

NEUROCOGNITION, SOCIAL COGNITION, AND FUNCTIONAL OUTCOME IN
SCHIZOPHRENIA AND HIGH-FUNCTIONING AUTISM

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ABSTRACT

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(Under the direction of David L. Penn)

The purpose of this dissertation was to compare two models of the relationships among neurocognition, social cognition, and functional outcome in schizophrenia and high-functioning autism (HFA). Forty-five participants with schizophrenia and thirty-four participants with HFA completed a battery of neurocognitive and social cognitive tasks, and the Social Functioning Scale as a measure of functional outcome. Composite variables were created for all three constructs. Within the schizophrenia sample, path analyses revealed a significant and negative relationship between neurocognition and functional outcome, a nonsignificant, positive relationship between social cognition and functional outcome, and modest support for social cognition serving as a mediator between neurocognition and functional outcome. Within the HFA sample, neither neurocognition nor social cognition significantly predicted functional outcome. Consistent with previous research, a strong, positive relationship between neurocognition and social cognition emerged in both samples, although this appears to be more robust for individuals with schizophrenia. In contrast, only a small proportion of the variance in functional outcome was accounted for by the models. It is suggested that use of the Social Functioning Scale may have contributed to these findings.

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CHAPTER I

THESIS OVERVIEW

The primary aim of this dissertation is to examine two different models that describe the relationships among neurocognition, social cognition, and functional outcome in schizophrenia. Numerous studies have demonstrated that individuals with schizophrenia exhibit deficits in neurocognition (Heinrichs & Zakzanis, 1998) and social cognition (Brune, 2005b; Edwards, Jackson, & Pattison, 2002), and that these deficits are related to functional outcome (i.e., social functioning, work functioning, etc.; Brune, 2005b; Edwards et al., 2002; Green, Kern, Braff, & Mintz, 2000). However, research has not elucidated *how* neurocognitive and social cognitive abilities are related to one another, nor has the exact nature of their relationship with functional outcome been clarified (Vauth, Rusch, Wirtz, & Corrigan, 2004).

The following literature review first highlights the importance of functional deficits in schizophrenia. Then, I review what is known about deficits in neurocognition, and its association with functional outcome. It is pointed out that due to the modest amount of variance that neurocognition accounts for in functional outcome, that other domains, more proximal to actual social behavior, have been explored; social cognition is one such domain. Therefore, I provide an overview of social cognition in schizophrenia, focusing specifically on two primary areas: emotion perception and Theory of Mind (ToM). This discussion is followed by an examination of the literature on whether neurocognition and social cognition

represent independent constructs. From this section, it is concluded that two different models may account for how neurocognition and social cognition relate to functional outcome: 1) a significant association between the independent domains of neurocognition and social cognition, with each domain having a unique relationship with functional outcome (i.e., the “direct effects model,” which will be identified as Model A); 2) social cognition serving as a mediator between neurocognition and functional outcome (i.e., the “mediational model,” which will be identified as Model B). This dissertation aimed to extend previous research by employing Structural Equation Modeling (SEM) to investigate the plausibility of these models. As cognitive skills appear to be deficient in early childhood prior to the onset of schizophrenia (e.g., Cornblatt, Obuchowski, Roberts, Pollack, & Erlenmeyer, 1999), while social cognitive abilities appear to be relatively intact before illness onset (e.g., Pinkham, Penn, Perkins, Graham, & Siegel, 2006), it seems likely that impaired neurocognition may affect the acquisition of normal social cognitive abilities (Green & Nuechterlein, 1999; Green et al., 2000). Thus, it is hypothesized that there will be a significant indirect effect of neurocognition on functional outcome via social cognition, which would provide support for the existence of a mediational relationship among these constructs.

A second aim of the proposed dissertation was to investigate whether the direct and mediational models evaluated in schizophrenia are unique to this clinical group or merely reflective of having significant impairments in social cognition and/or problems functioning socially/in the community. To address this issue, I will compare the structural relationships between these constructs in the schizophrenia sample to a comparison group of individuals with High-Functioning Autism (HFA). In contrast to schizophrenia, findings in the autism literature indicate the presence of early impairments in cognition and social cognition

(Charman, Swettenham, Baron-Cohen, Cox, Baird, & Drew, 1998), which suggests that the mediational model may not be a good approximation of the data in the HFA sample.

However, few studies have examined the nature of the relationships among neurocognition, social cognition, and functional outcome in autism; thus, this part of the dissertation is exploratory.

CHAPTER II

BACKGROUND AND SIGNIFICANCE

Deficits in social functioning (e.g., communicating with others, maintaining employment, and functioning in the community) are observed in many disorders, but are a defining feature of schizophrenia (Bellack, Morrison, Wixted, & Mueser, 1990). Moreover, social dysfunction is evident early in those who later develop schizophrenia (Davidson, Reichenbert, Rabinowitz, Weiser, & Kaplan, 1999; Dworkin et al., 1993; Walker, 1994), and is often present in first degree relatives (Hans, Auerbach, Asarnow, Styr, & Marcus, 2000). Thus, social functioning deficits occur before illness onset and may be a vulnerability factor for schizophrenia (reviewed in Pinkham, Penn, Perkins, & Lieberman, 2003). In addition, problems with social functioning greatly impact quality of life, as difficulties in communicating and maintaining employment are ubiquitous and have a negative impact on the lives of individuals with schizophrenia (Penn, Corrigan, Bentall, Racenstein, & Newman, 1997). Finally, social dysfunction predicts outcome for those with schizophrenia, such as relapse, poor illness course, and unemployment (Perlick, Stastney, Mattis, & Teresi, 1992; Sullivan, Marder, Liberman, Donahoe, & Mintz, 1990; Tien & Eaton, 1992). Thus, social impairment is a hallmark characteristic of schizophrenia and has important implications for the development, course, and outcome of the disorder.

The advent of successful neuroleptic treatment in psychosis and the subsequent transfer of individuals with schizophrenia from inpatient to outpatient community settings have likely contributed to the growing awareness of marked social dysfunction in

schizophrenia. Given this trend, and the aforementioned deleterious effects of poor social functioning, there has been growing interest in factors that underlie social dysfunction. These findings are complicated by the variability of definitions of social functioning used in the literature. This term has been used to apply to self- or other-report of interpersonal behaviors, behavior in community settings (e.g., skill ratings while shopping, self- or other-report of engaging in inappropriate behaviors such as yelling, or appropriate behaviors, such as going to the movies), skills of independent living (e.g., self-care skills, grooming, financial skills, etc.), ratings of social skill in laboratory settings, ratings of producing and enacting social problem solving, etc. Accordingly, some researchers have taken to describing this conglomeration of skills as “functional outcome,” a broader term which can be applied to all of these diverse areas. This dissertation also uses this terminology; although many of the behaviors described in the ensuing review and project are very social in nature, this broader term also allows inclusion of other less directly social behaviors, like engaging in activities in the community and caring for oneself.

Thus, given the interest in furthering understanding of the diverse array of skills encompassed in functional outcome, much attention has been turned toward factors which may contribute to poor functional outcome. If the nature of the factors that contribute to poor functional outcome can be delineated, interventions may be devised to ameliorate these underlying factors, which in turn, may have a concomitant impact on functional outcome. This is not trivial, as interventions focused on alleviating symptoms alone are not likely to markedly improve functional outcome, as several studies have shown little to no relationship between symptoms (particularly positive symptoms) and various areas of functional outcome (Appelo et al., 1992; Bellack et al., 1990; Lenzenweger & Dworkin, 1996; Lenzenweger,

Dworkin, & Wethington, 1991; Penn et al., 1997). Studies of treatment programs directly aimed at improving functional outcomes, such as increasing work functioning or social skills, typically find that improvements in these functioning domains are unrelated to symptoms (Bell & Bryson, 2001; Lysaker, Bell, Zito, & Bioty, 1995; Lysaker, Bryson, Davis, & Bell, 2005; Smith, Hull, Romanelli, Fertuck, & Weiss, 1999). Moreover, in a community-based psychosocial rehabilitation program, symptom and functional outcome change appeared to be distinct, with unassociated change trajectories (Brekke & Long, 2000). Finally, although CBT-based interventions have been successful in reducing symptoms, there is little evidence to suggest these improvements generalize to functional outcome (Cather, Penn, Otto, Yovel, Mueser, & Goff, 2005; Garety, Fowler, & Kuipers, 1997; Gumley, O'Grady, & McNay, 2003). Thus, attention has been turned to other factors that should theoretically relate to problems with social functioning. In the next sections, I will review the literature concerning two such factors, neurocognition and social cognition, followed by a discussion of the relationship between these constructs in schizophrenia.

Neurocognition and Schizophrenia

Neurocognition (also referred to in the literature as **cognition** or **non-social cognition**) was originally conceptualized as having a role in social impairments because basic cognitive skills were considered to be requisite for the acquisition of social knowledge and social skills, or for helping the individual use these skills flexibly in social situations (reviewed in Pinkham et al., 2003). Neurocognition is comprised of a wide variety of areas such as verbal and nonverbal memory, verbal fluency, visuoperceptual abilities, attention, executive functioning and cognitive flexibility, motor speed, and general cognitive ability such as IQ.

Heinrichs and Zakzanis (1998) conducted a thorough review of the literature, encompassing 204 studies. They found evidence for moderately large and reliable impairments in performance on the Wisconsin Card Sort Test, a measure frequently used to assess executive function or cognitive flexibility. A similar deficit was found in general intellectual ability, and IQ and executive processing were significantly correlated with one another. Across studies, reliable deficits in motor functioning, attention, spatial ability, and verbal fluency were also found. Heinrichs and Zakzanis concluded that significant cognitive impairments are present in schizophrenia, which is consistent with other comprehensive reviews of the field (Blanchard & Neale, 1994; Hoff & Kremen, 2002).

Although a generalized neurocognitive deficit has been supported in the majority of studies, there is variability in the magnitude of deficits across domains and across investigations. Furthermore, there is evidence of considerable within group differences, as some individuals are less impaired on neurocognitive tasks. In general, memory, executive functioning, and attention demonstrate the most consistent impairments in the preponderance of studies (Heinrichs & Zakzanis, 1998; Hoff & Kremen, 2002).

