et al., 1998, 1996). Not only are these basic social skills sometimes correlated with global social functioning in the community, but they are conceptually and empirically associated with work functioning as well (Bond et al., 1998; Kopelowicz et al., 1998; Tsang and Pearson, 2001).

3. Social support

Social support has been defined as the “...caring and sustenance provided by the social environment” (Kendler, 1997, p. 2) and “...he emotional support, advice, guidance, and appraisal, as well as the material aid and services, that people obtain from their social relationships” (Ell, 1984, p. 134). Perceived social support has long been considered important to prevention of relapse and to rehabilitation, consistent with stress-vulnerability models of schizophrenia which posit that social support buffers biopsychosocial stressors and encourages coping behavior (Kopelowicz et al., 1998). Perceived social support

has been found to predict problem-solving coping (Macdonald et al., 1998), five-year global functional outcome in first episode schizophrenia (Erickson et al., 1998), work status (Yanos et al., 2001), and community adaptation (Clinton et al., 1998). A relationship between perceived social support and perception of emotion seems likely: if persons with schizophrenia are deficient in both social and nonsocial cue perception and interpretation, it seems reasonable to expect difficulty in perceiving or accessing social support (Macdonald et al., 1998).

4. Functional outcome

While psychosocial outcome in schizophrenia may be considered in several domains, such as clinical, subjective, and functional (Brekke and Long, 2000), we focus on the functional outcomes of work, independent living, and social functioning of individuals living in the community. It has been argued that multiple domains of outcome in schizophrenia are linked but separate (Brekke and Long, 2000; Strauss and Carpenter, 1972) and that they could have distinct biosocial pathways (Brekke et al., 1997c). Using multiple domains of functional outcome will allow us to examine the differential or generalized impact of predictors in the model on specific outcome domains (Brekke et al., 1997a) as well as on global outcome.

The model we present attempts to integrate neuropsychological, psychological, and socio-behavioral variables to increase our understanding of the causal pathways to functional outcomes. Specifically, we predict that neurocognition directly influences social cognition, which in turn directly influences both social competence and social support, both of which influence the functional outcomes. Neurocognition will also directly influence social competence. Neurocognition and social cognition are also predicted to influence outcomes directly in addition to being mediated by social competence and social support. No hypothesis is made regarding a direct relationship between social support and social competence. The path model predicting global functional outcome is first examined, then the model is applied separately to the domains of work, independent living, and social functioning in order to assess the consistency of the model across distinct functional domains. The model is tested using

both concurrent functional status variables and 12-month prospective functional outcome variables.

5. Method

Participants in this study were recruited as they were admitted to four community-based psychosocial rehabilitation programs in urban Los Angeles. The programs were part of a county mandated mental health initiative (Young et al., 1998) and were selected on the basis of data showing that they were comprehensive service environments that yielded significant improvements in functional outcomes over time (Bae et al., 2004; Brekke et al., 1997b, 2003). Participants were assessed at baseline on all study variables and again 12 months later on the functional outcome variables. At baseline, psychosocial and functional status data were generally gathered within two weeks of the neuropsychological and social cognition testing. The psychosocial interviews were completed by trained research interviewers who were blind to the neuropsychological results. Neuropsychological testers were blind to the scores on the psychosocial measures.

5.1. Subjects

The sample consisted of 139 individuals diagnosed with schizophrenia or schizoaffective disorder who completed baseline test batteries including neurocognition, social cognition, and psychosocial functioning. Subjects were recruited and followed prospectively for 12 months from between 1996–2000. Fifty-six percent of the subjects came from site 1, 16% from site 2, 16% from site 3, and 12% from site 4. Diagnoses were determined using clinical records, a DSM-IV checklist, and collateral reports from the admitting clinician and on-site psychiatrist. Subjects were excluded if they met criteria for alcohol or drug dependence in the previous six months or if they had an identified neurological disorder. One hundred subjects completed the 12-month protocol on the current study variables (72% completion rate at 12 months). There was no statistically significant differential attrition across the program sites. Descriptive data are reported in Table 1. There were no statistically significant differences

Table 1

Characteristics of the subjects at baseline: baseline sample and 12-month completers

