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# From Perception to Functional Outcome in Schizophrenia

## *Modeling the Role of Ability and Motivation*

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**Context:** Schizophrenia remains a highly disabling disorder, but the specific determinants and pathways that lead to functional impairment are not well understood. It is not known whether these key determinants of outcome lie on 1 or multiple pathways.

**Objective:** To evaluate theoretically based models of pathways to functional outcome starting with early visual perception. The intervening variables were previously established determinants of outcome drawn from 2 general categories: ability (ie, social cognition and functional capacity) and beliefs/motivation (ie, defeatist beliefs, expressive and experiential negative symptoms). We evaluated an integrative model in which these intervening variables formed a single pathway to poor outcome.

**Design:** This was a cross-sectional study that applied structural equation modeling to evaluate the relationships among determinants of functional outcome in schizophrenia.

**Setting:** Assessments were conducted at a Veterans Administration Medical Center.

**Participants:** One hundred ninety-one clinically stable

outpatients with schizophrenia or schizoaffective disorder were recruited from the community.

**Results:** A measurement model showed that the latent variables of perception, social cognition, and functional outcome were well reflected by their indicators. An initial untrimmed structural model with functional capacity, defeatist beliefs, and expressive and experiential negative symptoms had good model fit. A final trimmed model was a single path running from perception to ability to motivational variables to outcome. It was more parsimonious and had better fit indices than the untrimmed model. Further, it could not be improved by adding or dropping connections that would change the single path to multiple paths. The indirect effect from perception to outcome was significant.

**Conclusions:** The final structural model was a single pathway running from perception to ability to beliefs/motivation to outcome. Hence, both ability and motivation appear to be needed for community functioning and can be modeled effectively on the same pathway.

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**S**CHIZOPHRENIA TREATMENT RESEARCH has moved well past management of psychotic symptoms to the more ambitious, and to the patient more personally meaningful, goal of “recovery.” In general, recovery refers to achievement of independent living, vocational or educational activities, and satisfying interpersonal relationships.<sup>1,2</sup> To achieve recovery, it is first necessary to identify the key determinants of poor functioning that interfere with successful adaptation. Functional outcome generally refers to the degree of success that a person has with social connections, vocational pursuits, and degree of independent living. Several determinants have been identified, with considerable focus on neurocognition and

negative symptoms.<sup>3-6</sup> However, other factors, including perception, social cognition, functional capacity, and defeatist beliefs, also influence functional success achieved by people with schizophrenia.<sup>7-10</sup> The goal of the current study was to evaluate how well data from a large sample of patients fit a single-pathway model that runs from visual perception through intervening variables to functional outcome.

Determinants of functional outcome in schizophrenia can be grouped into 3 general categories: (1) perception, (2) ability, and (3) beliefs/motivation. Perception constitutes an early-stage determinant for outcome<sup>7,11-14</sup> and can include measures of visual or auditory processing. In this study, we examined early visual per-

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ception assessed with measures of visual masking. Starting an outcome model with perception (as opposed to later stages like neurocognition) has advantages for interpretation because perceptual variables have rather direct and established ties to neural processes, and they are relatively less influenced by later processes.<sup>11,15</sup> Hence, early perceptual variables in a model are more likely to influence later variables instead of the other way around.

Performance-based measures from social cognition, neurocognition, and functional capacity can be called measures of ability.<sup>16</sup> Social cognition refers to mental processes that underlie social interactions, including perceiving, interpreting, managing, and generating responses to socially relevant stimuli, including intentions and behaviors of others.<sup>17,18</sup> Patients with schizophrenia consistently show impairment across a range of social cognitive tasks,<sup>19</sup> and a recent review found that social cognition was a mediator between nonsocial neurocognition and functional outcome in 14 of 15 studies that evaluated such a role.<sup>20</sup> We previously found social cognition to be a mediator between perception and functioning,<sup>7,8</sup> and the current study uses a larger, and entirely independent, sample to examine this question more thoroughly. Neurocognition (ie, nonsocial measures of cognition, including memory, attention, reasoning and problem solving, and speed of processing) was not included in the current data set because the focus of the project was visual perception, but it has been a consistent determinant of outcome in several literature reviews.<sup>5,6</sup> Functional capacity (also called competence) refers to the ability to demonstrate activities of daily living or social communications in a simulated setting<sup>21,22</sup> and it has been found to act as a mediator between neurocognition and functional outcome.<sup>9,10</sup>

Beliefs and motivational factors include negative symptoms, which are highly consistent correlates of daily functioning.<sup>3,23</sup> Negative symptoms are a multifaceted construct comprising 2 separable subdomains: expressive symptoms (affective flattening and alogia) and experiential symptoms (avolition/apathy and anhedonia/asociality).<sup>24</sup> Negative symptoms are often linked to motivational factors because they are associated with measures of intrinsic motivation,<sup>25</sup> and experiential negative symptoms, in particular, are largely defined in terms of motivation.<sup>26</sup>

Beyond identifying determinants, there is a substantial challenge of mapping the interactive pathways through these variables that lead to poor functional outcome. Theories can guide this process, but they have tended to focus on segments of the outcome pathway instead of running all the way from perception to outcome. For example, some “cascade” models have linked early auditory and visual perception to social cognition.<sup>8,11</sup> These theories posit that poor formation of visual and auditory percepts contributes to problems in higher-level processing, such as social cognition.

