Cognition and Social Functioning in Schizophrenia

David L. Penn, Will Spaulding, Dorie Reed, Mary Sullivan, Kim T. Mueser, and Debra A. Hope

THIS article reviews three studies investigating the relationship between information processing and social functioning in schizophrenia. The most consistent finding is the association between vigilance performance on a hybrid continuous performance/span of apprehension task and various indices of social functioning (e.g., ward behavior). However, the nature of the information processing–social functioning relationships is mutable and appears dependent on a number of factors (e.g., cross-sectional versus longitudinal designs). This article concludes with a discussion of treatment implications and future research directions.

Individuals with schizophrenia suffer from pervasive deficits in information processing. These deficits occur across a range of cognitive processes, including iconic memory, selective and sustained attention, and conceptual skills (reviewed by Braff 1993; Nuechterlein and Dawson 1984b) and may be present in premorbid, symptomatic, or remitted states (Cromwell and Spaulding 1978; Nuechterlein and Dawson 1984a; Zubin and Spring 1977). The ubiquity of cognitive impairment in schizophrenia has implications for psychosocial treatment: Individuals with persistent cognitive deficits may be ill prepared to deal with the demands of the rehabilitation milieu (Spaulding, Storms, Goodrich, and Sullivan 1986) and/or may acquire social skills at especially slow rates (e.g., Mueser, Bellack, Douglas, and Wade 1991). Thus, various researchers argue that remediation of cognitive deficits should be a core component in the psychosocial treatment of schizophrenia (Brenner, Hodel, Roder, and Corrigan 1992; Stuve, Erickson, and Spaulding 1991).

Before treatment strategies focus on cognitive rehabilitation, it is necessary to investigate whether cognitive deficits relate to other aspects of functioning, such as social competence (Bellack 1992; Green 1996; Hogarty and Flesher 1992; Liberman and Green 1992; Neale, Oltmanns, and Harvey 1985). If cognitive and social domains are relatively independent, then intervention at one level will have a limited impact on the other level. For exam-

David L. Penn, PhD, is Assistant Professor of Psychology at Louisiana State University.
Will Spaulding, PhD, is Professor of Psychology at the University of Nebraska – Lincoln.
Dorie Reed, PhD, is Staff Psychologist and *Mary Sullivan, MSW,* is Program Director at the Lincoln Regional Center/Community Transition Program.
Kim T. Mueser, PhD, is Professor of Psychiatry at the Dartmouth Medical School.
Debra A. Hope, PhD, is Associate Professor at the University of Nebraska – Lincoln.
The following individuals are acknowledged for their help during various stages of preparing this manuscript: Patrick W. Corrigan, PsyD and Susan Funkenstein, MA. The authors also acknowledge the staff and patients at the Academisch Medisch Centrum and the Lincoln Regional Center, Extended Care Program for their cooperation.
Address correspondence to David L. Penn, PhD, Louisiana State University, Department of Psychology, 236 Audubon Hall, Baton Rouge, LA 70803-5501.

ple, improving performance on a cognitive problem-solving task (e.g., The Wisconsin Card Sorting Test) may not improve an individual's ability to resolve interpersonal conflicts (Penn 1991). Conversely, a relationship between two domains suggests that functioning at one level may influence the rate of improvement or deterioration at the other level (e.g., improvement in vigilance performance serving as a prerequisite for changes in social perception to occur) (Brenner 1987; Green 1993).

This article summarizes a series of studies that investigated the relationship between information processing and social functioning in schizophrenia. The studies addressed the following research questions (in order of cognitive variables' relationships with increasingly more molar levels of social functioning): (a) Does information processing relate to *social* information processing? (b) What is the relationship between information processing and social competence during an interaction? (c) What are the cross-sectional and longitudinal relationships between information processing and naturally occurring behavior on the ward? Following description of the studies and their results, implications for treatment and future directions are discussed.

Information Processing and Social Information Processing

The first step in our research program was an investigation of information processing and social-cognitive problem solving (Penn et al. 1993). The study, which was conducted at the Academisch Medisch Centrum in the Netherlands, included three groups of subjects: (a) 24 adolescent schizophrenia inpatients, (b) 14 depressed patients enrolled in a day-treatment program, and (c) 25 nonpsychiatric control subjects. Information processing was assessed with COGLAB (Spaulding, Garbin, and Crinean 1989; Spaulding, Garbin, and Dras 1989), a computer-administered battery comprising test paradigms selected from the experimental psychopathology literature (i.e., reaction time, backward masking, continuous performance/span of apprehension [CP/Span] task, card sorting task [a computerized modified version of the Wisconsin Card Sorting task]).