	Baseline (N=139)	12-month (N=100)
Gender—male	96 (69.1%)	68 (68%)
Age		
Range	18–62 years	21–62 years
Mean	38.2	38.7
SD	9.0	9.6
Ethnicity		
White	59 (42.4%)	44 (44%)
African-American	56 (40.3)	33 (34.0)
Latino	16 (11.5)	13 (13.4)
Asian	5 (3.6)	5 (5.2)
Other	3 (2.2)	2 (2.1)
Marital status		
Single	103 (74.1)	72 (72%)
Married	3 (2.2)	2 (2.1)
Separated–divorced	30 (21.6)	23 (23.7)
Widowed	3 (2.2)	0 (0.0)
	Mean (SD)	Mean (SD)
Education	11.9 years (1.8)	12.1 years (1.8)
Length of illness	13.9 years (9.9)	13.5 years (10.2)
Neurocognitive composite (sum of z scores)	–0.22 (3.4)	–.19 (3.2)
Perception of emotion	38.7 (9.2)	38.4 (9.7)
Social support	58.2 (18.8)	57.9 (18.8)
Social competence	10.8 (1.7)	11.0 (1.6)
RFS total ^a	8.4 (3.7)	10.7 (1.8)
RFS social	2.9 (1.6)	3.0 (1.6)
RFS work	2.0 (1.6)	2.1 (1.7)
RFS independent	3.5 (1.8)	3.5 (1.8)
BPRS ^b	39.2 (10.7)	39.2 (11.1)
BPRS positive symp	6.9 (3.9)	6.7 (3.6)
BPRS negative symp	4.3 (2.0)	4.1 (1.8)
Medication days in previous 6 mos.	145.80 (63.87) —	138.63 (69.77) —
	all subjects	all subjects
	160.97 (45.25) —	158.43 (48.95) —
	of subjects taking medication	of subjects taking medication

^a Role Functioning Scale (Goodman et al., 1993); total of social, work, and independence subscales.

^b Expanded Brief Psychiatric Rating Scale (Lukoff et al., 1986; Overall and Gorham, 1962).

between the completers and non-completers on the variables in Table 1. All subjects signed an informed consent under protocols approved by the Institutional Review Board at the University of Southern California.

5.2. Measures

All psychosocial variables came from data gathered in face-to-face interviews conducted at a place of the subject's choosing, typically at a program site or their residence. The interviewers were masters-level clinicians trained using a protocol described in detail (Brekke et al., 1993). They were trained on the Brief Psychiatric Rating Scale (Lukoff et al., 1986) using a protocol described in Ventura et al. (1995). The neurocognitive and social cognition data came from laboratory-based assessments in a facility designed for this study.

5.2.1. Psychosocial measures

The measure of social competence is a subscale of the Community Adjustment Form (CAF) (Test et al., 1991). The CAF uses trained interviewers to gather behavioral event data from 17 domains of community functioning such as living situation, work and social functioning, family involvement, and medication use. It includes a 10-item scale of prosocial behaviors rated by the interviewer as an indicator of social competence. The behaviors reflect the four components of social skill described by Mueser and Bellack (Mueser and Bellack, 1998): nonverbal, paralinguistic, content, and balance. The intraclass correlation (ICC) used to assess inter-rater reliability was .91, and Cronbach's alpha was .7. The measure of perceived social support came from a self-report social support scale adapted from the Medical Outcomes Study Social Support Survey (Sherbourne and Stewart, 1991). Cronbach's alpha for the scale was .88.

The Role Functioning Scale (RFS; Goodman et al., 1993), a scale of choice for this population (Green and Gracely, 1987), is a functional outcome measure that was administered during the CAF interview. Interviewer ratings of work, social functioning, and independent living from the RFS are used for this study, in accordance with procedures described in Brekke et al. (1993). The RFS provides anchored descriptions and captures both the quantity and quality of functioning in that domain. After interview training, the ICC among three interviewers on the RFS items was $>.8$. In this study, we use the global score (sum of the three items) as well as each individual item as outcome variables. A principal components factor analysis of the three items found a single factor with eigen value

greater than 1 that explained 55% of the item variance and supported the use of the global score.