In addition, a promising theoretical development in understanding negative symptoms and their role in functioning comes from Beck and colleagues.<sup>27,28</sup> This theory proposes that ability and functional outcome are indirectly related through a causal pathway involving dysfunctional attitudes.<sup>27,29</sup> According to this model, reduced ability leads to discouraging life circumstances, and

these discouraging experiences engender negative attitudes and self-beliefs. These dysfunctional attitudes, in turn, contribute to decreased motivation and interest that are seen clinically as different types of negative symptoms. Although several types of dysfunctional attitudes have been considered,<sup>30-32</sup> support for this model comes primarily from studies examining “defeatist performance beliefs,” which are overly generalized negative beliefs about one’s ability to successfully perform tasks.<sup>28</sup> Defeatist performance beliefs are endorsed more strongly by individuals with schizophrenia than healthy controls and correlate with negative, but not positive, symptom severity, even after accounting for depression.<sup>30,33-35</sup> Furthermore, defeatist beliefs can mediate the relation between ability and negative symptoms.<sup>33,34</sup> Thus, there is growing support for this novel conceptualization of negative symptoms proposed by Beck and colleagues.

A key unresolved question in this area is whether measures of ability (eg, cognition) and measures of motivation (eg, negative symptoms) act independently on functional outcome or whether they are part of a single pathway. In other words, there could be 2 independent paths to functional outcome, one based on ability (what one can do) and the other on motivation (what one wants to do). Alternatively, there could be a single path in which ability helps to determine motivation (as proposed by Beck et al). Data are ambiguous on this question; some studies suggest negative symptoms lie on a separate pathway from cognition<sup>9,36</sup> and others suggest they lie on the same pathway as perceptual or ability measures.<sup>7,33</sup> A formal test of this question requires a large sample and a broad, multifaceted range of measures, including key intervening variables.

Adequate evaluation of pathways to functional outcome requires statistical modeling approaches such as structural equation modeling (SEM) instead of traditional hypothesis-testing approaches. Structural equation modeling requires relatively large sample sizes and theoretically based models of outcome to guide the process. We started by evaluating a single-path model because it is consistent with both our previous empirical work<sup>7,34</sup> and the theoretical work of Beck and colleagues.<sup>27,33</sup> It is also the most parsimonious starting model. Evaluation of a single path with SEM provides information regarding whether the model would be improved by modifying it into 2 or more paths.

## METHODS

### PARTICIPANTS

One hundred ninety-one patients were recruited from community residences and outpatient treatment clinics at the Veterans Affairs Greater Los Angeles Healthcare System. Patients met criteria for schizophrenia (n = 173) or schizoaffective disorder (n = 18) based on the Structured Clinical Interview for DSM-IV Axis I Disorders.<sup>37</sup> Additional selection criteria included age between 18 and 60 years, no substance use disorder in the past 6 months, no identifiable neurological disorder and IQ more than 70 based on review of medical records, no history of loss of consciousness for more than 1 hour, and sufficient fluency in English to comprehend the informed con-

**Table 1. Demographic Information and Symptom Ratings**

	Schizophrenic Patients, Mean (SD) (n = 191)
Age, y	46.6 (9.8)
Education, y	12.7 (1.8)
Parental education, y	13.5 (3.6)
Male, %	67.5
Duration of illness, y	24.2 (11.3)
Expanded BPRS <sup>a</sup> score	
Total score	44.5 (10.3)
Negative symptoms, <sup>b</sup> (mean per item)	1.8 (0.9)
Positive symptoms, <sup>c</sup> (mean per item)	2.2 (0.9)
SANS global scores	
Affective flattening	1.5 (1.4)
Alogia	0.7 (1.1)
Avolition	2.9 (1.1)
Anhedonia	2.6 (1.3)

Abbreviations: BPRS, Brief Psychiatric Rating Scale; SANS, Scale for the Assessment of Negative Symptoms.

<sup>a</sup> Expanded 24-item version of the BPRS.<sup>38</sup>

<sup>b</sup> Negative symptoms = blunted affect, emotional withdrawal, and motor retardation.