Neurocognition and Functional Outcome

Much of the recent enthusiasm for studying neurocognition in schizophrenia is based on its association with functional outcome (Green, 1996). Among the various neurocognitive variables, executive functioning, which typically includes such abilities as planning and cognitive flexibility, appears to have one of the most reliable relationships with functional outcome. It is thought that executive functioning can be helpful in planning courses of action, attempting to solve social problems, remaining flexible, and being able to change one's behavior in a social situation. Meltzer and McGurk (1999) found evidence for a

relationship between work functioning and executive functioning, as regression analyses revealed that executive functioning was able to differentiate between three levels of work groups. This finding is supported by other studies which have found evidence for the role of executive functioning abilities in work performance (McGurk & Mueser, 2003; McGurk, Mueser, Harvey, LaPuglia, & Marder, 2003). Executive functioning has also shown a relationship with community functioning (Green & Nuechterlein, 1999; Rempfer, Hamera, Brown, & Cromwell, 2003), and accounted for 6% of the variance in successful completion of activities of daily living in another study (self-care skills; Velligan, Bow-Thomas, Mahurin, Miller, & Halgunseth, 2000). Addington and Addington (1999; 2000) found cognitive flexibility was associated with being able to define or identify the nature of social problems. However, in contrast to Green and Nuechterlein (1999), they found no relationship between executive functioning and general social and community functioning as assessed by the Social Functioning Scale (which assesses a variety of behaviors in functional outcome). Another negative finding is Brune (2005a), who found that severe social and behavior problems as measured on the Social Behavior Scale were not related to executive functioning. However, in two reviews of the literature, it was concluded that executive functioning was dependably related to community functioning, inconsistently related to social skills, and not associated with social problem solving (Green, 1996; Green et al., 2000).

Memory abilities have also been investigated in relation to functional outcome in schizophrenia. Remembering who people are, their history, social scripts, and social knowledge are all necessary social processes, and these abilities can be conceptualized as requiring intact memory for adequate performance. Research generally supports a

correlational association between memory and functional outcome in schizophrenia. For example, individuals with schizophrenia who were employed full-time performed significantly better on working memory tasks than those who were unemployed (Meltzer & McGurk, 1999), and working memory has been associated with independent living skills (Rempfer, Hamera, Brown, & Cromwell, 2003; Revheim, Schechter, Kim, Silipo, Allingham, Butler, & Javitt, in press). Likewise, recognition and recall memory was significantly associated with interpersonal problem solving (Corrigan & Toomey, 1995). Verbal memory has shown significant associations with community functioning (Green, 1996; Green & Nuechterlein, 1999; Reeder, Newton, Frangou, & Wykes, 2004; Smith, Hull, Goodman, Hedayat-Harris, Willson, Israel, & Munich, 1999; Velligan et al., 2000), social problem solving (Addington & Addington, 1999; 2000), and accounted for 20% of the variance in work functioning (Bryson, Bell, Kaplan, Greig, & Lysaker, 1998; Velligan et al., 2000), 13% of the variance in social competence, and 15% in activities of daily living (Velligan et al., 2000). Although one study found no evidence to support a relationship between verbal memory and social skills at work (Bryson et al., 1998), in general, reviews of the literature support the role of memory in functional outcomes (Green, 1996; Green et al., 2000; Reeder et al., 2004).

Verbal abilities, as measured by verbal IQ, vocabulary proficiency, and verbal fluency, have also been implicated in normal social interactions. Verbal ability is related to social problem solving and severe social problems in schizophrenia (Addington & Addington, 1999; 2000; Brekke et al., 1997; Brune, 2005a), as well as independent living skills (Rempfer et al., 2003). However, other studies have not found support for a relationship between verbal ability and functional outcome (Addington, McCleary, & Munroe-Blum, 1998; Green,

1996). Nevertheless, reviews of the literature indicate that verbal fluency is related to general community outcome (Green et al., 2000), and that verbal IQ is inconsistently related to social problem solving (Green, 1996).

Attention (or vigilance) has also received some interest in the literature given the necessity of sustained attention in order to have successful conversations and attend appropriately to social cues, which are typically presented for only brief periods of time. Indeed, vigilance is related to employment status and work functioning (Meltzer & McGurk, 1999; Velligan et al., 2000), higher global social competence (Penn, Mueser, Spaulding, Hope, & Reed, 1995; Velligan et al., 2000), social problem solving (Bowen, Wallace, Glynn, Nuechterlein, Lutzker, & Kuehnel, 1994), and general community functioning (Green, 1996; Green & Nuechterlein, 1999; Prouteau, Verdoux, Briand, Lesage, Lalonde, Nicole, Reinharz, & Stip, 2004). Another study found vigilance to be significantly associated with providing a solution and enacting the solution to social problems, but not with general social and community functioning (Addington & Addington, 2000; Addington et al., 1998). In general, among various indices of functional outcome, attention tends to show the most consistent relationships with social problem solving and social skills (Green, 1996).

Visuospatial abilities may impact the way people inspect social cues and information for the purpose of gleaning insight into proper behavioral responses to social situations. For example, scanning the face for cues indicating emotional expressions is a complex process that requires intact visual processing strategies. Although two studies found evidence for a relationship between visuospatial skills and functional outcome (Brekke et al., 1997; Dickerson, Boronow, Ringel, & Parente, 1996), two did not (Addington & Addington, 2000; Addington et al., 1998). Finally, psychomotor speed has been examined in a few studies, and

was related to general community functioning, social problem solving, social skills (Green et al., 2000), daily problem-solving/independent living skills (Revheim et al., in press), and work functioning (Evans, Bond, Meyer, Won Kim, Lysaker, Gibson, & Tunis, 2004). It should be noted that relatively few studies have examined the association between visuoperceptual processes or psychomotor ability and functional outcome in comparison to other neurocognitive abilities; thus, confident conclusions cannot be drawn at this time.

In addition to findings on specific neurocognitive abilities, studies have also combined measures of neurocognitive functioning to ascertain their collective association with functional outcome. For example, a neurocognitive composite index explained 16 to 30% of the variance in various functional outcomes in one study (Velligan et al., 2000), and approximately 45% of the variance in social functioning in a second study (Velligan et al., 1997). In contrast, only 7% of the variance in vocational functioning was accounted for in a third study (Vauth et al., 2004), and did not enter a stepwise regression model predicting general social functioning in a fourth (Sponheim, Surerus-Johnson, Spont, & Dieperink, 2003). McGurk and colleagues (2000) conducted a longitudinal study with 168 geriatric patients with chronic schizophrenia, and found evidence for a link between their neurocognition composite and social functioning beyond the influence of baseline social functioning. Specifically, the neurocognitive composite accounted for 3.6% of the variance in social functioning one year later, after the effect of baseline functioning had been statistically removed. Thus, even in a sample with poor social functioning and a chronic course of schizophrenia, cognitive functioning was still predictive of a small proportion of variance in current social functioning (McGurk et al., 2000). These findings are similar to those found in a first-episode sample, as neurocognitive impairment accounted for 4-6% of

the variance in social functioning at 1 and 2 years (Addington, Saeedi, & Addington, 2005). Overall, it appears that composite measures of neurocognitive functioning account for 20 to 60% of the variance in various functional outcomes (Bell & Bryson, 2001; reviewed in Green et al., 2000).

Thus, individuals with schizophrenia clearly demonstrate deficits in most areas of neurocognitive functioning. Reviews of the literature generally conclude that there are significant associations between memory processes and executive processing with poor functional outcome, with a recent review also supporting a link between baseline neurocognitive functioning and functional outcome at some later time point (Green, Kern, & Heaton, 2004). Other aspects of neurocognition, such as verbal fluency, motor speed, vigilance, and visuo-perceptual abilities have not (yet) demonstrated a consistent relationship with functional outcome. Finally, composite measures of neurocognition account for approximately 20-60% of the variance in functional outcome in schizophrenia.

Limitations of the Neurocognitive Approach to Understanding Functional Outcome

While most of the aforementioned studies found evidence for a significant relationship between at least one aspect of neurocognition and functional outcome, the amount of variance accounted for is typically rather modest (Green, 1996; Green et al., 2000; Penn et al., 1997). In fact, although Green et al. (2000) reported that 20-60% of the variance in functional outcome could be explained by composite measures of neurocognition, closer inspection of that review reveals that the variance accounted for by most of the studies was in the 20-40% range; studies reporting variance estimates of greater than 40% were the exception, rather than the rule. Thus, anywhere from 60-80% of the variance in functional outcome is unaccounted for by traditional neurocognitive measures.

Recall that one rationale for identifying factors that relate to functional outcome is that they may prove to be sound targets for interventions (both pharmacological and psychosocial). Thus, remediation of neurocognitive deficits should result in improvements in various indices of functional outcome. Unfortunately, this has not been the case. Although research has shown that deficits on particular neurocognitive tasks can indeed be significantly improved after neurocognitive training, generalization of improvements to similar neurocognitive tasks has not been consistently demonstrated (Kurtz, Moberg, Gur, & Gur, 2001). Furthermore, recent reviews of the neurocognitive remediation literature have concluded that, in general, there is scarce evidence for a significant impact on functional outcome (Kurtz et al., 2001; Pilling et al., 2002). This suggests that other factors may underlie social impairments in schizophrenia and may be appropriate targets of psychosocial interventions.

Independent research groups have suggested that the field of neurocognition in schizophrenia has been largely atheoretical, and that attention must focus on identifying mediators and other factors involved in functional outcome in order to form a more theoretically-based approach to the study of neurocognition in schizophrenia (Green et al., 2000; Penn et al., 1997). In addition, Green et al. concluded the mediators themselves might be identified as intervention targets, which would likely improve the effectiveness of treatments aimed at ameliorating social and community functioning deficits. Social cognition is a likely candidate for mediation, as it has conceptual links with both neurocognition and functional outcome. Specifically, it has elements of the basic neurocognitive abilities typically assessed (such as information processing), but it goes beyond these basic abilities to process more complex and personally relevant social

information. It also has clear links with functional outcome, as the rapid processing of a variety of social stimuli is essential for social interaction, and problems in this area can impact peer, romantic, and family relationships in addition to work/school behavior. In addition, appropriate assessment of social cues from the environment (such as if someone increases distance or makes a facial expression as a cue for body odor) as well as interacting with others to learn skills such as home and financial care, can have important implications for skills of daily living. Thus, social cognition is thought to be an important contributing factor to functional outcome, and has a theoretical basis as a potential mediator for the relationship between neurocognition and poor functional outcome (Green et al., 2000; Kee, Kern, & Green, 1998; Penn et al., 1997).

Social Cognition and Schizophrenia

There are several definitions of social cognition that have been proposed in the diverse literatures of social psychology, evolutionary psychology, biological psychiatry, and clinical psychology. Fiske and Taylor (1991) defined social cognition as the “way in which people make sense of other people” (p.1), which is similar to Roloff and Berger’s (1982) definition that “social cognition represents the organized thoughts people have about human interaction” (p.21), and Ostrom’s (1984) definition stating that social cognition is “a domain of cognition that involves the perception, interpretation, and processing of social information” (p.176). Social cognition has been viewed by some researchers as a set of abilities that developed because it became beneficial from an evolutionary standpoint to be able to make sense of a complex social environment (Brune, 2005b). However, the most comprehensive definitions are those that link social cognitive abilities to real-world functioning. Brothers’ (1990) definition described social cognition as the “mental operations

underlying social interactions, which include the human ability and capacity to perceive the intentions and dispositions of others” (p.28). Similarly, Adolphs (2001) identified social cognition as “the ability to construct representations of the relation between oneself and others and to use those representations flexibly to guide social behavior” (p.231).