5.2.2. Social cognition measures

Affect perception was measured by the following three scales from which the simple sum of correct responses was derived: 1) the Facial Emotion Identification Test (Kerr and Neale, 1993), 2) the Voice Emotion Identification Test (Kerr and Neale, 1993), and 3) the Videotape Affect Perception Test (Bellack et al., 1996). These tests and the procedures for administering them are fully described in Kee et al. (1998). All three require the subject to select one of six basic emotions (i.e., happy, angry, afraid, sad, surprised, and ashamed) that best describes the emotion presented in photographs, on audiotape, or in videotaped scenes of interpersonal situations.

5.2.3. Neurocognitive measures

The neurocognitive measure in this study is a composite created to reflect verbal fluency, immediate memory, secondary memory, sustained attention, and mental flexibility. It was derived from five tests by summing the standardized scores. The five tests were the Controlled Oral Word Association Test (Lezak, 1995), the Digit Span Distractibility Test (Oltmanns and Neale, 1975), the California Verbal Learning Test (Delis et al., 1987), the Degraded-Stimulus Continuous Performance Test (Nuechterlein and Asarnow, 1992), and perseverative errors from the Wisconsin Card Sorting Test (WCST; Heaton, 1981). A principal components factor analysis of the five scores found there was a single factor with eigen value above 1 that accounted for over 50% of the total score variance.

5.3. Data analysis

Path analysis is a method to test the theory-driven causal relationships of constructs in a proposed theoretical model. It can be used in non-experimental contexts with statistical associations, and when combined with theory it is used to test causal structures among variables. It has been used in schizophrenia research to specify paths to relapse (Nuechterlein et al., 1992), as well as to understand the influence of expressed emotion on social adjustment (King and Dixon, 1996). Since it is impossible to meet the specification requirement that all relevant variables be included in the

model, it is critical to be theoretically driven in variable selection and to seek high levels of reliability in the measures. The method employs a series of regression equations to determine the direct and indirect effects of variables in the model. The path coefficients are standardized partial regression coefficients that describe numerically to what extent a change in a predictor variable affects a dependent variable with all other variables in the model held constant. Analyses were done with the LISREL 8.50 program (Jöreskog and Sörbom, 1993) using the default maximum likelihood procedure to estimate the parameters through iteration.

We tested our model in three stages. The first stage examined the model with the four predictor variables, excluding the functional outcomes. This allowed us to examine the empirical viability of the stage one model alone and to trim any statistically non-significant paths so as to avoid starting with paths that would become redundant in the final outcome models. Second, using the predictor model from stage one, we tested the full models of concurrent functional outcomes starting with global outcome, and then proceeding to the specific domains of independent living, social and work functioning. Third, the models were tested using the 12-month prospective functional outcome variables. In testing these prospective models we did not control for baseline functional status as we were not examining change in mean functional scores over time, nor did we expect the impact of the predictors to be empirically unique across baseline and prospective outcomes; in fact, it would be hard to

explain how the mechanisms of influence would not be the same at both time points.

6. Results

The means and standard deviations of the variables in the path analysis are shown in Table 1. Zero-order correlations of the manifest variables in the path analysis are shown in Table 2. When symptom levels were entered as a covariate into all of the models tested, there was no change in most of the parameters estimated, and in other instances it was negligible; therefore, the results are presented without including the symptom variable in the models.

6.1. Model fit

We used the following six well-recognized fit indices: the χ^2 test; the Normed Fit Index (NFI), where values greater than .9 are considered good; the Standardized Root Mean Square Residual (SRMR) where a lower score indicates better fit; Adjusted Goodness-of-Fit Index (AGFI) where above .9 is good fit; the Root Mean Square Error of Approximation (RMSEA) where values of less than .08 are considered good; the Expected Cross-Validation Index (ECVI) where a small ECVI value indicates the model is more likely to cross-validate with a new sample (Loehlin, 1998; Maruyama, 1998).