Social-cognitive problem solving (SCPS) was assessed with the means-ends problem solving task (MEPS) (Platt and Spivack 1975) and an alternative solution generation task (ALT). In the MEPS task the subject is presented with seven vignettes involving a hypothetical individual. Each vignette describes a beginning, in which a hypothetical problem is present, and an ending, in which the problem is resolved. The subject's task is to fill in the middle of the vignette – how the hypothetical individual solved the problem. The ALT task is similar to the MEPS insofar as a hypothetical interpersonal problem is presented. However, the subject's task is now to generate as many alternative solutions as possible to the interpersonal problem, regardless of solution quality. Although these tasks are not without their critics (e.g., Bellack, Morrison, and Mueser 1989), performance on the MEPS and ALT tasks have been found to differentiate control from clinical groups in both adult and child samples (reviewed in Fischler and Kendall 1988; Tisdelle and St. Lawrence 1986).

SCPS was indexed as the total number of means (i.e., a specific strategy, cognitive and/or behavioral, which moves one closer to problem resolution) and alternative solutions for the MEPS and ALT tasks respectively. Interrater reliability for the subjects' responses to the MEPS and ALT tasks was high (Pearson correlation coefficients = 80). Clinical subjects were tested within their first month of treatment and approximately 3 months later when their symptoms had remitted.

Pearson correlations were conducted on information processing and social-cognitive problem solving variables both cross-sectionally and longitudinally. To control for Type I error, a more stringent alpha level of .01 was set for all correlations. The results of the analyses revealed

different correlational patterns for the three groups. For the nonclinical controls, *none* of the correlations were statistically significant. This may have been due in some cases to range restriction and in others to what is known in psychological assessment as the "twisted pear" phenomenon (Fisher 1959): A test is most predictive of functioning for scores indicative of pathology or impairment. Thus, COGLAB may only be predictive of SCPS for groups who demonstrate impairment in information processing. Alternatively, these results may reflect a functional independence between these particular information processing and social-cognitive problem solving measures. Such a conclusion is consistent with research indicating that "social intelligence" is not strongly predicted by various cognitive tasks (reviewed in Sternberg, Wagner, Williams, and Horvath 1995).

For the depressed group, better SCPS at Time 1 was associated with better performance on the backward masking task. In the backward masking task, subjects have to identify two briefly presented digits that are immediately followed by a patterned mask (e.g., XX). Interestingly, at Time 2, when symptoms had remitted, none of the correlations were significant. This suggests that as clinical status stabilizes, the predictive efficiency of information processing approaches that of normal subjects. Longitudinally, changes in SCPS were associated with changes in ability to disattend from distracting stimuli (i.e., presented during the reaction time task). It was hypothesized that the mechanisms underlying these relationships were sustained attention and effortful processes. Thus, it is possible that as clinical depression remits, more cognitive "resources" can be allocated to external problems which in turn could protect previously depressed individuals from future relapse.

For the group with schizophrenia, better SCPS during symptom exacerbation and remission was associated with an increase in hits and false alarms during a vigilance task (i.e., CP/Span). In this task, subjects have to identify a briefly presented target digit (e.g., the number 4) across three conditions: (a) digits presented one at a time, (b) digits presented in an array of six, and (c) digits presented in an array of six with a new target (e.g., the target is switched from number 4 to number 7). The response style of individuals who accrue a large number of hits and false alarms on a vigilance task can be described as "liberal"; rather than responding only when they are confident that a given digit is the target in question, they are more apt to identify that any given stimulus is the target digit, even if that digit turns out to be incorrect.

Although one may question whether this response style is better characterized as "erratic" rather than "liberal," the data from this study suggest otherwise: The association between SCPS and performance on CP/Span (i.e., number of hits and false alarms) was not random but rather was associated with the difficulty of the task. Specifically, the bivariate relationship between hit/false alarm rate and SCPS became stronger as task demands increased. This suggests that subjects attempted to increase their response rate in the face of changing task parameters. This relationship held during the longitudinal analyses (i.e., residualized change scores[1]), with the additional cognitive variable of errors on the card sorting task being associated with changes in SCPS. Therefore, schizophrenia patients with a more liberal response style on the vigilance task (i.e., more likely to both correctly and incorrectly identify digits as the target) demonstrated better SCPS both cross-sectionally and longitudinally.