Thus, most definitions of social cognition share the idea that social cognition is a set of related neurocognitive processes applied to the recognition, understanding, accurate processing, and effective use of social cues and information in real-world situations (Penn et al., 1997). In schizophrenia, the most commonly studied domains of social cognition include emotion perception and Theory of Mind (ToM; Green, Olivier, Crawley, Penn, & Silverstein, 2005; Pinkham et al., 2003). The general research findings on these domains (in schizophrenia) are reviewed next.

Emotion Perception

Emotion perception (also called emotion recognition, affect recognition, or affect perception) is the ability to ascertain emotional information (i.e., what the other person is feeling) from facial expressions, vocal inflections (i.e., prosody), body movement, or some combination of these. Stimuli in facial emotion recognition studies typically include static facial expressions to which the person identifies an emotion label or designates whether pairs of faces are depicting similar or different emotions. Emotional prosody stimuli require participants to match an emotion label to a content-neutral sentence presented verbally with vocal inflection and intonation used to express emotions. Finally, some studies have used video stimuli (with actors depicting emotions and/or participating in emotional social interactions) including a combination of these features to assess accurate emotion

recognition. Thus, stimuli used to assess emotion perception vary in visual complexity and in the number of cues available to the respondent.

The majority of studies examining emotion perception abilities have concluded that individuals with schizophrenia tend to perform worse than non-clinical controls on tasks of facial and vocal emotion recognition. In general, deficits in emotion perception have been observed in both chronically ill outpatient (Hellewell, Connell, & Deakin, 1994; Hooker & Park, 2002; Kohler, Bilker, Hagoort, Gur, & Gur, 2000; Kohler et al., 2003; Sachs, Steger-Wuchse, Krypsin-Exner, Gur, & Katschnig, 2004; although see Joseph, Sturgeon, & Leff, 1992 for an exception) and inpatient samples (Archer, Hay, & Young, 1992; Brune, 2005a; Feinberg, Rifkin, Schaffer, & Walker, 1986; Heimberg, Gur, Erwin, Shtasel, & Gur, 1992; Kerr & Neale, 1993; Mueser et al., 1996; Novic, Luchins, & Perline, 1984; Penn et al., 2000; Salem, Kring, & Kerr, 1996; Walker, Marwit, & Emory, 1980; Walker, McGuire, & Bettes, 1984). Of note, some studies have also found evidence for a deficit in face recognition (i.e., being able to identify the *identity* of faces rather than emotion) of similar magnitude to deficits in emotion recognition, or have concluded there is no longer evidence for a deficit in emotion recognition after the effect of face recognition has been statistically removed (e.g., Kerr & Neale, 1993; Salem et al., 1996; see Penn et al. 2000, for an exception). These findings suggest that impairments in emotion perception may be due, in part, to basic face processing deficits. This issue will be explored in more depth in the following section.

In addition, the valence of the emotion is related to performance on affect recognition tasks. Happiness is generally the easiest emotion to identify, which is consistent with research showing that individuals with schizophrenia are not impaired when making emotion

judgments concerning this affect (Gosselin, Kirouac, & Dore, 1995; Russell, Suzuki, & Ishida, 1993). Surprise, the only other commonly studied positively-valenced emotion, is also thought to be less difficult to identify by some researchers (Kline, Smith, & Ellis, 1992), but not others (Baron-Cohen, Spitz, & Cross, 1993). Conversely, there is consistent evidence that individuals with schizophrenia are significantly impaired in perceiving negatively-valenced emotions (Cramer, Weegman, & O'Neil, 1989; Mandal & Rai, 1987; Zuroff & Colussy, 1986), specifically fear (Archer, Hay, & Young, 1994; Gaebel & Wolwer, 1992, Mandal & Palchoudhury, 1985; Kohler et al., 2003), anger (Mandal & Palchoudhury, 1985; Morrison, Bellack, & Mueser, 1988), and sadness (Archer et al., 1994; Kohler et al., 2000; Schneider, Gur, Gur, & Shtasel, 1995). These findings make sense in light of recent evidence suggesting that neural underpinnings of emotion perception may be specific to the valence of the emotion (e.g., Davidson, 2000; Jansari, Tranel, & Adolphs, 2000).

In sum, reviews of the literature indicate that individuals with schizophrenia are impaired, relative to non-clinical controls, in emotion perception, with these impairments most consistent for negative emotions. It is important to note that the majority of the studies have not included a variety of emotion perception tasks within the same study. This may be a critical omission as there appears to be no single emotion perception task that adequately assesses this construct, and that schizophrenia-related deficits may vary as a function of task characteristics (e.g., emotion identification versus matching; identifying static faces versus complex scenes; Edwards et al., 2002; Mandal, Pandey, & Prasad, 1998; Penn et al., 1997). In addition, emotion perception ranges from simply identifying the affect expressed in a social stimulus (e.g., “angry”), to more complex judgments about what this affect means (e.g., that the angry person should be avoided or not trusted). Therefore, in order to obtain a

comprehensive understanding of emotion perception in schizophrenia, a range of emotion perception tasks that vary in how the emotional information is presented (e.g., faces versus social scenes) and/or in the types of judgments required (i.e., identifying affect versus making dispositional judgments of trustworthiness) was included in this dissertation.

ToM

ToM involves both the ability to understand that others have mental states different from one's own, and the capability to make inferences about the content of those mental states (e.g., others' intentions). Frith (1992) has argued that ToM skills might develop normally in those with schizophrenia, but deteriorate after the onset of psychosis, although there is no direct empirical support for this assertion (Brune, 2005b). ToM is typically (although not exclusively) assessed with first- and second-order false belief tasks. First-order ToM is the understanding that another person can hold a false belief about the world; whereas second-order ToM involves the understanding one can have an incorrect belief about someone else's incorrect belief. The "Sally-Anne" task is one of the most commonly used first-order tasks whereby participants are told a story about a girl, Sally, who hides an object and leaves the room. Subsequently, her friend, Anne, comes into the room and moves the hidden object to another hidden location. If one has first-order ToM abilities intact, one would recognize that Sally would look for her object in the original hidden location, because she does not know Anne has placed the object in a different location. In essence, participants would need to differentiate between their own mental state (i.e., they know the true location of the object) and Sally's mental state (i.e., she believes the object is in its original location).

In second-order tasks, like the "Ice Cream Van" story, participants are told a story in which characters learn new information at different points in time. For example, a boy and

girl are told an ice cream van will be in the park all day. The children go their separate ways. The boy talks to the ice cream van driver and finds out the van is headed to the church. The girl also finds out this piece of information, but separately from the boy. A person with intact second-order ToM would understand that the girl, who knows the boy has gone to buy ice cream, will look for the boy in the park rather than the church. Thus, one character (the girl) will falsely believe another character (the boy) maintains an incorrect view of reality because she is unaware that he has obtained additional information out of her presence. These tasks are typically accompanied by “reality” questions (e.g., “Where is the boy really going?”) to ensure participants comprehend the situation, in addition to the ToM questions (e.g., “Where does the girl think the boy went to get ice cream?”). More recently, other tasks have been developed, such as Baron-Cohen et al.’s (2001) Eyes Task, where individuals ascertain mental states from the expression in the eyes, and the Hinting task (Corcoran, 2001), which requires participants to guess a character’s intentions based on a verbal statement or hint (e.g., a child who wants some candy may say to his mother at the supermarket: “Oh, that chocolate looks good.” The participant would be asked what the child meant by that statement).

In this project, ToM was only assessed with the Eyes Task, as the social cognitive battery was set prior to this dissertation (see Methods). Of course, this represents a limitation, as it would have been optimal to sample a variety of ToM tasks (including those that address first- and second-order beliefs), so as to adequately capture the ToM construct.

In general, individuals with schizophrenia have deficits in ToM abilities, with these impairments being most consistent for second-order ToM tasks (reviewed in Brune, 2005b; Penn, Addington, & Pinkham, in press; Pickup & Frith, 2001). It has been argued that

individuals with schizophrenia perform normally on first-order ToM tasks (Doody, Gotz, Johnstone, Frith, Cunningham-Owens, 1998) because they are capable of understanding that other people have different mental states, thoughts, or intentions than they do, but have difficulty correctly interpreting cues to appropriately ascertain the mental states of others, which is necessary for second-order tasks (Brune, 2003).

These impairments in ToM are present in schizophrenia regardless of whether individuals are acutely ill (Corcoran, Mercer, & Frith, 1995; Drury, Robinson, & Birchwood, 1998; Frith & Corcoran, 1996; Pickup & Frith, 2001) or when their symptoms are remitted (Herold, Tenyi, Lenard, & Trixler, 2002; Janssen, Krabbendam, Jolles, & van Os, 2003; Sarfati, Hardy-Bayle, Besche, & Widlocher, 1997), although the deficits are not as pronounced as during acute psychosis. In addition, ToM deficits are present across both inpatient and outpatient samples (Brunet, Sarfati, & Hardy-Bayle, 2003; Langdon, Davies, & Colthart, 2002; Langdon et al., 1997; Sarfati, Hardy-Bayle, Brunet, & Widlocher, 1999), and they are not associated with any specific symptom type (e.g., paranoia; see Brune, 2005b for a review). Thus, it appears problems with ToM are trait deficits, although they may be exacerbated during an acute episode (i.e., have elements of state dependence as well).

A prominent issue is whether ToM impairments in schizophrenia are a result of lower IQ, rather than a specific deficit in social cognition. Corcoran et al. (1995) found that deficits in ToM abilities remained after controlling for IQ, a finding that has been replicated in several other studies (Brune, 2005a; Brunet et al., 2003; Janssen et al., 2003; Kington, Jones, Watt, Hopkin, & Williams, 2000; Mazza, DeRisio, Surian, Roncone, Casacchia, 2001; Mitchley, Barber, Gray, Brooks, & Livingston, 1998; however see Brune, 2003 for an exception). Doody and colleagues (1998) examined ToM in schizophrenia participants, participants with

a mild learning disability, individuals with both schizophrenia and a learning disability (“comorbid group”), and normal controls. Schizophrenia participants with normal IQs differed from normal controls on the second-order task, and performance was not related to IQ. In the comorbid group and the learning disabled alone group, IQ had an effect on task performance. When participants who did not understand the task (as evidenced by incorrect responses to reality questions) were eliminated, there was no longer an effect of IQ on the results, and the difference between schizophrenia and normal participants remained. Thus, in this study, level of IQ was associated with participants’ general ability to comprehend ToM scenarios, although having a psychotic disorder also had an impact on performance. Taking all these studies under consideration, Brune (2005b) concluded that ToM deficits are relatively independent of intellectual functioning and thus not reflective of general cognitive impairments.