<sup>c</sup> Positive symptoms = grandiosity, suspiciousness, hallucinations, unusual thought content, bizarre behavior, disorientation, and conceptual disorganization.<sup>39</sup>

sent form and study procedures. All participants had the capacity to give informed consent based on a quiz of main content, and they provided written informed consent after all procedures were fully explained in accordance with procedures approved by the institutional review boards at the Veterans Affairs Greater Los Angeles Healthcare System and the University of California, Los Angeles. One hundred sixty-four patients were receiving atypical antipsychotic medications; 8, typical antipsychotic medications; and 7, both types of medication, and 12 were not taking an antipsychotic. Demographic and clinical summary data are provided in **Table 1**.

## MEASURES

Brief descriptions of each measure are included next, and references are provided that contain more complete descriptions and, when available, psychometric properties of the measures when used with patients with schizophrenia.

### 1. VISUAL PERCEPTION

#### Location Masking

In the location masking task,<sup>40-42</sup> the target consisted of a single square with a notch that could appear at the top, bottom, or left side of the square. The target could appear at 1 of 4 different locations, arranged in a notional square, on the computer screen. The mask consisted of a pattern of squares that occupied every possible target location. The target was presented for 12.5 milliseconds and the mask was presented for 25 milliseconds. As in previous masking studies, we first used a psychophysical procedure to equate the participants on the target threshold so that each subject could identify an unmasked target at 84% accuracy. Both forward and backward masking were assessed. In forward masking, the mask preceded the target, whereas in backward masking the mask followed the target. Six stimulus-onset asynchronies (SOAs) were used in both forward and backward masking (12.5, 25.0, 37.5, 50.0, 62.5, and

75 milliseconds). Participants' scores were averaged across SOAs separately for forward and backward masking.

#### 4-Dot Masking

In the 4-dot masking procedure, 4 potential targets appeared in a notional square on the screen followed by a mask surrounding one of the potential targets.<sup>41,43</sup> The mask cued which target the participant was supposed to identify. The target array consisted of 4 squares with a notch missing from either the top, bottom, or left side of the square, and the mask was 4 dots that surrounded, but did not touch, one of the potential targets. The target was presented for 25 milliseconds and the mask, for 37.5 milliseconds. Target stimuli were suprathreshold for all subjects, unlike the location masking condition, which used an individual's threshold. Twelve trials were presented for each of 8 SOAs (0, 25, 50, 75, 100, 125, 150, and 175 milliseconds). In 4-dot masking, performance typically decreases with increasing SOAs, unlike the pattern for location masking. A summary score across the 8 SOAs was used.

## 2. ABILITY

### Social Cognition

**The Profile of Nonverbal Sensitivity.** The Profile of Nonverbal Sensitivity included the first 110 scenes of the full instrument<sup>44,45</sup> and assessed social perception. Scenes of this videotape-based measure lasted 2 seconds and contained the facial expressions, voice intonations, and/or bodily gestures of a white woman. Each scene contained 1, 2, or 3 social cues. After watching each scene, the participant selected from 2 labels (eg, saying a prayer or talking to a lost child) the one that best described the situation that was observed. As in prior studies that used the Profile of Nonverbal Sensitivity in persons with schizophrenia, administration was modified to reduce demands on attention and reading comprehension.<sup>8</sup> Prior to each scene, the videotape was paused as the experimenter read the 2 possible labels aloud as the participant read the labels silently from a card. The number of correct responses was the dependent variable.

**The Awareness of Social Inference Test.** The Awareness of Social Inference Test (Part III) is a measure of theory of mind (ie, mentalizing) and consists of 16 videotaped scenes, each lasting 15 to 60 seconds, depicting lies or sarcasm (8 of each).<sup>46,47</sup> The lie scenes involved either white lies or sympathetic lies. A prologue/epilogue provided information to the viewer about the nature of the conversational exchange. Participants were asked to answer 4 types of forced-choice (yes/no) questions: the first asked the participant to think about what one character in the scene was doing to the other; the second asked what the character was trying to say to the other person; the third asked what the character was thinking; and the fourth asked what the character was feeling. The videotape was paused between each scene to allow the participant time to answer. The test provides an overall total score, which was used in the current study.

**Mayer-Salovey-Caruso Emotional Intelligence Test 2.0.** The Mayer-Salovey-Caruso Emotional Intelligence Test 2.0 (MSCEIT) is a self-report instrument that consists of 141 items and 8 ability subscales that assess 4 components (branches) of emotion processing.<sup>48-50</sup> As in previous studies with schizophrenia, the tester administered the MSCEIT booklet individually to the participant.<sup>49</sup> The first branch, Identifying Emotions, measured emotion perception in faces and pictures. The second branch, Using Emotions, examined how mood en-

hances thinking and reasoning and which emotions are associated with which sensations. The third branch, Understanding Emotions, measured the ability to comprehend emotional information, including blends and changes between and among emotions. The fourth branch, Managing Emotions, examined the regulation of emotions in oneself and in one's relationships with others by presenting vignettes of various situations, along with ways to cope with the emotions depicted in these vignettes. We used the MSCEIT total score.