The liberal response style may be the result of patients compensating for information-processing deficits. Such compensatory efforts may be a cognitive barometer of readiness to improve functioning: Individuals who have an *awareness* of their cognitive deficits will be those most likely

[1]Residualized change scores were calculated. Time 1 values were regressed onto Time 2 values, with the residual representing the change score used in the regression analyses.

to modify their cognitive performance to changing task demands. This suggests that greater *metacognition* is an important factor in SCPS. An alternative explanation is that the relationship between response style and SCPS is mediated by disinhibition. Individuals may respond liberally to stimuli without regard to the appropriateness of their responses. This would be associated with social problem-solving performance because SCPS tasks were coded quantitatively rather than qualitatively. Irrespective of the interpretation espoused, the liberal response style seems to tap into significant aspects of social-cognitive problem solving.

The findings from Penn et al. (1993) can be summarized as follows: (a) There are no significant relationships between information processing and SCPS for nonclinical control subjects; (b) for patients with depression, higher SCPS is associated with better ability to engage in effortful processing of information, such as sustained attention and resistance to distractibility; and (c) the SCPS in young patients with schizophrenia is related to a more liberal response style on vigilance tasks.

Information Processing and Social Competence

In the next step of our research program, we investigated whether a relationship exists between information processing and social competence during an interaction (Penn, Mueser, Spaulding, Hope, and Reed 1995). Social competence comprises a number of components, including paralinguistic skills (e.g., speech fluency), nonverbal skills (e.g., eye contact), and verbal content (Bellack, Morrison, Wixted, and Mueser 1990; Liberman 1982). Among schizophrenia patients, social competence is associated with community functioning (Bellack, Morrison, Mueser, Wade, and Sayers 1990) and relapse rate (Sullivan, Marder, Liberman, Donahoe, and Mintz 1990). Thus, delineating how information processing relates to social competence may have important implications for prognosis. For example, schizophrenia patients with attentional deficits may lose track of the conversational topic. Such deficits can result in the introduction of inappropriate or tangential topic matter, rendering the interaction bizarre or uncomfortable for the other individual.

The subjects in Penn, Mueser, Spaulding, et al. (1995) were 38 inpatients with chronic schizophrenia. All subjects were administered COGLAB and participated in an unstructured 3-minute role-play used in previous research with patients with schizophrenia (Penn, Hope, Spaulding, and Kucera 1994). Among inpatients with schizophrenia, performance on this role-play task is related to both symptoms (Penn et al. 1994) and ward behavior (Penn, Mueser, Doonan, and Nishith 1995b). Furthermore, social skill during unstructured role-plays is associated with emotion perception among outpatients with schizophrenia (Ihnen, Penn, Corrigan, Nelson, and Martin 1996). Therefore, the unstructured role-play used in Penn, Mueser, Spaulding, et al. (1995) appears to be tapping into important aspects of functioning among individuals with schizophrenia.

Role-play performance was coded for global (i.e., "overall") social skill ("global"), paralinguistic skills ("Paralinguistic") and nonverbal skills ("Nonverbal") by a pair of independent raters who demonstrated good interrater reliability (r = .72–.95). Table 1 summarizes the pattern of correlations between COGLAB and social skill. Higher global social skill was associated with better performance on the continuous performance/span of apprehension (more hits, less false alarms) and reaction time tasks. The relationship between number of false alarms and global social skill remained significant even after controlling for Type I error (i.e., by applying Bonferroni correction to the alpha level). Better nonverbal skills were associated with fewer random errors (i.e., nonperseverative) on the card sorting task. Greater paralinguistic skills were associated with

Table 1

INTERCORRELATIONS BETWEEN COGLAB SUMMARY SCORES WITH SKILL MEASURES

		Social Skill	
COGLAB	*Global*	*Nonverbal*	*Paralinguistic*
1. RT	−.32**	−.25	−.36**
2. CP/SPAN	.28**	.12	.18
3. FALRM	−.51***	.11	−.15
4. MASK	.21	.09	.08
5. CARDS-P	−.14	−.13	−.19
6. CARDS-R	−.22	−.32**	−.31**

Note. RT = reaction time; CP/Span = total hits on continuous performance/span of apprehension; FALRM = total false alarms on CP/SPAN; MASK = total hits on backward masking; CARDS-P = perserverative errors on the card sporting task; CARDS-R = random errors on the card sorting task. Adapted from Penn et al. 1995a.