Given the existence of these two cognitive domains, neurocognition and social cognition, the next question is whether they represent a single or separate constructs. Thus, in the ensuing section, I review the research that has examined the relationship between neurocognition and social cognition in schizophrenia.

Social Cognition and Neurocognition: A Differentiation that is Worth Making?

Several researchers have questioned whether there is a specific deficit in social cognition in schizophrenia, or whether a generalized performance deficit across domains can account for findings (note this debate is most frequently brought up with emotion perception studies in particular; e.g., Bryson, Bell, & Lysaker, 1997; Johnston, Katsikitis, & Carr, 2001; Penn et al., 2000). In other words, can deficits in social cognition be accounted for by neurocognitive deficits? The argument in support of a generalized deficit is based on

research showing that individuals with schizophrenia perform similarly across measures of affect perception and face recognition (Kerr & Neale, 1993; Salem et al., 1996) and that measures of social cognition and neurocognition are significantly associated with one another (Bozikas, Kosmidis, Anezoulaki, Giannokou, & Karavatos, 2004; Brune, 2005a; Kohler et al., 2000).

Although the arguments for a generalized deficit have merit, there appears to be sufficient evidence to support conceptualizing these domains as relatively separate. In the following section, I will highlight several areas of research (and conceptual arguments) supporting dissociations between neurocognition and social cognition. Specifically, I will discuss: 1) differences in how these constructs are measured and coded; 2) studies which have shown a dissociation between neurocognition and social cognition based on either differential deficit designs or neural models; 3) the typically modest relationship between neurocognition and social cognition; and, 4) preliminary support for independent relationships between neurocognition or social cognition with functional outcome.

First, when the study of social cognition in schizophrenia initially emerged, Penn and colleagues argued that a face valid, although not empirical means, of contrasting these constructs, is comparing the tasks used to assess them (Penn et al., 1997). For example, neurocognitive stimuli are often affectively neutral or nonsensical (in schizophrenia research), whereas most social cognitive measures include some type of emotional or personally relevant information. Second, in social cognition, attributes of the stimuli that cannot be observed (e.g., someone's mental state) are often the construct of interest, but most of the characteristics and the corresponding answers to items in cognitive stimuli are directly observable. Finally, absolute correctness is not a common index of performance on social

cognitive tasks. For example, research on attributions in schizophrenia shows that attributional *biases* characterize persecutory delusions (i.e., blaming others rather than situations for negative outcomes), which does not correspond to a “correct-incorrect” distinction. In contrast, many of the neurocognitive tasks in schizophrenia research have a correct answer, such as only having one possibility of making the fewest moves to solve a puzzle, or a finite number of categories to sort cards (although responses styles in signal detection paradigms are obvious exceptions, among others; Penn et al., 1997).

Second, investigations into the neural substrates underlying neurocognition and social cognition have suggested there are two brain systems involved in the processing of emotions: a ventral system, including the amygdala, ventral anterior cingulate gyrus, and ventral prefrontal cortex, which plays a role in identifying emotion; and a dorsal system, including the hippocampus, dorsal regions of the anterior cingulate gyrus, and the dorsal prefrontal cortex, which is involved in the allocation of attention, planning, and effortful behavior (Bozikas et al., 2004; Phillips, Drevets, Rauch, & Lane, 2003). Furthermore, some researchers have concluded there is evidence to support the presence of a “social cognitive neural circuit,” incorporating the amygdala, fusiform gyrus, superior temporal sulcus, and prefrontal cortices (Adolphs, 2001; Blakemore & Frith, 2004; Lee et al., 2004; Phillips et al., 2003; Pinkham et al., 2003). The amygdala, in particular, has been found to play an important role in responses to emotional stimuli, particularly in the identification of the emotional significance of stimuli in general (Adolphs et al., 1999; Adolphs, Baron-Cohen, & Tranel, 2002; Phillips, 2003), and negatively-valenced emotions in particular (Adolphs & Tranel, 2003). Thus, it appears that certain neural structures show greater activation during

social cognitive than neurocognitive processing, which again, lends support for the relative distinction between these constructs (Phillips et al., 2003).

There is also evidence that performance on neurocognitive and social cognitive tasks is dissociable. Specifically, Brunet and colleagues (2003) demonstrated that individuals with schizophrenia were able to complete sequences of physical causality, but not causality due to intentionality (ToM), thus highlighting the specificity of ToM deficits, rather than a general difficulty with linking causal events (Brunet et al., 2003). Similarly, Cutting and Murphy (1981) asked participants questions about social information (i.e., social knowledge) and general knowledge, and discovered those with schizophrenia demonstrated the greatest impairment on the social knowledge task. Similar dissociations can be found in individuals with brain damage and other neuropsychiatric disorders. For example, individuals with frontal lobe damage (Anderson, Bechara, Damasio, Tranel, & Damasio, 1999; Blair & Cipolotti, 2000; Fine, Lumsden, & Blair, 2001) or prosopagnosia (Kanwisher, 2000) show significantly impaired performance in varying areas of social cognition such as ToM and facial processing, but have intact discrimination of other types of non-social stimuli. In contrast, individuals with Williams' syndrome tend to show a relative strength in social cognitive abilities, such as the detection of basic emotions from faces and normal performance on first-order ToM tasks (Jones et al., 2000), but have marked deficits in other aspects of neurocognition (Tager-Flusberg, Boshart, & Baron-Cohen, 1998; reviewed in Pinkham et al., 2003).

Third, there is only a modest association between neurocognition and social cognition in schizophrenia. For example, affect recognition has been found to have a moderate relationship with various memory processes, as bivariate correlations range from .23 (Silver

& Shlomo, 2001) to .50 (Schneider et al., 1995), with several other studies supporting correlation estimates within this range (Bryson et al., 1997; Kohler et al., 2000; Sachs et al., 2004). However, the relationship between memory and another aspect of social cognition, ToM, has received equivocal support, with one study finding no relationship (Mazza et al., 2001), and another suggesting memory accounts for 8% of the variance in ToM abilities (Greig, Bryson, & Bell, 2004). Attention has shown a significant association with affect perception in some studies ($r=.20$ to $.60$; Bryson et al., 1997; Kee et al., 1998; Kohler et al., 2000; Penn et al., 1993), but not others (Penn, Spaulding, Reed, & Sullivan, 1996). Furthermore, executive functioning or cognitive flexibility also had a modest relationship with affect perception in some studies ($r=.29$ -.50; Kohler et al., 2000; Sachs et al., 2004; Schneider et al., 1995), but again, not in others (Penn et al., 1996). In addition, there is no evidence of a significant relationship between executive functioning and social problem solving (Green, 1996) or ToM (Langdon et al., 2002; Mazza et al., 2001). Moreover, verbal fluency has not been significantly related to ToM abilities (Schenkel, Spaulding, & Silverstein, 2005). Finally, general cognitive functioning does not have a consistent relationship with social cognition; a neurocognitive composite accounted for 40% of the variance in social cue perception in one study (Lancaster Evans, Bond, & Lysaker, 2003), IQ was modestly related to social problem solving in another study (Bellack, Sayers, Mueser, & Bennett, 1994), and general neurocognitive ability was unrelated to affect perception in a third study (Silver & Shlomo, 2001). Thus, the modest degree of shared variance between neurocognition and social cognition indicates non-overlapping constructs.

Fourth, there is evidence that neurocognition and social cognition make non-overlapping contributions to functional outcome in schizophrenia. It is clear that social cognition has a

consistent relationship with functional outcome (Appelo et al., 1992; Brune, 2005a; Hooker & Park; 2002; Kee, Green, Mintz, & Brekke, 2003; Mueser et al., 1996; Penn, Ritchie, Francis, Combs, & Martin, 2002; Pinkham & Penn, in press; Toomey, Wallace, Corrigan, Schuldberg, & Green, 1997). In fact, some studies have shown that social cognition has a stronger relationship with functional outcome than neurocognition (Penn et al., 1996; Pollice et al., 2002; Vauth et al., 2004). Other studies have shown that the relationship between social cognition and functional outcome cannot be explained by neurocognitive factors (Corrigan & Toomey, 1995; Poole, Tobias, & Vinogradov, 2000), and that both domains appear to make an independent or equal contribution to functional outcomes (Addington, Saeedi, & Addington, 2005; Brune, 2005a; Roncone et al., 2002). Therefore, the independent relationships of neurocognition or social cognition with functional outcome indicate that they represent relatively discrete domains.

Previous work examining the relationships among neurocognition, social cognition, and functional outcome is generally based on a “direct effects model,” which suggests that neurocognition and social cognition are correlated, yet relatively independent domains, with each having a unique relationship with functional outcome (see Figure 1, Appendix C). Much of the research in the foregoing discussion is consistent with this model, with several studies finding significant correlations among measures of social and neurocognition, and these domains both demonstrating a significant, non-overlapping relationship with functional outcome (e.g., Roncone et al., 2002). However, none of these studies have assessed the utility of the direct effects model using a more advanced statistical modeling procedure; in fact, most have only used multiple regression or correlations in their investigations. Although these statistical approaches are informative, they are plagued by measurement

error, which can be quite high in some studies (e.g., Salem et al., 1996). In addition, other statistical approaches do not allow modeling of the relationships *among* independent variables; a significant omission given that neurocognition and social cognition are often found to relate to one another. Specifically, SEM helps address the problem of measurement error by estimating latent variables (i.e., latent or underlying constructs). Latent variables are considered “free” from measurement error because they are comprised only of the covariance among the indicators (i.e., directly observed and measured variables like the Eyes test or verbal fluency). Forming the underlying constructs in this manner allows the portion of variance from each indicator which is unassociated with the latent construct (of which measurement error is a major component) to be removed from the latent construct; thus, the relationships among latent constructs can be estimated without measurement error. This is in contrast to regression, which assumes *no* measurement error (clearly always an incorrect assumption), without actually removing or separately modeling this error. Thus, an approach allowing modeling of the relationships among the independent variables, as well as one which can address the issue of measurement error, is warranted to further explore the nature of the relationships among neurocognition, social cognition, and functional outcome.