### Functional Capacity: UCSD Performance-Based Skills Assessment

The UCSD Performance-Based Skills Assessment (UPSA) is a performance-based simulation of daily activities and involves role-play tasks in 5 skill areas considered essential to functioning in the community.<sup>51</sup> The areas include General Organization, Finance, Social/Communications, Transportation, and Household Chores. Psychometrics of the UPSA used with schizophrenia are generally strong.<sup>22</sup> The patients' total UPSA summary score across the 5 areas was the dependent measure.

## 3. BELIEFS/MOTIVATION

### Dysfunctional Attitudes Scale

Participants completed the 15-item defeatist performance beliefs subscale from the Dysfunctional Attitudes Scale.<sup>52</sup> The defeatist performance belief subscale has been the focus in previous schizophrenia research,<sup>33</sup> and it consists of statements describing overgeneralized conclusions about one's ability to perform tasks (eg, "If you cannot do something well, there is little point in doing it at all").

### Negative Symptoms: The Scale for the Assessment of Negative Symptoms

The Scale for the Assessment of Negative Symptoms was used to evaluate negative symptoms during the preceding month.<sup>53</sup> This interview-based rating scale contains anchored items that lead to global ratings of 4 negative symptoms: affective flattening, avolition, anhedonia/asociality, and avolition/apathy. The Scale for the Assessment of Negative Symptoms items and global ratings range from 0 (not at all) to 5 (severe). We separated negative symptoms into experiential (avolition and anhedonia) and expressive (affective flattening and avolition) components.<sup>7,24</sup>

## 4. FUNCTIONAL OUTCOME: THE ROLE FUNCTIONING SCALE

The Role Functioning Scale (RFS) was used to assess functional status.<sup>54,55</sup> It is based on a semistructured interview with the participant and includes subscales for work, independent living, family relations, and social functioning. The RFS ratings range from 1 (severely impaired functioning) to 7 (optimal functioning). Each RFS subscale provides anchored descriptions for all levels of functioning that capture both the quantity and quality of functioning in that domain.

## DATA ANALYSES

Structural equation modeling uses a combination of indicators (single variables) and latent variables (underlying factors) that can be estimated for constructs with 3 or more indicators. In the current data set, we had a sufficient number of indicators

**Table 2. Descriptive Statistics**

	Mean (SD)
Forward masking, %	57.1 (18.3)
Backward masking, %	43.8 (16.6)
4-Dot masking, %	55.3 (15.1)
PONS	78.6 (7.1)
TASIT	45.7 (7.3)
MSCEIT	82.3 (13.3)
UPSA	74.6 (11.3)
Defeatist beliefs	51.9 (18.1)
Expressive negative symptoms	1.1 (1.1)
Experiential negative symptoms	2.8 (1.0)
Functional outcome	3.7 (1.3)

Abbreviations: MSCEIT, Mayer-Salovey-Caruso Emotional Intelligence Test 2.0; PONS, Profile of Nonverbal Sensitivity; TASIT, The Awareness of Social Inference Test (Part III); UPSA, UCSD Performance Skills Assessment.

for perception, social cognition, and functional outcome to estimate latent variables for these constructs. The remaining constructs were represented by a single indicator.

The relationship between the measured variables in the population was estimated using the sample covariance matrix, and the hypothesized latent structure was tested by fitting the measurement model linking the latent variables to their indicators. This confirmatory factor analysis supported the notion that social cognition and early visual perception are separable constructs. The latent variable "early visual processing" was indexed with 3 indicators: forward masking, backward masking, and 4-dot masking. "Social cognition" was indexed with the total scores on the Profile of Nonverbal Sensitivity, The Awareness of Social Inference Test, and MSCEIT. "Functional outcome" was a latent variable with 4 indicators: scores on the independent living, work, family, and social functioning subscales of the RFS.

The hypothesized SEM models were estimated with the structural equation package EQS.<sup>56</sup> Of the fit indices available, we provide 3 commonly reported indices that address different aspects of a well-fitting model to allow for a comprehensive evaluation of model fit.<sup>57</sup> The  $\chi^2$  statistic is a measure of absolute fit, ie, it evaluates the difference between the sample covariance matrix and the covariance matrix implied by the fitted model, and it is very sensitive to sample size; the composite fit index (CFI) is a measure of comparative fit, ie, it evaluates how much improvement the fitted model offers over a model that assumes all measured variables are uncorrelated; and the root mean square error of approximation (RMSEA) is a measure of absolute fit that is based on the noncentrality parameter of the  $\chi^2$  statistic. The issue of missing data was addressed by first analyzing only complete cases and repeating the analyses using a covariance matrix based on imputing missing data using the EM algorithm.<sup>58</sup> Because the pattern of results was virtually identical, and pairwise percentage of missing data was less than 10% in all cases, only the results with imputed data are reported.