**$p < .05$.

***$p < .01$ (Bonferroni corrected).

both faster reaction time and fewer random errors on the card sorting task.

Backward multiple regression analyses were then conducted to determine the most parsimonious set of COGLAB variables which predict (in the statistical sense) social skill. Table 2 summarizes the final model for each criterion variable. Global social skill was significantly predicted by *fewer* false alarms on the CP/Span task. Paralinguistic skill was significantly predicted by faster reaction time. The association between Nonverbal skills and random errors approached significance. These models held after controlling for the possible mediating role of third variables (e.g., symptomatology). In other words, the associations between information processing and social competence could not be explained by demographic or symptom variables. Furthermore, the robustness of the findings were confirmed through cross-validation by splitting the sample in half; the predictor variables that constituted the final regression models for each half of the sample paralleled the regression models summarized in Table 2.

These findings suggest that better performance on the vigilance task is associated with greater social competence during a role-play. The findings appear at odds with those reported earlier by Penn et al. (1993) regarding the vigilance response bias. A number of differences between these two studies may account for

Table 2

FINAL MULTIPLE REGRESSION MODELS PREDICTING SOCIAL SKILL FROM COGLAB SUMMARY SCORES

CV	*PV*	*Beta*	R^2	*F*
Global	FALRM	−.52	.27	12.5***
Nonverbal	CARDS-R	−.32	.11	3.9*
Paralinguistic	RT	−.36	.13	5.1**

Note. CV = criterion variable; PV = predictor variables; FALRM = total false alarms; CARDS-R = random errors on the card sorting task; RT = average reaction time. Adapted from Penn et al. 1995a.

*$p < .06$.

**$p < .05$.

***$p < .01$.

the discrepant findings regarding false alarms. First, the subjects in Penn, Mueser, Spaulding, et al. (1995) were a chronic sample, whereas those in Penn et al. (1993) were acutely ill adolescents. Thus, the stage of illness in schizophrenia, as well as chronicity and age of subjects, may mediate the relationship between information processing and social functioning. Second, the dependent measures differed across the two studies (i.e., SCPS and social competence). Specifically, the indices of SCPS (i.e., the MEPS and ALT tasks) were coded in quantitative rather than qualitative terms, whereas social skill during the unstructured role-play was evaluated qualitatively. In this sense, the SCPS tasks may be indicative of strategies to respond liberally, irrespective of the quality of responses. Therefore, generative capacity may be an important factor in SCPS. For social interactions, however, such a cognitive strategy may not be effective. Rather, one needs to be vigilant when responding to cues in the environment so that the response matches the social cue (e.g., someone who is crying should be consoled rather than ignored or laughed at). Thus, discriminative processing on vigilance tasks (i.e., more hits, fewer false alarms) may underlie appropriate social performance.

The relationship between vigilance and social skill may be mediated by the ability to internally represent stimuli for current and future utilization (Cohen and Servan-Schreiber 1993). Specifically, in the CP/Span task, the subject is required to remember a target digit and respond when that digit appears. An important component of social competence during the role-play is to keep track of the conversational topic. Schizophrenia subjects who are unable to represent social information in working memory will poorly track the topic of conversation and receive lower ratings on social competence.

The other significant finding involves the relationship between poorer paralinguistic skills and slower reaction time. It appears that paralinguistic skills, such as frequent pauses, speech dysfluencies, and slow speech rate, are direct reflections of a longer latency to respond during a social encounter. Therefore, this relationship appears to be mediated by the ability to rapidly respond to stimuli in the environment.

As discussed above, the regression model predicting nonverbal skills from nonperseverative errors on the card sorting task approached statistical significance. This finding is noteworthy in that much of the focus in schizophrenia research has been on perseverative rather than nonperseverative errors (reviewed by van der Does and van den Bosch 1992). Interestingly, based on their review of the literature, van der Does and van den Bosch (1992) concluded that perhaps too much emphasis has been placed on perseverative errors as the critical index of performance among individuals with schizophrenia. Our findings suggest that nonperseverative errors may also have clinical relevance in this population.

The results of Penn, Mueser, Spaulding, et al. (1995) can be summarized as follows: (a) Higher global social competence during an unstructured role-play was associated with better vigilance (i.e., more hits, fewer false alarms); (b) poorer paralinguistic skills were associated with slower reaction time; and (c) the overall pattern of correlations between information processing and the three indices of social competence suggest a differentiated rather than a single global relationship. In other words the association between the cognitive and social variables cannot be explained by a general impairment in both domains. Rather, specific deficits in cognitive functioning were related to specific social variables.