A second model, the mediational model (see Figure 2, Appendix C), identifies social cognition to be a mediator between neurocognition and functional outcome (Green & Nuechterlein, 1999; Green et al., 2000; Kee et al., 1998; Penn, 1991; Penn et al., 1997). Green and colleagues have argued that the association between neurocognition and social cognition exists because intact neurocognitive abilities are requisite for normal social cognitive function (Green & Nuechterlein, 1999; Green et al., 2000; Kee et al., 1998). Indirect support for a mediational model is garnered from findings that neurocognition is

often impaired early in childhood in those at risk for developing schizophrenia (Cornblatt et al., 1999; Wolf, Cornblatt, Roberts, Shapiro, & Erlenmeyer, 2002), whereas there is little evidence, at this time, that deficits in social cognition precede the onset of psychosis (Penn et al., 1997; Pinkham et al., 2006). Green and Penn have also argued that social cognitive abilities, such as emotion perception and ToM, appear to be necessary in order to interact normally with others, suggesting a mediational role for social cognition. This highlights another advantage of SEM, namely it allows for testing of indirect effects (i.e., mediational effects) and total effects of independent variables. Thus, in this context, it allows direct, statistical testing of the *indirect* effect neurocognition has on functional outcome, testing of the *direct* effect neurocognition has on functional outcome, and ascertainment of the *total* effect of neurocognition on functional outcome (*both* indirect and direct effects). Although it does not allow a direct, statistical comparison of the mediational and direct effects models because they are not nested, it does allow direct testing of nested models, such as a mediational model with and without a direct effect of neurocognition on functional outcome (i.e., partial versus full mediation). In addition, structural equation modeling has also been used effectively in other areas of schizophrenia research. Specifically, the techniques of path analysis and structural equation modeling have been used in schizophrenia research to understand such diverse topics as pathways to relapse (Nuechterlein et al., 1992), patient attitudes toward treatment (Day, Bentall, & Roberts, 2005), risk factors for developing schizophrenia (Zhao, Liu, & Wang, 1995), the influence of expressed emotion in families on patients' social adjustment (King & Dixon, 1996), and pathways to stigmatizing attitudes and behavior toward schizophrenia (Corrigan, Edwards, Green, Diwan, & Penn, 2001).

Only a few studies have gone beyond multiple regression analyses to examine these issues. Vauth et al. (2004) used SEM to evaluate different models of the relationships among neurocognition, social cognition, and work functioning in schizophrenia. They concluded that the mediational model provided a better explanation for the observed data than neurocognition or social cognition alone, and that the direct relationship between social cognition and work functioning appeared to be stronger than the direct relationship between neurocognition and work functioning. Furthermore, a direct comparison between the generalized deficit model (i.e., neurocognition and social cognition were integrated into one construct) and the mediational model, yielded a significantly poorer fit with the observed data. Thus, Vauth et al. found support for the possible superiority of a mediational model over the generalized deficit model in their sample. Although they found substantiating evidence for the utility of the mediational model, they did not directly test the strength of the indirect (i.e., mediational) effect or examine the other model implied by the literature, the direct effects model.

Brekke, Kay, Kee, and Green, 2005 used path analysis to examine the relationships between a neurocognition composite, a social cognition composite (of 3 emotion perception tasks), reported social support, social skill, and functional outcome (as measured by subscales from the Role Functioning Scale (Goodman et al., 1993), assessing work, social functioning, and independent living). The path from neurocognition to social skill was not significant, and the direct paths from neurocognition to functional outcome were not significant, so they were removed from the model. Brekke and colleagues (2005) performed several separate path analyses, predicting the composite of functional outcome, as well as follow-up path analyses for the individual functional outcome subscales. They found the

neurocognition composite had a significant indirect relationship with functional outcome via social cognition (i.e., a mediational relationship). In addition, social cognition had a significant direct effect on functional outcome, as well as significant indirect effects through social skills and social support. The same basic results were found for the individual domains of independent living, work functioning, and social functioning, with the exception of some of the indirect paths of social cognition to functional outcome (via social skill or social support) being insignificant depending on the functional outcome examined. Interestingly, these results generally held for functional outcome measured one year later, although the relationships were not quite as strong. Brekke and colleagues (2005) argued these findings suggest that social cognition may need to be regarded as a central construct in understanding functional outcome.

Finally, Sergi et al (in press) used SEM to examine social perception as a mediator between early visual processing and functional outcome (using the Role Functioning Scale with the independent living skills, social functioning, and work functioning subscales). Sergi et al. used the four subscales of the visual processing task to form a latent variable, and the subscales of the Role Functioning scale to form the latent construct for functional outcome. The latent construct of social cognition only had one indicator – the results on the social perception test. Sergi et al. found evidence for a mediational relationship: the indirect effect of early visual processing on functional outcome was significant, as was its relationship with social perception; the model fit statistics were superior for the mediational model versus the basic model just incorporating early visual processing and functional outcome; and the direct effect of early visual processing on functional outcome was not significant. Thus, these three

studies have begun to provide more direct support for social cognition serving as a mediator between neurocognition and functional outcome.

The primary aim of this dissertation was to examine the plausibility of the direct effects and mediational models in schizophrenia using SEM. The proposed dissertation extends the results of Vauth et al. (2004), Brekke et al. (2005) and Sergi et al. (in press) in the following manner: 1) using a broader range of social cognition measures, which assess both emotion perception and ToM, to further investigate the plausibility of the mediational model; 2) evaluating a direct effects model, which has received some support in the literature, but was not assessed in the aforementioned studies (most compared the mediational model to a model just containing neurocognition and functional outcome); and, 3) utilizing a different, comprehensive measure of functional outcome, which encompasses such diverse areas as independent living skills, work functioning, and interpersonal communication.

In the ensuing section, I present background research relevant to the secondary aim of this dissertation: Are the structural relationships between neurocognition, social cognition, and functional outcome unique to schizophrenia or present in other groups with impairments in social cognition and/or social and community functioning?

Evidence for Specificity of a Direct Effects Model in Schizophrenia

Much of the research examining the relationships among neurocognition, social cognition, and functional outcome has shown that the associations among these constructs differ across samples. For example, Brune (2005a) found that none of the social cognition tasks correlated with neurocognition in the non-clinical control sample (i.e., individuals without a diagnosis of a mental illness), but that social cognition was significantly related to impaired neurocognition in the patient sample. Similarly, other studies have provided evidence that

relationships between social cognition and neurocognition are significant in a schizophrenia sample, but not in a non-clinical (Addington & Addington, 1998; Corrigan & Toomey, 1995; Kohler et al., 2000; Penn, van der Does, Spaulding, Garbin, Linszen, & Dingemans, 1993; Toomey et al., 1997) or in a depressed sample (Penn et al., 1993). As can be gleaned from the foregoing, most of the previous research has only assessed this differential pattern between a schizophrenia and a non-clinical sample; it does not address the issue of whether these findings are unique to schizophrenia or reflective of having a psychiatric disorder in general, having significant social impairments, or simply exhibiting greater variability in performance on social cognitive and functional outcome measures (than non-clinical controls might show). One method for addressing this issue is to include a psychiatric control group (e.g., depression; Penn et al., 1993), but this controls for the presence of some symptoms (and to some extent, the experience of having a psychiatric disorder), but not social deficits, which have a stronger relationship with social cognition than symptoms do. Therefore, an ideal comparison group might be one with core social deficits, similar to individuals with schizophrenia. In the following section, I will highlight the value of employing a comparison group comprised of individuals with High-Functioning Autism (HFA) as a way of extending previous research in this area.

Why Compare HFA and Schizophrenia?

A comparison group comprised of individuals who also experience significant and pervasive difficulties with social functioning would address the aforementioned gap in the literature and also provide a sample with greater variability in performance on neurocognitive, social cognitive, and functional outcome measures than non-clinical controls. A group of this nature would provide additional information about the specificity of these

deficits to schizophrenia and would help elucidate the underlying structure of these deficits in two groups with significant social dysfunction. Thus, a comparison group of those diagnosed with HFA was added to this dissertation. HFA provides a particularly unique and useful comparison given the similarities that exist between autism and schizophrenia (Bolte & Poutska, 2003; Konstantareas & Hewitt, 2001). Three areas of research support the inclusion of a sample of individuals with HFA into the study: 1) evidence for intermediate phenotypes in relatives with autism similar to those with schizophrenia; 2) similar symptom presentations across disorders; and, 3) the two disorders share some similar deficits in neurocognition, social cognition, and functional outcome.

One supporting argument for comparing HFA and schizophrenia comes from studies of endophenotypes in schizophrenia or autism. Specifically, similar phenotypic variants may be observed in relatives of those with schizophrenia as relatives of those with autism. For example, one study found that a subset of those with childhood onset schizophrenia (which shows clinical and neurobiological links with adult onset schizophrenia; see Asarnow & Asarnow, 1994 and Nicolson & Rapoport, 1999) had marked features of pervasive developmental disorder. Seventeen percent of the siblings of children from this subgroup met full criteria for autism, reflecting a total rate for the entire sample (4.9%) similar to those who have a sibling with autism (Sporn, Addington, Gostay, Ordonez, Gornick et al., 2004). In a study of Asperger's syndrome, 15% of probands with Asperger's had a relative with schizophrenia, a rate which is significantly higher than the general population (1%; Ghaziuddin, 2005). In autism, the broad autism phenotype is characterized by aloofness, rigidity, anxiety, pragmatic and speech impairments, lower executive functioning abilities, and difficulties in interpersonal relations, such as in social and communication skills (Bishop,

Maybery, Maley, Wong, Hill, & Hallmayer, 2004; Hughes, Leboyer, & Bouvard, 1997; Piven, 1999; Piven & Palmer, 1997; Yirmiya & Shaken, 2005). Parents of those with autism are also less likely to have a large number of friends, and are less likely to have high quality friendships than parents of children with Down's syndrome (Piven, Palmer, Landa, Santangelo, Jacobit, & Childress, 1997). In order to inform future work on the relationships between genes and behavior, as well as gene-brain-behavior relationships, a better understanding of how particular deficits underlie the defining features of these disorders is needed. Specifically, social functioning deficits are a defining feature of both autism and schizophrenia, and thus attempts to understand how other observed deficits (i.e., in neurocognition and social cognition) contribute to this defining feature could help future studies in this area (Piven, 1999).

The two disorders share a number of symptoms in common, such as a lack of interest in social interaction, poor attention, and affective flattening (Konstantareas & Hewitt, 2001). Inpatients with schizophrenia have been found to exhibit autistic-like symptoms (Sheitman, Kraus, Bodfish, & Carmel, 2003), whereas individuals with autism have displayed features of thought disorder and poor reality testing typical of schizophrenia (Dykens, Volkmar, & Glick, 1991). Another study found that half of the participants with autism also met criteria for schizophrenia (typically the disorganized subtype; Konstantareas & Hewitt, 2001). Along the same lines, Wolff (1995) claimed that it can be difficult to differentially diagnose HFA versus schizoid personality disorder, which may be present in first-degree relatives of individuals with schizophrenia. Individuals with HFA (as opposed to autism) may serve as a better comparison group than autism in general, as they have IQs that are not in the mentally retarded range and have more normal language abilities like individuals with schizophrenia,

while still displaying significant social dysfunction (Klin, Jones, Schultz, Volkmar, & Cohen, 2002).