6.1.1. Predictor model

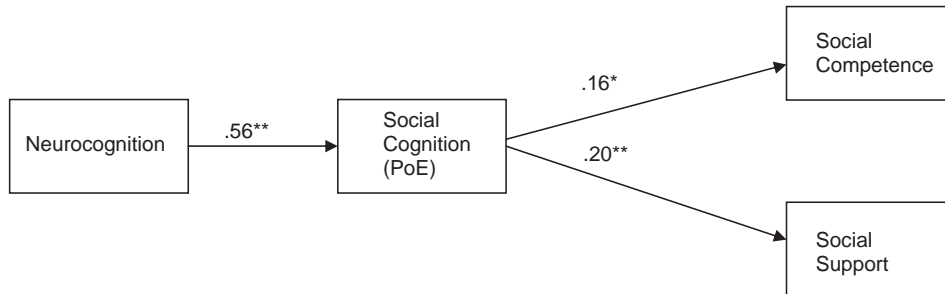
The final predictor model is shown in Fig. 2. The proposed path from neurocognition to social competence was not statistically significant ($b = .036$, $t = .35$, $p > .10$),

Table 2
Pearson correlations among model variables

	1	2	3	4	5	6	7	8	9	10	11
1. Neuro-cognition	–										
2. Perc. of emotion	.56**	–									
3. Social support	.03	.17*	–								
4. Social competence	.12*	.17*	.10	–							
5. RFS ^a global, baseline	.21**	.35**	.19*	.31**	–						
6. RFS ^a global, 12 mos.	.25**	.30**	.15	.22*	.65**	–					
7. RFS ^a social, baseline	.17*	.25**	.35**	.18*	.67**	.51**	–				
8. RFS ^a social, 12 mos.	.15	.18*	.20*	.12	.38**	.79**	.48**	–			
9. RFS ^a work, baseline	.19*	.22**	.02	.34**	.74**	.43**	.19*	.12	–		
10. RFS ^a work, 12 mos.	.25**	.27**	.09	.18*	.58**	.78**	.41**	.39**	.50**	–	
11. RFS ^a indep. living, baseline	.13*	.31**	.07	.19*	.83**	.34**	.34**	.27**	.48**	.41**	–
12. RFS ^a indep. living, 12 mos.	.18*	.26**	.08	.21*	.59**	.80**	.32**	.46**	.39**	.44**	.61**

* $p < .05$; ** $p < .01$; one-tailed.

^a Role Functioning Scale (Goodman et al., 1993); global is sum of social, work, and independence subscales.



** $p < .01$, * $p < .05$, one-tailed.

Fig. 2. Predictor model.

therefore it was eliminated from all further model testing. All of the remaining paths were statistically significant. The increment to χ^2 test was not significant between the initial and final predictor model. From Table 3 it can be seen that the fit indices for the final predictor model were strong. These results support the viability of our predictor model and it was used in each of the outcome models tested below.

6.1.2. Global outcome models

Based on each of the fit indices (see Table 3), the global model of concurrent functional status fit the data well. All of the direct effect parameter estimates were in the expected direction and five of seven path estimates were statistically significant. The model explained 21% of the variance in global functional outcome. The direct path from neurocognition to functional outcome was not significant, while the path from social support to outcome was significant at a trend level ($p < .07$). Since the direct path from neurocognition to

functional outcome was not significant for the global model, each of the specific outcome models was run and in each instance this path was not statistically significant, with the parameter ranging from $-.01$ to $.07$, so this path was eliminated from the model. The impact of eliminating this path was minimal on the other parameters, and this was the case for each of the other concurrent outcome models. The final full model explained 21% of the variance in concurrent global functional status (see Fig. 3). The fit indices were strong, and this more parsimonious model fit the data well (see Table 3).

The model predicting 12-month global functional outcomes is presented in Fig. 4. Compared to the concurrent model, there was some degradation on most parameters; however, the model explained 14% of the variance in prospective outcomes, still a medium effect size. All of the model fit indices were excellent (see Table 3). These findings support the viability of the model in predicting 12-month prospective functional outcomes.