## RESULTS

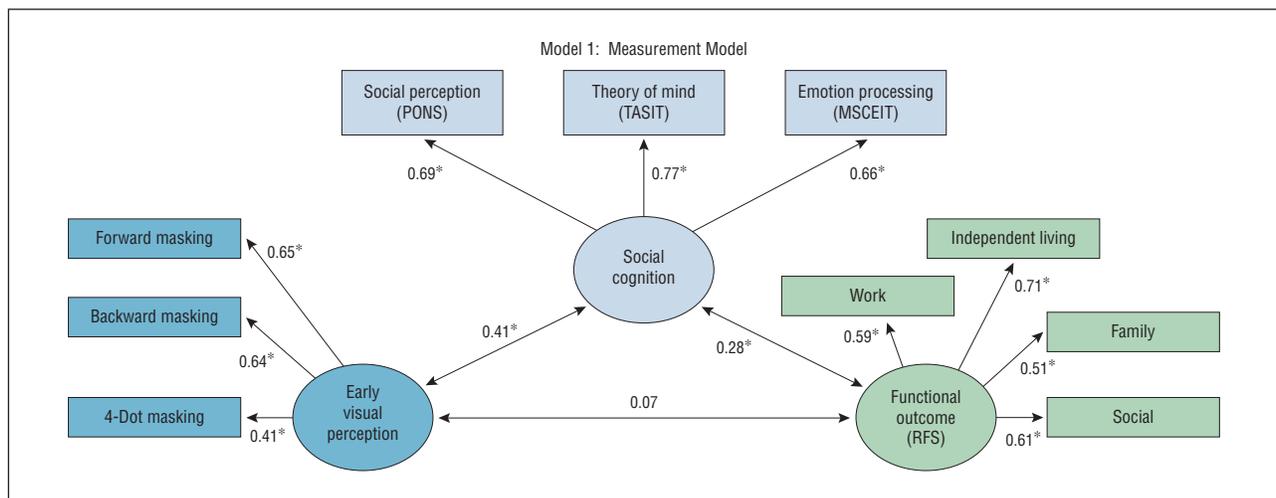
The summary statistics for each variable are shown in **Table 2**, and the bivariate intercorrelations among the measures are shown in **Table 3**. As expected, the intercorrelations among variables were generally higher within category (perceptual, ability, beliefs/negative symptoms) than between categories. The specific asso-

**Table 3. Intercorrelations Among Measures Included in the Models**

	Forward Masking	Backward Masking	4-Dot Masking	Social Perception (PONS)	Theory of Mind (TASIT)	Emotion Processing (MSCEIT)	Functional Capacity (UPSA)	Defeatist Beliefs	Expressive Negative Symptoms	Experiential Negative Symptoms	Functional Outcome
Forward masking											
Backward masking	0.442 <sup>a</sup>										
4-Dot masking	0.199 <sup>b</sup>	0.264 <sup>a</sup>									
Social perception (PONS)	0.255 <sup>a</sup>	0.164 <sup>b</sup>	0.083								
Theory of mind (TASIT)	0.233 <sup>a</sup>	0.200 <sup>a</sup>	0.281 <sup>a</sup>	0.526 <sup>a</sup>							
Emotion processing (MSCEIT)	0.087	0.113	0.225 <sup>a</sup>	0.466 <sup>a</sup>	0.488 <sup>a</sup>						
Functional capacity (UPSA)	0.089	0.093	0.242 <sup>a</sup>	0.460 <sup>a</sup>	0.479 <sup>a</sup>	0.477 <sup>a</sup>					
Defeatist beliefs	-0.139	-0.122	-0.074	-0.257 <sup>a</sup>	-0.206 <sup>a</sup>	-0.363 <sup>a</sup>	-0.331 <sup>a</sup>				
Expressive negative symptoms	0.041	-0.018	0.050	-0.091	0.085	0.050	-0.069	0.166 <sup>b</sup>			
Experiential negative symptoms	-0.166 <sup>b</sup>	-0.122	0.042	-0.130	-0.021	-0.083	-0.096	0.256 <sup>a</sup>	0.349 <sup>a</sup>		
Functional outcome	0.184 <sup>b</sup>	0.083	0.013	0.133	0.155 <sup>b</sup>	0.172	0.138	-0.287 <sup>a</sup>	-0.231 <sup>a</sup>	-0.703 <sup>a</sup>	

Abbreviations: MSCEIT, Mayer-Salovey-Caruso Emotional Intelligence Test 2.0; PONS, Profile of Nonverbal Sensitivity; TASIT, The Awareness of Social Inference Test (Part III); UPSA, UCSD Performance Skills Assessment.