Individuals with HFA share some overlapping neurocognitive impairments with schizophrenia. For example, both groups are impaired in executive processing (Bolte, Rudolf, & Poustka, 2002; Ozonoff & Strayer, 1997), verbal fluency (Kleinmans, Akshoomoff, & Delis, 2005), and psychomotor speed (Goldstein, Johnson, & Minshew, 2001). Indeed, Bolte and colleagues (2002) argued that those with schizophrenia or autism both tend to have neurocognitive impairments, and concluded that more convergent findings rather than discrepancies had been found thus far.

Studies of emotion perception in HFA also reveal similar deficits to those reported in schizophrenia. Individuals with HFA have demonstrated impairments in the recognition of basic emotion relative to non-clinical controls (Capps, Yirmiya & Sigman, 1992; Celani, Battacchi, & Arcidiacono, 1999; Deruelle, Rondan, Gepner, & Tardif, 2004; Loveland, et al., 1997). It also appears individuals with HFA perform best in perceiving happiness compared to other emotions (Adolphs, Sears, & Piven, 2001; Baron-Cohen et al., 1993; Baron-Cohen, Wheelwright, & Jolliffe, 1997), consistent with findings from schizophrenia research. Furthermore, some studies have found that individuals with HFA exhibit deficits on some social cognitive tasks, while maintaining somewhat intact performance on similar neurocognitive tasks (Celani et al. 1999), consistent with the dissociation between neurocognition and social cognition observed in schizophrenia. In addition, the moderate associations between executive functioning, verbal memory, or IQ and aspects of social cognition (e.g., theory of mind tasks, emotion perception) have also been found in autism (Buitelaar, van der Wees, Swaab-Barneveld, & Jan van der Gaag, 1999; Ozonoff,

Pennington, & Rogers, 1991). Finally, individuals with HFA can perform normally on tasks of emotion perception with fewer choices (Baron-Cohen, Jolliffe, Moritmore, & Robertson, 1997; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001), but appear to be significantly impaired on tasks with more choices or more dispositional judgments (Adolphs et al., 2001). Thus, it also appears necessary to include a variety of emotion perception measures in studies of HFA with varying cue sources and types of judgments, similar to what has been suggested in schizophrenia (Edwards et al., 2002).

Consistent with research on schizophrenia, ToM abilities are also deficient in individuals with HFA. Individuals with autism typically perform poorly on ToM tasks (Baron-Cohen, 1995; Baron-Cohen et al., 2001), although some research suggests that individuals with HFA, in particular, may only be impaired on higher-order mental tasks rather than simpler tests of first-order ToM (Baron-Cohen, O’Riordan, Stone, Jones, & Plaisted, 1999; Baron-Cohen, Wheelwright, & Jolliffe, 1997; Capps et al., 1992; Dahlgren & Trillingsgaard, 1996; Kaland, Moller-Nielsen, Callesen, Mortensen, Gottlieb, & Smith, 2002; Rutherford, Baron-Cohen, & Wheelwright, 2002), and sometimes even second-order ToM (Bowler, 1992; Ozonoff et al., 1991). These findings are consistent with recent research in schizophrenia (Brune, 2005b).

Research also supports relatively poor functional outcome as being common in HFA, such as being unable to maintain employment in a competitive setting (i.e., not supported employment or workshop; Orsmond, Krauss, & Seltzer, 2004). Furthermore, those with HFA have been found to have fewer friendships, and to display less interpersonal communication behaviors than same-aged, similar IQ peers (Baron-Cohen & Wheelwright, 2003; Bauminger, Shulman, & Agam, 2003). Corcoran et al. (1995) have argued that both groups exhibit social difficulties in childhood. Indeed, social dysfunction is a defining

feature of HFA, as individuals must display sustained impairment in social interaction to receive the diagnosis, and often have difficulty with subtle aspects of social communication (APA, 2000).

The foregoing suggests that both groups share similar deficits in neurocognition, social cognition, and functional outcome. However, the studies reviewed above did not directly compare individuals with HFA and those with schizophrenia. Thus, in the ensuing section, I will review the few studies that have directly compared individuals with HFA and schizophrenia on these constructs.

Direct Comparisons of HFA and Schizophrenia

Research directly comparing neurocognitive impairments in schizophrenia and HFA has generally been inconclusive about the relative performance of individuals with schizophrenia or HFA. For example, Bolte et al. (2002) found that individuals with schizophrenia and HFA differed on their performance on two subtests of the Wechsler intelligence scale, with schizophrenia participants scoring better on Comprehension, and HFA participants obtaining better scores on Similarities. Waterhouse and Fein (1984) found evidence for similar neurocognitive deficiencies in children with schizophrenia or autism, but found those with schizophrenia consistently scored higher than those with autism. In contrast, Schneider and Asarnow (1987) found that the Wisconsin Card Sort and a task assessing visual search strategies were unable to satisfactorily differentiate individuals with HFA and schizophrenia. Thus, at the present time, it is unclear whether these groups differ in neurocognitive abilities.

Studies examining emotion perception in schizophrenia and autism have generally shown that individuals with HFA perform worse on tests of emotion recognition. Specifically, Bolte and Poustka (2003) found that individuals with HFA performed significantly worse on

recognizing facial expressions of emotions than those with schizophrenia and normal controls. This pattern of performance is not limited to the visual modality, as individuals with HFA have also shown greater impairments than individuals with schizophrenia and non-clinical controls on an emotional prosody task (VanLancker, Cornelius, & Kreiman, 1989).

ToM abilities are deficient in both groups, with some limited evidence suggesting individuals with HFA perform worse than those with schizophrenia. Specifically, children with schizophrenia or HFA performed significantly worse than normal controls on ToM tasks; and, although the HFA group appeared to perform worse than the schizophrenia group, the statistical comparisons were only significant on one of the ToM tasks (Pilowsky, Yirmiya, Arbelle, & Mozes, 2000). Pickup and Frith (2001) did not directly compare those with schizophrenia and autism. However, they used the same measures with their schizophrenia sample that are typically studied in autism. They concluded individuals with autism performed substantially worse on their first- and second-order ToM tasks than schizophrenia participants. Conversely, Craig et al. (2004) did not find evidence of greater ToM impairments in HFA, as they found that participants with paranoid delusions or individuals with Asperger's syndrome were similarly deficient in their ToM abilities as compared to normal controls (Craig, Hatton, Craig, & Bentall, 2004). In addition, another study of individuals with Asperger's syndrome or schizophrenia and non-clinical controls found no evidence for overall group differences, although planned contrasts revealed those with schizophrenia performed significantly worse than controls, but no different than those with Asperger's (Bowler, 1992).

Finally, one study compared social behavior in individuals with autism or schizophrenia with comorbid mental retardation, and concluded that while the groups are similarly deficient

in their social skills, the expression of these impairments varies by group (Matson, Mayville, Lott, Bielecki, & Logan, 2003). Specifically, Matson et al. (2003) found individuals with psychosis or autism tended to perform worse than the control groups on assessments of their nonverbal social behavior. Among inappropriate social behaviors, individuals with psychosis tended to perform more intrusive behaviors, such as following the staff around or inappropriately touching others, whereas those with autism tended to make more inappropriate verbal remarks. However, another study found autistic children to be more impaired than psychotic children in language and social skills, although the psychotic sample had higher IQs (Matese, Matson, & Sevin, 1994).

Therefore, the foregoing indicates that few studies have directly compared individuals with HFA and schizophrenia in the domains of neurocognition, social cognition, and functional outcome. There is some evidence, albeit limited, that individuals with HFA are more impaired in emotion perception and ToM relative to individuals with schizophrenia. Confident conclusions regarding group differences in neurocognition and functional outcome cannot be made at this time, however. Finally, no study has directly compared these groups on neurocognitive, social cognitive, and social/community functioning abilities in the same study, nor has the relationship between neurocognition and social cognition with functional outcome been adequately assessed in HFA (Abdi & Sharma, 2004). Accordingly, the second aim of the proposed dissertation was to examine whether the models of the associations among these constructs suggested by the literature in schizophrenia also fits the observed data from individuals with HFA.

Aims of the Current Study

The current dissertation aimed to address some of the limitations highlighted in the foregoing discussion. First, I examined the nature of the relationships between neurocognition and social cognition with functional outcome in schizophrenia using Structural Equation Modeling (SEM). SEM “is a comprehensive statistical approach to testing hypotheses about relations among observed and latent variables” (p.1; Hoyle, 1995) and was intended to examine two models indicated by the literature: 1) the direct effects model (Model A), i.e., neurocognition and social cognition make independent, influential contributions to functional outcome (Figure 1, Appendix C); and 2) the mediational model (Model B), i.e., social cognition mediates the relationship between neurocognition and functional outcome (Figure 2, Appendix C). Although examination of the underlying structure of these constructs will be exploratory due to sample size constraints, using multiple measures of neurocognition and social cognition contributes to and extends previous research by allowing examination of latent constructs, which are free from measurement error. This is a particular strength given the somewhat limited reliability of assessments, particularly of social cognition (e.g., Salem et al., 1996), which has been found previously. SEM also allows modeling of relationships among the independent variables, which is a significant advantage over correlational or regression approaches.

The second aim of this dissertation was to ascertain whether the nature of the relationships among neurocognition, social cognition, and functional outcome in HFA adhere to the models suggested by the schizophrenia literature. A multiple group comparison will be conducted within the SEM framework in order to achieve this aim.

Thus, the current study tested the following research questions: 1) how do the proposed models (the direct effects and mediational models) fit the data in the schizophrenia sample?

Is there evidence to support social cognition as a potential mediator between neurocognition and functional outcome in schizophrenia? 2) How do these models fit the data in an HFA sample? Is there support for similar relationships among neurocognition, social cognition, and functional outcome in schizophrenia and HFA?

It was hypothesized that the indirect effect tested in Model B will be significant in the schizophrenia sample. Findings indicating neurocognitive, but not social cognitive, impairments prior to illness onset (Cornblatt et al., 1999; Penn et al., 1997; Pinkham et al., 2006; Wolf et al., 2002) provide theoretical support of a mediational relationship between these constructs. Specifically, this research suggests neurocognitive abilities may influence the acquisition of social cognitive abilities, and because neurocognition is deficient, social cognitive abilities may be undermined (Green & Nuechterlein, 1999; Green et al., 2000). Indeed, Frith (1992) suggested those with schizophrenia may not exhibit pronounced deficits in theory of mind abilities until after illness onset and neurocognitive deterioration. Social cognition also appears to have the most direct theoretical connection to social functioning, given the proximity between social cognitive abilities and social behavior, further supporting its role as a mediator (Green & Nuechterlein, 1999; Green et al., 2000). In contrast, the indirect effect may not be significant in the HFA sample given findings that neurocognition and social cognition are impaired from infancy in individuals with autism (Charman et al., 1998); therefore, the direct effects of neurocognition and social cognition may be stronger in the HFA sample.