Table 3
Model fit indices

Model	χ^2	NFI ^a	SRMR ^b	AGFI ^c	ECVI ^d	RMSEA ^e
Predictor	1.99; $df=3$ $p = .57$	.96	.037	.98	.12 CI=(.12-.17)	0.0; CI=(0.0-.12); $p(RMSEA < .05) = .70$
Initial global	1.03; $df=3$; $p=0.79$	.99	.021	.99	.20; CI= (.20-.22)	0.0; CI=(0.0-.91); $p(RMSEA < .05) = .87$
Baseline global model	2.02; $df=4$; $p=0.73$	.98	.026	.98	.19; CI=(.19-.22)	.0; CI=(0.0-.09); $p(RMSEA < .05) = .83$
12-month global model	4.56 $df=4$; $p=0.34$	.95	.04	.95	.19; CI=(.19-.26)	0.02; CI= (0.0-.13); $p(RMSEA < .05) = .53$

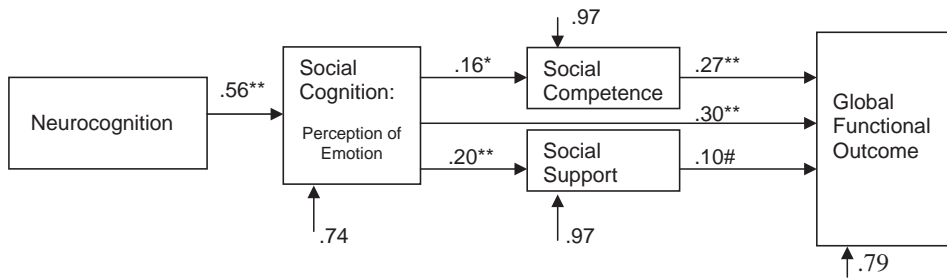
^a Normed Fit Index.

^b Standardized Root Mean Square Residual.

^c Adjusted Goodness of Fit Index.

^d Expected Cross-Validation Index.

^e Root Mean Square Error of Approximation.



** p < .01, * p < .05, # p < .10, one-tailed.

Fig. 3. Final model of concurrent global functional status.

6.1.3. Models of distinct outcome domains

Concurrent and prospective models predicting the three distinct outcome domains of social, work, and independent living also fit the data very well. In terms of concurrent functional variables, the model explained 19% of the variation in social functioning, 15% of the variation in work functioning, and 11% of the variation in independent living. Considering 12-month functional outcomes, the model explained 10% of the variance in social, work and independent living outcomes. The model fit indices were all in the good to excellent range. These domain specific results suggest that the global model generalizes well from global to the three functional domains. The only consistent difference across functional domains was that social support became a much stronger and statistically significant predictor of social outcomes.

6.1.4. Model misspecification

The fit of a global concurrent outcome model with the variables in miss-specified order (not simply reversed) was tested. χ^2 was statistically significant ($p < .001$), the NFI was .81, the AGFI was .76, and the SRMR was $> .09$. These indices represent a notable degradation in model fit from

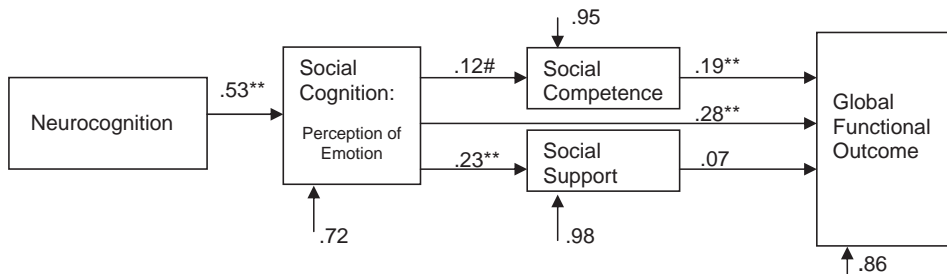
the theoretically specified model and reinforce the importance of the specified ordering of the variables in this model.

6.2. Direct and indirect effects

The direct effects are noted in Fig. 2a–d. The indirect effects are computed by summing the path coefficient products for each indirect path from predictor to outcome. The total effect is figured by adding direct plus indirect effects. Tables 4 and 5 present direct, indirect, and total effects in each of the concurrent and prospective models. The pattern and magnitude of direct and indirect effects was very similar for the concurrent and prospective models with two exceptions. The indirect effect of social cognition on global outcome is no longer statistically significant (changing from .06 to .04), while the magnitude of the betas for work outcomes are larger at 12-months compared to baseline.