<sup>a</sup>  $P < .01$ .  
<sup>b</sup>  $P < .05$ .



**Figure 1.** This Figure reflects a measurement model that shows the degree of fit between the 3 latent variables (early visual perception, social cognition, and functional outcome) and their respective indicators. MSCEIT indicates Mayer-Salovey-Caruso Emotional Intelligence Test 2.0; PONS, Profile of Nonverbal Sensitivity; RFS, Role Functioning Scale; and TASIT, The Awareness of Social Inference Test (Part III). \*Significant at  $P < .05$ .

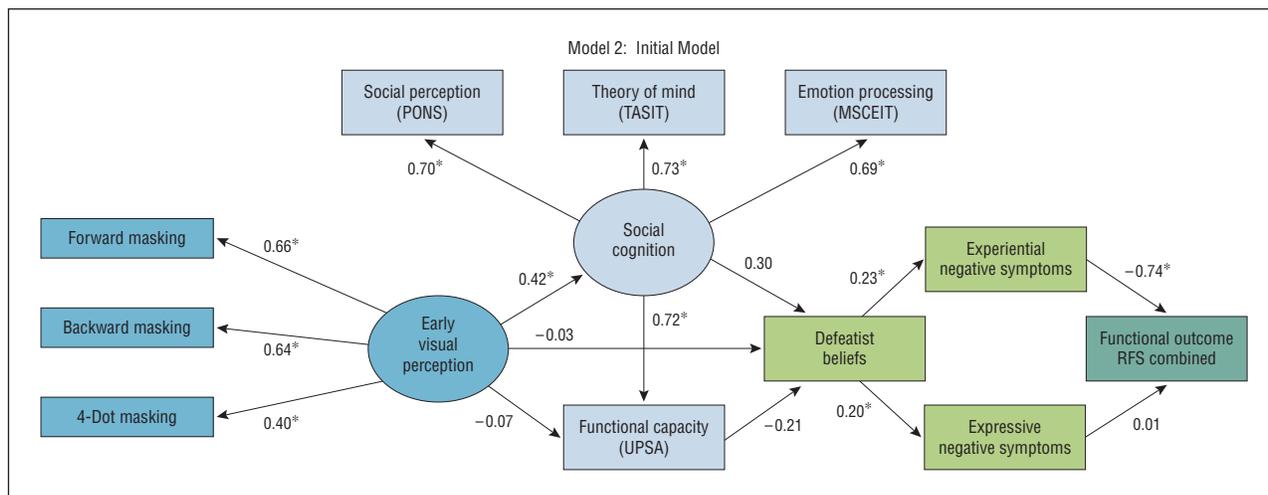
ciations were then evaluated with SEM in a series of 3 models.

### MEASUREMENT MODEL

The first model examined the degree to which the latent variables for early visual perception, social cognition, and functional outcome loaded on their respective indicators (**Figure 1**). This first model is essentially a confirmatory factor analysis and model fit was extremely good ( $\chi^2 = 31.64$ ;  $P = .48$ ; CFI = 1.00; RMSEA = 0.00), indicating that the latent variables and indicators were strongly associated. Based on this degree of fit, we reduced functional outcome to a single variable for subsequent models as a way to conserve free parameters and increase stability of the parameter estimates for the remaining models.

### INITIAL MODEL

We then added functional capacity, defeatist beliefs, and experiential and expressive negative symptoms to create a single path in the model (**Figure 2**). Model fit was good ( $\chi^2 = 74.90$ ;  $P < .001$ ; CFI = 0.91; RMSEA = 0.08). Next, we made changes to this model based on conceptual and statistical considerations. For conceptual modifications, we dropped expressive negative symptoms because it was unrelated to functional outcome, which is the focus of this model. In terms of statistical considerations, we dropped functional capacity because of its very close association with social cognition. Because of this tight connection, the explained variance in defeatist beliefs was split between social cognition and functional capacity so that neither path was significant. Finally, modification indices from the EQS



**Figure 2.** This Figure is a schematic of the initial nontrimmed structural model that includes all of the variables considered. MSCEIT indicates Mayer-Salovey-Caruso Emotional Intelligence Test 2.0; PONS, Profile of Nonverbal Sensitivity; RFS, Role Functioning Scale; TASIT, The Awareness of Social Inference Test (Part III); and UPSA, UCSD Performance-Based Skills Assessment. \*Significant at  $P < .05$ .

software were used to determine other paths that could be dropped to improve fit.

### FINAL MODEL

After the modifications mentioned earlier, the resulting, more streamlined model had good fit ( $\chi^2 = 39.41$ ;  $P = .04$ ; CFI = 0.96; RMSEA = 0.06). The model reflects a relatively linear sequence leading from perception to ability to beliefs/negative symptoms and to functional outcome. The strength of the model was supported by the significant standardized indirect effect of early visual processing through all other variables to functioning (0.028;  $P < .05$ ). In other words, we found a significant indirect effect through 3 intervening variables. This model explains 49% of the variance in RFS total score.