CHAPTER III

METHODS

Source of data for the current study

The proposed aims were accomplished through analysis of data from two grant-supported studies. The first grant, entitled “A Neuropsychological Family Study of Autism and the BAP,” was funded by NIMH to examine the Broad Autism Phenotype (Joe Piven, M.D., Principal Investigator). The second grant, the Autism-Schizophrenia Social Cognition Study, was funded by Johnson & Johnson to examine social cognitive functioning in individuals with schizophrenia, HFA, and non-clinical controls (David Penn, Ph.D., Principal Investigator).

Design and Procedure

Data analyzed for the current study aims derive from a battery of neurocognitive and social cognitive tasks administered to individuals with HFA or schizophrenia. Participants with HFA were recruited from the registry of families with member who has autism from the TEACCH center. Participants with schizophrenia were recruited from the local outpatient clinic at UNC Hospitals as well as through other studies conducted in Penn’s research laboratory. Before any study procedures were administered, all participants read and signed the consent form and the Health Insurance Portability and Accountability Act (HIPAA) authorization form (Appendix A), and discussed it with the experimenter to ensure they fully understood the procedures. All individuals with autism must have met algorithm criteria of the Autism Diagnostic Interview-Revised (Lord, Rutter, & LeCouteur, 1994) for autism.

Algorithm criteria are described further in the Measures section. Diagnosis was confirmed through administration of the Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord, et al., 2000), which is described below.

The Structured Clinical Interview for DSM-IV (SCID; First, Spitzer, Gibbon, & Williams, 1995; described below) was used to diagnose all participants with schizophrenia or schizoaffective disorder. Diagnoses were confirmed by medical records whenever possible. All participant groups must have obtained a score of the Wechsler Abbreviated Scale for Intelligence (WASI; Wechsler, 1999) of greater or equal to 70 to be eligible for study participation. The minimum IQ score criterion ensures that all individuals with autism will be considered to have HFA.

Given the length of the assessment battery, participants were given the option of completing the assessment battery in 1 or 2 sessions. The main battery and clinical interviewing were typically administered in 3-4 hours. The autism group usually required a longer time frame, given the duration of the autism clinical assessments. The majority of participants were tested in the laboratory at the University of North Carolina Psychology Department or the STAART Center. If participants lived a significant distance from Chapel Hill, research assistants provided them with the option of being tested in their home.

Measures

Measures are listed by the constructs they assess. Most of the visual stimuli were presented on a computer monitor. Confirmatory Factor Analyses (CFA) were conducted on neurocognitive and social cognitive measures in order to assess whether they reliably assess the underlying factor, and thus, only a subset of the neurocognitive and social cognitive measures were included in the main analyses.

Autism Diagnosis/Symptoms. The Autism Diagnostic Interview-Revised (ADI-R; Lord et al., 1994) is a semi-structured interview with the parent allowing assessment of information relevant to diagnosis. The Autism Diagnostic Observation Schedule-Generic (ADOS-G; Lord et al., 2000) is a structured observation designed to elicit social interaction and language use, which allows confirmation of symptoms and multiple areas of functioning reported during the ADI-R. Algorithms have been developed for the ADI-R to ascertain diagnosis and have been found to adequately discriminate between autism and mental-age matched, non-autistic controls (Lord et al., 1994). The ADI-R requires approximately 2 hours to administer. ADI-R algorithm cut-offs are at least greater than 10 for the social domain, and greater than 3 for repetitive behavior domains. In addition, there are communication cutoffs of greater than 8 for verbal and greater than 7 if nonverbal. The ADI-R is audiotaped and ADOS-G is videotaped in order to perform random reliability checks.

Schizophrenia Diagnosis/Symptoms. The Structured Clinical Interview for DSM-IV Axis I Diagnosis – Patient Version (SCID-P; First et al., 1995) was used to confirm diagnosis that was reported by the patient and documented in medical records. It consists of a series of interview questions aimed at ascertaining past and present symptoms consistent with criteria listed in the Diagnostic and Statistical Manual for Mental Disorders (DSM-IV; APA, 1994). The Positive and Negative Syndrome Scale (PANSS; Kay, Fiszbein, & Opler, 1987) was used to assess current levels of schizophrenia-related symptoms. Participants answer questions in a brief (30 minute) semi-structured interview, which allows the examiner to rate their current symptom level. Interviewers on both instruments were fully trained by Dr. Penn and have high reliability (ICC > .80).

Neurocognitive Functioning. Several constructs of neurocognitive functioning were assessed in this study and are described below.

IQ. IQ was assessed for the purposes of establishing study eligibility criteria and to assess general intellectual functioning. Participant groups were matched to the extent possible on IQ scores in order to equate groups on general cognitive ability. The Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999) was chosen given that has a strong relationship to the full Wechsler Adult Intelligence Scale. An abbreviated version was deemed necessary given the lengthy neuropsychological battery in order to reduce strain on research participants. The two subtest version of the WASI, comprising the Vocabulary and Matrix Reasoning subtests, was used to estimate full scale IQ (FSIQ). The two subtest version is highly correlated with full-scale IQ on the full Wechsler intelligence scale (Wechsler, 1999), and the subtests have high factor loadings on a general intelligence factor (Kaufman, 1994).

Verbal fluency. Verbal fluency concerns the ability to generate words in response to verbal prompts, such as letters or categories (e.g., animals). The Controlled Oral Word Association Test (COWAT; Benton, Hamsher, & Sivan, 1983) is a measure of a person's ability to generate words to specific letter prompts (i.e., C, F, and L). Participants were given one minute to generate as many words as possible to a given letter excluding proper nouns and numbers. The number of words was summed for each letter and a correction score was added to the total, taking years of education and age into account.

Visuoperceptual Ability. This domain of neurocognitive functioning allows examination of whether participants have general deficits in their ability to process and accurately perceive visual stimuli. The Benton Lines Test (Benton, Hamsher, Varney, & Spreen, 1983)

is a well-established test of visual perceptual ability that requires participants to match the orientation of a target line with the orientation of another line from several choices. The number of correct items was summed and added to a correction score taking age and gender into account.

Psychomotor Speed. This domain assesses participants' speed of processing while completing a motor task. Trails A (from Trails A and B) requires participants to connect numbers in order as quickly as they can (Reitan & Wolfson, 1985). Trails A has been used individually to effectively measure motor speed (Goldstein et al., 2001). Individuals with schizophrenia (Bozikas et al., 2004; Green, 1996) and autism (Goldstein et al., 2001) typically show deficits in this area. The amount of time taken to complete the measure was converted into a normative score based on the participants' age, years of education, and gender.

Executive Function. This construct encompasses many abilities, such as planful and sequential behavior, initiating and choosing behaviors, and cognitive flexibility (Duncan, 1986). Executive functioning was measured by Trail B (from Trails A and B), assesses the individual's cognitive flexibility (Reitan & Wolfson, 1985). In Trail B, participants alternately connect numbers and letters in order (e.g., 1 to A to 2 to B). This type of cognitive flexibility has been shown to be deficient in autism (Ozonoff, Strayer, McMahon, & Filloux, 1994) and schizophrenia (Cools, Brouwer, deJong, & Slooff, 2000). Performance was indexed as a normative score, using the time to complete the task in comparison to a similar age, years of education, and gender comparison group.

Social Cognition. Social cognitive abilities in the areas of emotion perception and ToM were assessed and are described below.

Emotion Perception. Emotion perception abilities were assessed in three tasks: Point-Light Motion Displays, Movie Stills, and the Trustworthiness Task. These tasks vary in the source of cues in the presented stimulus (still scenes, biological motion movies, still facial photos), as well as the type of judgment (choosing an emotion from five or seven choices versus making more dispositional social judgments of trustworthiness).

The Point-Light Motion Displays (Heberlein, Tranel, Damasio, & Adolphs, 2001) consist of a series of 22 short films (ranging 5 to 20 seconds) of an actor moving in ways that convey emotional information (e.g., dancing joyfully). The short movies were filmed in the dark with lights on the major joints of the body and the head, and thus are a series of dots moving across the screen. This allows no additional information to be garnered from the person's facial expression, and therefore judgments are solely based on body movement. As research has supported biological motion being a unique source of socially relevant information, it has been suggested that deficits in this area may have a variety of implications for social perception in general (Kim, Doop, Blake, & Park, 2005). Participants were asked to choose one of five emotion words to describe "how the dots might be feeling": happy, sad, afraid, angry, or neutral. Performance is converted to accuracy scores on the basis of data from a reference group. For example, if 100% of normal participants thought the answer was 'happy,' and the participant said the response was 'happy,' they would earn a score of 1.0, or a zero for all other responses. On the other hand, if 50% of normal participants said 'angry,' 40% said 'happy,' and 10% said 'afraid' in response to the item, one would earn a score of 1.0 for answering 'angry,' 0.8 for answering 'happy,' and 0.2 for answering 'afraid.' It has been argued that scoring the measure in this manner allows assessment of degrees of impairment related to a normal population rather than an absolute correct or incorrect score

(Majewska, Tranel, Damasio, & Adolphs, 2001). Accuracy scores were summed and averaged to form two scales: accuracy on positive emotions and accuracy on negative emotions.

The Movie Stills task (Majewska et al., 2001) consists of 16 photographs of complex scenes from movies with clear emotional content. The stimuli were chosen based on reliability data in a normative sample. Participants were first shown the movie stills with the faces blocked out, then are re-shown the 16 photographs with the faces present. Participants were required to choose one of the seven emotion words (happy, sad, afraid, surprised, angry, disgusted, or neutral) that best describe what the actors in the movie still are feeling. Performance was converted to accuracy scores on the basis of data from a reference group as described above for the Point-Light Displays.

Individuals with amygdala damage have demonstrated impaired performance on this task (Majewska et al., 2001). When individuals with bilateral amygdala damage were administered the Movie Stills task, they demonstrated superior accuracy for scenes in which the faces were erased. For fear, sadness, and particularly anger, those with bilateral amygdala damage benefited less from the presence of a facial expression for identifying emotion. This pattern was present to a lesser extent in those with unilateral amygdala damage (Adolphs & Tranel, 2003). Accuracy scores were summed and averaged to form two scales: accuracy on positive emotions and accuracy on negative emotions.

In the Abbreviated Trustworthiness Task (Adolphs, Tranel, & Damasio, 1998), participants are shown 42 faces of unfamiliar people and are asked to judge how much they would trust the person by providing a rating on a 7 point scale, ranging from -3 (very untrustworthy) to +3 (very trustworthy). The photographs were carefully chosen in order to

maximize the variance in ratings given by normal participants. This set of stimuli has been shown to discriminate individuals with bilateral amygdala damage from normal and other brain damaged participants (Adolphs et al., 2001). Responses are converted to deviation scores by subtracting the normative response to each photo. The most trustworthy and least trustworthy faces according to the normed scores were then used to form two scales: the average deviation on trustworthy faces and the average deviation on untrustworthy faces. This was then reverse-scored, so that higher scores reflected better performance in order to be consistent with the other measures.