7. Discussion

We tested a model that included neurocognition, social cognition, social competence, and social support



** p < .01, * p < .05, # p < .10, one-tailed.

Fig. 4. Final model of 12-month prospective global outcome.

Table 4
Direct, indirect, and total effects on baseline functional status

Predictors	Outcomes			
	RFS Global (<i>t</i> -value)	Social (<i>t</i> -value)	Work (<i>t</i> -value)	Independent (<i>t</i> -value)
Direct effects				
Indirect effects	.20**(3.85)	.14**(2.82)	.13**(2.48)	.18** (3.45)
Total effects	.20**(3.85)	.14**(2.82)	.13**(2.48)	.18** (3.45)
Perc. of emotion				
Direct effects	.28**(3.58)	.17*(2.17)	.17* (2.06)	.28** (3.41)
Indirect effects	.06*(2.14)	.07*(2.16)	.05 (1.47)	.03 (1.09)
Total effects	.35**(4.33)	.25**(3.00)	.22**(2.60)	.31** (3.79)

Direct effects also shown in Fig. 3a–b.

* $p < .05$; ** $p < .01$, one-tailed.

as predictors of global functional outcome, and also as predictors of the separate outcome domains of work, independent living, and social functioning. The results indicate a fairly consistent pattern across outcome domains and across time. First, the statistically significant total effects of neurocognition on functional outcome were entirely mediated through other variables in each of the models tested. Second, social cognition had significant direct effects across all four outcomes and significant indirect effects on global and social outcomes; therefore, in addition to having a consistently direct effect on outcome, the effects of social cognition were also mediated through social support and social competence for global and social outcomes. Social competence had a consistent direct effect across outcomes, while social support had the most notable direct effects on global and social outcomes. Third, the models of global outcome had explanatory effect sizes in the medium range for both the concurrent and 12-month prospective outcomes. Overall, there was consistent evidence that these biosocial models of

functional outcome in schizophrenia were empirically viable with strong fit to the data.

Previous research has linked the selected variables to some aspects of functional outcome in separate studies, but none has empirically tested a multi-level causal model, and there has been little examination of these associations across functional domains (Green, 1996; Green et al., 2000). In essence, previous research has asked *whether* these variables were singularly associated with functional outcome, while in this study we asked *how* these variables combined to influence outcome in schizophrenia. For example, previous studies have illustrated the direct (typically bivariate) impact of neurocognition on functional outcome (Green, 1996; Green et al., 2000). A central finding from this study was that the influence of neurocognition was largely indirect through other variables such as social cognition, social support, and social competence.

These findings also illustrate the importance of social cognition to the study of functional outcome.

Table 5
Direct, indirect, and total effects on 12-month functional outcomes

Predictors	Outcomes			
	RFS Global (<i>t</i> -value)	Social (<i>t</i> -value)	Work (<i>t</i> -value)	Independent (<i>t</i> -value)
Direct effects				
Indirect effects	.17** (3.45)	.11** (2.33)	.14** (2.93)	.14** (2.97)
Total effects	.17** (3.45)	.11** (2.33)	.14** (2.93)	.14** (2.97)
Perc. of emotion				
Direct effects	.28** (3.39)	.15* (1.83)	.24** (2.86)	.25** (2.99)
Indirect effects	.04 (1.46)	.05* (1.9)	.02 (.92)	.02 (.64)
Total effects	.32** (3.91)	.21** (2.46)	.26** (3.20)	.27** (3.25)

Direct effects also shown in Fig. 4.

* $p < .05$; ** $p < .01$, one-tailed.

Social cognition has been receiving increased attention in studies on schizophrenia (Corrigan and Penn, 2001; Penn et al., 1997a; Pinkham et al., 2003) but has not been tested previously in a model of functional outcome. Social cognition was strongly associated with neurocognition in the model, which suggests that some aspects of social cognition have neurocognitive underpinnings. In this model social cognition had direct effects on outcome, it mediated the impact of neurocognition on outcome, and its influence was partially mediated through social competence and social support. Hence, social cognition may be a central construct in the understanding of functional outcomes in schizophrenia.