Information Processing and Ward Behavior

Thus far, social functioning was based on performance during laboratory-based tasks (e.g., role-play). These role-play assessments are very useful for assessing social skills in which the patient is di-

rectly interacting with another individual, such as conversation skills, conflict resolution, and being appropriately assertive. However, these role-play assessments may not adequately evaluate patients' more "milieu-based behaviors." These behaviors would include following rules, presenting with good hygiene, arguing with staff and/or other patients, and so on (Spaulding 1986). Therefore, an evaluation of the ecological validity of information-processing variables would be incomplete unless their association with naturally occurring behavior on the ward is assessed. With this issue in mind, Spaulding, Penn, and Garbin (in press) investigated the cross-sectional and longitudinal relationships between information-processing and ward behavior.

The subjects in Spaulding et al. (in press) were 112 chronic psychiatric inpatients. Once again, cognitive functioning was assessed with COGLAB. Ward behavior was measured by the Nurse's Observational Scale for Inpatient Evaluation, 30-item version (NOSIE-30) (Honigfeld, Gillis, and Klett 1966). The NOSIE-30 is a behavioral checklist completed by one or more psychiatric technicians, based on direct observation of patients' behavior over a period of the previous 72 hours. The NOSIE-30 has six empirically derived subscales and a composite Total Assets Scale. Periodic interrater reliability analyses revealed Pearson correlations between .68 and .72 for all scales. For purposes of parsimony, only data regarding the Total Assets Scale will be reported. Information processing and ward behavior were assessed on two occasions: during initial entry into psychiatric rehabilitation and approximately 6 months later.

Two sets of stepwise multiple regression analyses are summarized in Table 3: (a) cross-sectional prediction of total assets from COGLAB at Time 1 and Time 2 and (b) change in cognitive functioning predicting change in total assets. The cross-sectional regression models are remarkably similar. At Time 1, more total assets are predicted by faster reaction time. At Time 2, fewer reaction time trials exceeding 1 second and less reaction time crossover[2] constitute the predictor set. The results suggest that attentional processes operating within the first second of information intake are associated with ward functioning. The presence of the crossover effect indicates that subjects who are better able to utilize redundant stimulus information (i.e., a constant preparatory interval) function more effectively in the rehabilitation milieu. Therefore, attentional processes likely interact with maintaining a response *set* to relate to social behavior.

As illustrated in Table 3, an increase in total assets over six months is associated with a decrease in false alarms on the CP/Span task. It should also be noted that number of hits on the CP/Span task was a member of the full-model predictor set but did not enter into the stepwise solution. This finding is consistent with the cross-sectional results, regarding false alarm rate, reported by Penn, Mueser, Spaulding, et al. (1995). Therefore, improvement in vigilance performance is associated with improvement in overall ward functioning.

The results of Spaulding et al. (in press) can be summarized as follows: (a) Cross-sectionally, early attentional processes (i.e., operating within the first second of stimulus presentation) and maintenance of a response set are associated with ward behavior; and (b) longitudinal improvement in ward behavior is associated with improvement in vigilance performance.

Treatment Implications

The results of three studies converge on the finding that performance on vigilance and reaction time tasks are associated

[2]Reaction time crossover refers to a paradigm based on the length of time (i.e., preparatory interval [PI]) between a warning stimulus (e.g., "Get ready") and an imperative stimulus (e.g., "Let go"). Individuals with schizophrenia tend to have a *slower* reaction time with regular PIs (e.g., 7 seconds) than irregular PIs (e.g., 5 seconds, 7 seconds, and so on). This is the opposite of what occurs in control subjects (Bellissimo and Steffy 1972).

Table 3

FINAL STEPWISE REGRESSION MODELS PREDICTING NOSIE TOTAL ASSETS FROM COGLAB CROSS-SECTIONALLY AND LONGITUDINALLY

CV	*PV*	*Beta*	R^2	*F*
		Time 1		
Total assets	RT	−.41	.16	19.8**
		Time 2		
Total assets	RT > 1	−.43		
	RT cross	−.22	.21	10.8**
		Residualized Change Scores		
Total assets	FALRM	−.32	.09	7.3**

Note. Total assets = NOSIE-30 total assets; RT = average reaction time; RT > 1 = number of reaction time for which latency was greater than 1 second; RT cross = reaction time crossover; FALRM = total false alarms on the CP/SPAN task. Adapted from Spaulding et al. in press).