No changes were suggested through the modification indices that would turn the single pathway into a dual pathway (eg, a separate path for motivation). The model was not improved by adding a direct link between social cognition and functional outcome that would create a pathway separate from negative symptoms. Also, the connection between ability and motivation (ie, between social cognition and defeatist beliefs) was relatively high (-0.44) and could not be dropped.

Compared with the initial model, the final model was more parsimonious (requiring fewer constructs and connections) and the fit indices were slightly higher. Because it was more parsimonious, the model was also more stable: there were 18 free parameters and 191 subjects, which is more than 10 subjects per parameter. Based on these results, it can be concluded that a single pathway running from perception to ability to motivational variables to functioning provides good model fit, and additional paths do not improve the model.

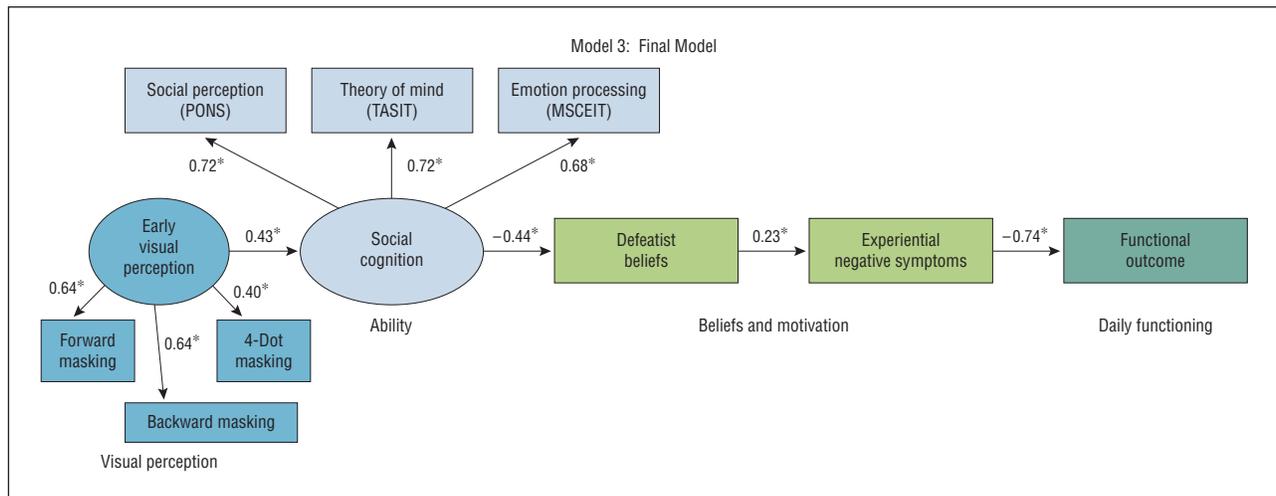
### COMMENT

We evaluated models of outcome in schizophrenia ranging from microlevel early visual perception to mac-

rolelevel daily community functioning. We conclude that ability and motivational factors can be modeled effectively with a single, relatively streamlined pathway. The a priori theories that generated this model stemmed from 2 separate literatures: one on connections between perceptual processing and social cognition and one on connections between dysfunctional attitudes and negative symptoms. Results suggest that success in daily living involves both what patients can do and also whether they are motivated to apply their abilities to the challenges of daily living.

The theoretical connection between perceptual processes and social cognition is based on a cascade model in which poor perceptual information contributes to inaccurate higher-level information,<sup>11</sup> and it has received increasing support from the literature. Previous publications from our laboratory with an independent sample used a single measure of social cognition, social perception, that mediated the relationship between visual perception and functioning.<sup>7,8</sup> A previous article<sup>7</sup> modeled visual perception to functional outcome and reported 2 mediating paths (one for social cognition and one for negative symptoms), but it did not include defeatist beliefs or any measure of dysfunctional attitudes. Hence, it was lacking this key intervening step between ability and motivation. Also, other groups reported that problems in early auditory processing are associated with problems in emotion detection from voice prosody.<sup>11,59,60</sup> Other studies found that an early visual process (contour integration) is related to the higher-level social cognitive construct of theory of mind.<sup>61,62</sup>

Despite its strong theoretical grounding, the connection between defeatist beliefs and negative symptoms has received less empirical support so far. Studies from other groups have shown connections between defeatist beliefs and both negative symptoms and social functioning.<sup>30,33,35</sup> Also, a previous study from our laboratory with a partially overlapping sample found defeatist beliefs were connected to a combined negative symptom score.<sup>34</sup> An interpretive advantage of the current study is that we ex-