We found that social competence and social support, directly linked to outcome in previous studies, also mediated the effects of neurocognition and social cognition on functional outcome. Social competence had consistent direct effects across domains except for the domain of social functioning, which is where social support exerted its largest direct influence.

Testing these models with both concurrent and prospective functional outcomes adds strength to the design by introducing a time ordering of the predictor and criterion variables. It reduces concerns about measurement contamination when predictor and outcome variables are measured at the same time. A notable finding was that the causal model yielded explanatory effects in the medium size range for global outcomes at both baseline and 12 months. While the strength of most of the effects did degrade from baseline to 12 months, the strength of the total effects actually increased from baseline to 12 months for work outcome. Also, given the strong correlation between the baseline and 12-month functional outcomes, it is very likely that much of the influence of the predictors on prospective functional outcome is mediated through baseline functional status. This does not dilute the significance of the model, but it does suggest a possible causal chain or cascade of influence among the predictor and criterion variables over time, as has been suggested by Spaulding et al. (1999).

These study findings have implications for the treatment and rehabilitation of functional outcomes in schizophrenia. Models of psychosocial rehabilitation in schizophrenia typically focus on strategies for intervening directly at the level of psychosocial behavior or for altering support mechanisms in an indi-

vidual's living or work environments (Bustillo et al., 2001; Mueser and Bellack, 1998). While there are some promising methods for the remediation of neurocognitive or social cognitive deficits (Brenner et al., 1992; Hogarty et al., 2004; Medalia et al., 2002; Wykes and van der Gaag, 2001) these methods are in the early stages of development and testing, and they have not generally been integrated into existing psychosocial rehabilitation strategies. Our present findings suggest that interventions that target more basic levels such as neurocognition and social cognition could be integral to creating and maintaining change in functional outcome domains. For example, many studies indicate that the functional gains accrued during active intervention are lost once the intervention ends or attenuates (Brekke et al., 1997a; Mueser and Bellack, 1998; Scott and Dixon, 1995). One hypothesis is that the maintenance of functional change might first require rehabilitation at more rudimentary levels such as neurocognition or social cognition before the effects of psychosocial intervention can be retained. For example, Spaulding et al. (1999) examined the relationship between changes in neurocognition and changes in social competence during rehabilitation. These accruing findings suggest that multi-modal and multifaceted interventions that include intervention strategies for basic neurocognition and social cognition should be combined with interventions that target direct behavioral change such as social skills training or work rehabilitation. Multi-modal intervention models such as this are currently being tested (Andres et al., 2001).

Several limitations to this study suggest caution concerning our conclusions. Foremost is the use of correlational data to construe causal influences. There is a long tradition of such use under certain conditions (Loehlin, 1998) which we have addressed four ways. First, we used a theory-driven approach to the data; second, we used statistical methods that have been designed to describe causality within a theoretical context; third, we tested a contra-theoretical model; fourth, we used the model to predict prospective outcomes. It is also important to note that our model represents between-subject variation, not individual change over time. Future analyses can model factors related to patterns of within-subject change over time. Another issue is that while we had important explanatory effects, the large residuals indicate that there

are multiple important variables left out of the analysis. For example, there may be other neurocognitive factors that, if included, would increase our explanatory power. However, we believe that theory and previous research lay a reasonable foundation for the model presented. Also, path analysis posits one-way causality; there may be bi-directional or reciprocal causal relationships among these variables. The study sample was not randomly selected, and it was a clinically stable outpatient population entering comprehensive psychosocial rehabilitation; therefore, any conclusions may not generalize to other clinical populations. We measured only one type of social cognition, namely, emotion perception. It is possible that other types of social cognition, such as social perception, theory of mind, or attributional bias may have somewhat different patterns of relationships to outcome. Finally, the use of a global construct of neurocognition could mask the influence of distinct neurocognitive variables. These relationships can be addressed in future research.

Acknowledgement

This research was supported by grants MH53282 and MH01628 from the National Institute of Mental Health awarded to the first author, and by the Department of Veterans Affairs VISN 22 Mental Illness Research Education and Clinical Center.

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