**$p < .01$.

with social functioning. This suggests that cognitive remediation should focus on skills such as discriminative processing (i.e., reacting only to some stimuli but not to others) and ability to rapidly respond to stimulus presentation. Normalization of these cognitive skills may impact various aspects of social performance, including overall social skill, paralinguistic skills, and ambient ward behavior.

Ability to maintain set may also have a relationship with social functioning (Liberman et al. 1986). Both the vigilance and reaction time tasks require an individual to maintain a *readiness* to respond. If the individual is unable to anticipate the onset of a stimulus (e.g., the appearance of a target digit on a vigilance task), then what appears to be a deficit in early information processing may be loss of set (Shakow 1963), more of a molar cognitive process. Impairment in the maintenance of cognitive set is consistent with various findings in schizophrenia, such as inability to utilize context (Cohen and Servan-Schreiber 1993; Silverstein et al. 1996) and deficits in both personal constructs (reviewed by Space and Cromwell 1978) and social schemata (Corrigan, Wallace, and Green 1992).

There is as of yet no systematic method for developing cognitive/social-cognitive sets in schizophrenia patients. However, techniques designed to improve performance on the Wisconsin Card Sort (e.g., telling the subject the rules ahead of time) (Stratta, Mancini, Mattei, Casacchia, and Rossi 1994) and on social cue perception tasks (e.g., instructing subjects to be prepared to describe social vignettes in their own words) (cf. Corrigan, Nugent-Hirschbeck, and Wolfe 1995) overlap in their attempt to help schizophrenia patients anticipate and organize novel stimuli. In essence, these techniques may be contributing to the utilization of cognitive templates to interpret cognitive and social information. As noted by Stratta et al. (1994), their processing strategy allows "the interpretation of the incoming stimulus on the basis of expectations determined by context and past experience, rather than specific instruction regarding the task, which is likely to result in an ephemeral response of poor heuristic value" (p. 915).

Schemata may be mediating factors in the role of memory in social functioning (Corrigan, Wallace, Schade, and Green 1994; Mueser et al. 1991). Research from the social cognition literature indicates that memory is enhanced for schema-consistent information (reviewed by Fiske and Taylor 1991). Thus, deficits in the formation or maintenance of social schemata will likely compromise memory. Indirect support for this hypothesis was reported

by Penn, Storzbach, and Spaulding (1992), who found that performance on the Tactual Performance Test-Incidental Memory Task had the strongest relationship with social functioning among all memory variables (e.g., Denman Memory Scale). This task requires blindfolded subjects to place a series of geometric objects into their correct places on a board. Following trials with both hands separately and together (i.e., three trials), subjects are given a surprise memory task requiring them to reproduce the board and the exact location of the geometric objects. Subjects with higher performance may be spontaneously forming a mental map of the board while engaging in the placement of the objects. Thus, performance on this task may be as much a function of inability to recruit schemata, as the result of deficits in nonverbal memory skills.

Future Directions

The studies reviewed in this paper have implications for future research. First, a broader range of cognitive skills need to be evaluated in relationship to social functioning (e.g., memory). This will allow evaluation of the relative contribution of more micro vis-à-vis molar cognitive processes to social functioning. Second, the range of social functioning assessments, especially in the role-play domain, need to be extended. For example, it should not be a surprise that perseverative errors do not have a strong relationship with social competence during an unstructured role-play (i.e., Penn, Mueser, Spaulding, et al. 1995); a brief interaction in which a range of superficial topics are discussed (e.g., the weather) is not likely to elicit perseverative behavior. Role-plays that require more complex cognitive skills (e.g., conflict resolution) and/or those in which the topics are systematically changed (e.g., to see if verbal behavior during one topic persists to a novel topic) may be more conducive for demonstrating a relationship with cognitive perseveration measures.

A final area to pursue is that of social cognition (Penn 1991; Penn, Corrigan, Bentall, Racenstein, and Newman 1997). Recent findings suggest that cognition and social cognition make independent contributions to both interpersonal problem-solving skills and social competence (Corrigan and Toomey 1995; Penn, Spaulding, Reed, and Sullivan 1996). Thus, the processing of social information may be especially important in understanding social functioning among individuals with schizophrenia. The research reviewed in this article represents an attempt to understand the cognitive factors underlying social functioning in schizophrenia. The ultimate goal is to move these results from the laboratory into the clinical setting, where interventions can be developed which remediate social impairment and reduce the likelihood of relapse. Our program of studies are a critical first step in achieving this goal.

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