**Figure 3.** This Figure is the final trimmed model after modifications. It shows a single path running through early visual perception, ability, beliefs/motivation, and functional outcome. MSCEIT indicates Mayer-Salovey-Caruso Emotional Intelligence Test 2.0; PONS, Profile of Nonverbal Sensitivity; and TASIT, The Awareness of Social Inference Test (Part III). \*Significant at  $P < .05$ .

amined differential relationships between defeatist beliefs and expressive vs experiential negative symptoms.<sup>30</sup> Dysfunctional attitudes include more than defeatist beliefs, which was the focus in this study.<sup>28</sup> Other beliefs, such as maladaptive beliefs about one's ability to communicate effectively, might be more closely linked to expressive negative symptoms. Understanding the determinants of experiential (as opposed to expressive) negative symptoms is particularly important given their strong relationship to functioning.<sup>7,63</sup>

Although functional capacity has been reported to be a determinant of outcome in other studies, it was not retained in the final model in our study.<sup>10,36</sup> This decision was prompted by the very close association between our measure of functional capacity (UPSA) and the latent variable of social cognition. Because of this close association, the information provided by functional capacity was largely redundant with social cognition, and it split the covariance from ability to defeatist beliefs, leaving both pathways smaller and nonsignificant. In the context of this model, functional capacity acted more like an additional indicator for the social cognition latent variable. It would have been statistically possible to create a new latent variable of "ability" with social cognition and functional capacity, but our initial focus on social cognition guided the final model. The strong association between the UPSA score and social cognition is consistent with similar findings from an independent sample from our laboratory.<sup>64</sup> Evidence across laboratories and methods indicates that neurocognition, social cognition, and functional capacity have substantial intercorrelations (at least when using composite scores) and can be reasonably considered reflections of a general ability factor.<sup>22,65</sup> Despite these strong associations, neurocognition and social cognition are modeled better as separate factors.<sup>66,67</sup>

As with all uses of SEM, this analysis is based on a priori theoretical models that guided the initial arrangement of variables. It is possible that other configurations of these variables would work equally well or better. We can only say that the observed data fit the proposed model (early perception to ability to beliefs to negative symptoms to

functioning) rather well, and the integrated model in **Figure 3** is a highly plausible sequence of steps based on that.

Beyond the constraints of the SEM method, this study had several limitations. As mentioned earlier, the study did not include measures of neurocognition (because data came from a project on perception and social cognition), but previously reported intercorrelations among neurocognition, social cognition, and the UPSA suggest they are all reasonable reflections of ability. Also, the study was cross-sectional. Hence, we do not know if the model would hold up if long-term outcome had been used instead of concurrent outcome. Path analyses from a collaborative study that used a 12-month follow-up and a different set of variables found similar results for cross-sectional and prospective analyses.<sup>55</sup> On the other hand, we previously reported that relationships between social cognition and outcome became stronger over time with first-episode samples.<sup>68</sup> In addition, the strong association between experiential negative symptoms and functional outcome might be partially explained by measurement overlap in these 2 areas.<sup>26</sup> That is one reason for a recent effort to develop new scales that assess experiential negative symptoms as separately as possible from current community functioning.<sup>69</sup> Our sample was predominantly male and relatively long term, so its representativeness is limited. Also, because modification indices were used to refine the final model, replication with an independent sample is needed. Finally, the study only examined within-subject factors. Future models may want to include situational and contextual factors, eg, family support, consistency of mental health services, and local economic conditions.

It is mainly intuitive that perception is linked to ability, defeatist beliefs are linked to negative symptoms, and negative symptoms are linked to daily functioning. The result of putting the pieces together in an integrative model yields some less intuitive findings, particularly the transition from ability to motivation. However, these results match the theoretical framework outlined by Beck and colleagues,<sup>27,28</sup> who proposed that the repeated discour-

agement from having reduced abilities leads, over time, to dysfunctional attitudes such as defeatist beliefs. The model is essentially developmental; it assumes that the dysfunctional attitudes are built up over years of living with limited abilities. The current results are consistent with the predicted, but perhaps still surprising, finding that the connections from perception and ability to daily functioning work through motivational variables. This sequence of domains is also consistent with findings that cognitive therapy directed at dysfunctional attitudes can yield improvements in negative symptoms in patients with schizophrenia.<sup>70</sup>

The single pathway model that is supported in this study helps to provide a rationale for early perceptual and cognitive interventions, such as plasticity-based training.<sup>71</sup> With a single pathway, it is theoretically possible (though not assured) that an intervention directed at early components (eg, perception, cognition) could have beneficial effects on subsequent processing stages and functional outcome. With a dual-pathway model, at least 1 intervention per path would be needed. The single pathway model also suggests that interventions for early components that occur early during the illness (eg, prodromal or first-episode stages) could help prevent development of defeatist beliefs, thereby interrupting the detrimental consequences of the pathway.

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