ToM. ToM was assessed with the Eyes Task (Baron-Cohen et al., 2001). Participants were shown a pair of eyes and asked to choose among four words the one that best describes what the person is thinking or feeling. Although this task is different from the typical hinting or first- and second-order ToM tasks more commonly applied, it has been argued that it is a test of higher-order mental states (Adolphs et al., 2002). A glossary is provided for participants in order to eliminate the effects of not understanding the meaning of the words used in the task. The Eyes Task has been found to differentiate individuals with HFA from normal controls (Baron-Cohen et al., 2001) and is associated with activation of the amygdala (Baron-Cohen et al., 1999). The percentage of correct responses was used as a summary score for this measure.

Social Functioning. Social Functioning was assessed with the Social Functioning Scale (SFS; Birchwood et al., 1990; see Appendix B). The SFS is a self-report measure comprised of 74 items that are rated by the respondent on Likert and frequency scales. It inquires about participants' interpersonal functioning (e.g., friendships), prosocial behavior (e.g., helping others), recreational functioning (e.g., going to the movies), and occupational functioning

(e.g., searching for employment). The SFS contains 7 subscales: social engagement/withdrawal, interpersonal communication/behavior, frequency of performing activities of daily living, competence at independent living, recreation, prosocial activities (common social activities such as sports), occupation/employment, which can also be summed to compute a total score (Birchwood et al., 1990). Although the SFS has been used in a wide variety of studies within the schizophrenia literature, a limitation of the SFS is it has not been validated in a HFA sample. This issue is addressed in the Discussion.

Data Analytic Plan

Confirmatory Factor Analysis

Confirmatory Factor Analyses (CFA) were conducted prior to examining the structural models within SEM. CFA and theory were used to choose the best indicators of each latent construct (i.e., neurocognition, social cognition), and to determine whether the subscales of the Social Functioning Scale are reliably measuring one construct. The indicators, or observed variables, have been outlined above in the Methods section. Latent constructs (or latent variables) are “unobserved variables implied by the covariances among two or more indicators,” and can be thought of as what the multiple indicators have in common with one another (p. 3, Hoyle, 1995).

As there are five indicators for neurocognition and seven indicators for social cognition, the reliability of each measure was examined carefully via examination of the R^2 coefficients, which provide an estimate of the amount of variance in the indicator that is accounted for by the underlying construct. All other variability is considered error. Factor loadings were also examined in conjunction with the R^2 coefficients to choose the most appropriate indicators.

These analyses were conducted with the entire sample, as the same indicators must be chosen for each group in order to compare models across groups.

Structural Equation Model

First, maximum likelihood (ML) estimation was chosen as the iterative procedure as it is the most commonly used estimation procedure in the field, and when the indicators are strongly related to the latent variables, ML has been shown to be a robust procedure to use with small sample sizes (MacCallum, Widaman, Zhang, & Hong, 1999). It maximizes the probability that the observed covariances are drawn from a population assumed to be the same as the one estimated by the coefficients. The free parameters are given values based on this procedure which minimize the values in the residual matrix (the resultant matrix from the comparison of the covariance matrix generated by the free parameters to the covariance matrix estimated by the observed data). The maximum likelihood method of estimating missing data points using all available information from the data (referred to as Full Information Maximum Likelihood or FIML) was used, as this procedure has been found to have the least amount of bias in its estimated values (Arbuckle, 2000).

Second, the models were specified. The direct effects model (Model A; see Figure 3, Appendix C) was specified as having an association (i.e., a correlational relationship) between the latent constructs of neurocognition and social cognition. In turn, neurocognition and social cognition are both exogenous variables (i.e., there is no causal influence on them) with directional, influential relationships on functional outcome. The mediational model (Model B; see Figure 4, Appendix C) has a directional relationship from the exogenous variable of neurocognition to social cognition, and another directional relationship from both neurocognition and social cognition to functional outcome. In addition, the metric of the

underlying latent constructs must be set in order to produce a valid model with interpretable parameters. The path between each latent variable and the indicator with the highest factor loading or reliability estimate (R^2) was constrained as a fixed parameter with a value 1.0. Thus, three parameters, the path between each latent construct and its corresponding best indicator, was set at 1.0.

Because both models produced negative variances in both samples (see description in Results), the SEM approach was subsequently abandoned in favor of path analysis. Path analysis still allows testing of multiple dependent relationships. As such, it provides an opportunity to test mediation (as compared to a series of models which must be conducted for Baron and Kenny's (1986) approach in regression). It also allows specification of correlational relationships among independent variables which is a significant advantage over a multiple regression approach.

Path Analysis

The two models were specified within a path analysis framework by creating composites of neurocognition, social cognition, and functional outcome using the indicators chosen in the CFAs. The fit indices and structural coefficients were examined for each model. The chi-square (χ^2) goodness-of-fit statistic is one of the most commonly-used statistical tests within this framework, and it indicates the degree of consistency between the pattern of fixed and free parameters and the pattern of variances and covariances in the observed data. It tests the null hypothesis that the matrix estimated from the model parameters equals the observed data matrix. It should *not* be significant if there is good model fit. The Comparative Fit Index (CFI) and the Root Mean Squared Error of Approximation (RMSEA) were examined, given that they tend to be the least biased indices in small samples (Hu &

Bentler, 1998). Both indices use conventional cut-offs to indicate good model fit. The model parameters, which provide information about the relationships among the latent variables, were also interpreted. The standardized structural coefficients are the same as standardized regression weights, which facilitates interpretation. However, because the model was then compared to another sample, unstandardized coefficients is preferred, as the standardized estimate does not take the different means and variances which may exist across groups into account (Byrne, 2001). In addition, squared multiple correlations were obtained for each composite to acquire an estimate of the amount of variance explained by the other variables.

Comparison with HFA. First, I tested the mean structure of the model across groups. Specifically, this comparison provides insight into whether the groups have significantly different means on the composites. Second, I tested for invariant structural relations. This procedure tests whether the relationships among the composites are the same in the schizophrenia and HFA samples.

CHAPTER IV

RESULTS

Demographic Characteristics

Demographic characteristics for both samples are displayed in Table 1 (Appendix C). There were no significant differences in education level, IQ, or gender. However, individuals with schizophrenia were significantly older than those with HFA ($t(75)=4.57$, $p<.001$), and groups significantly differed on ethnicity ($\chi^2(2, N=75)=7.77$, $p=.021$), with the schizophrenia group having a higher proportion of African-American participants. Neither of these variables were related to neurocognition, social cognition, or functional outcome.

Introductory Confirmatory Factor Analyses

Preliminary CFAs were conducted on the constructs of neurocognition, social cognition, and functional outcome. These analyses were conducted with the entire sample (HFA and schizophrenia) in order to facilitate comparing these constructs across both samples in the structural models.

Neurocognition

Preliminary Models. The latent variable for neurocognition was first estimated by using all five indicators of neurocognition: verbal fluency, IQ, general perceptual ability, psychomotor speed, and executive functioning. This model did not fit the data well, given the significant chi-square ($\chi^2(5, N=79) = 27.37$, $p < .001$), and unsatisfactory fit statistics (CFI = .741, RMSEA = .239). Theory and the multiple correlation estimates were used to determine the next model. Specifically, psychomotor speed is most conceptually different from the other

four, and there are fewer studies supporting its association with functional outcome than the other indicators (Green, 1996; Green et al., 2000). In addition, it had the lowest squared multiple correlation among the five constructs ($r^2 = .250$). Thus, psychomotor speed was eliminated from the model, and the CFA was tested again.

Final Model. The resultant model, with four indicators of neurocognition (verbal fluency, IQ, general perceptual ability and executive functioning) fit the data well, with a nonsignificant chi-square estimate ($\chi^2(2, N=79) = 1.56, p=.457$), and excellent fit indices (CFI=1.0, RMSEA < .001). The squared multiple correlations were variable, with a high estimate for IQ ($r^2 = .805$) and lower, but comparable estimates for the other three indicators (executive functioning, $r^2 = .323$; verbal fluency, $r^2 = .348$; general perception, $r^2 = .347$). Although the estimates for three indicators appear low, this is consistent with the literature, which has shown IQ to account for a large proportion of the variance in neurocognitive ability with smaller contributions from other variables (Cohen et al., 2006; Pollice et al., 2002). In addition, the other estimates were similar in size and the model had excellent fit statistics; thus, this model was chosen as the most appropriate for the latent variable of neurocognition.

Social Cognition

Preliminary Models. The latent construct for social cognition was again first estimated by including all seven indicators (point light positive and negative emotions, movie stills difference score [blanks minus faces] positive and negative emotions, trustworthy and untrustworthy faces, and the eyes test). This model did not produce a solution because it had a negative variance. I then attempted to reduce the number of indicators without losing all of the information from the variables themselves. Thus, the variables comprising separate

scales for valence (i.e., positive versus negative emotions, trustworthy versus untrustworthy) were collapsed into a single measure. Accordingly, the resultant model was comprised of four indicators: eyes test, point light total, movie stills difference score total, and trustworthiness total. This model had a moderate fit with the data ($\chi^2(2, N=79) = 2.18$, $p=.336$, CFI=.992, RMSEA=.034). Examination of the squared multiple correlations revealed the movie stills difference score was not loading on the underlying factor of social cognition ($r^2=.001$). Before eliminating this variable, it was deemed necessary to score it in a manner consistent with the other variables; that is, as an accuracy score rather than the difference between two accuracy scores. Thus, it was computed as a total accuracy score (across valence and presence of faces). A model with movie stills total, point light total, eyes test, and trustworthiness total as indicators produced a model with excellent fit statistics ($\chi^2(2, N=79) = .732$, $p=.732$, CFI=1.0, RMSEA< .001). However, the squared multiple correlation for the trustworthy indicator was low ($r^2=.153$).

Final Model. Given the low squared multiple correlation for the trustworthiness scale, a three indicator model eliminating the trustworthiness scale was estimated. This model was also nonsignificant ($\chi^2(13, N=79) = 10.19$, $p=.678$) with excellent fit indices (CFI=1.0, RMSEA < .001), and with squared multiple correlation estimates more consistent with the neurocognition model (Eyes, $r^2=.690$; Movie stills, $r^2=.301$; Point light, $r^2=.345$). Examination of these variables from both a statistical (i.e., bivariate correlations) and theoretical perspective did not yield potential sub-factors. Consequently, the three indicator model appeared to be the most appropriate method for estimating the underlying construct of social cognition.

Functional Outcome

Preliminary Models. Consistent with the other latent constructs, the full model with all seven subscales of the SFS was specified first (independence competence, independence performance, social engagement, interpersonal communication, occupational functioning, prosocial activities, and recreation activities). This model did not fit the data ($\chi^2(14, N=79) = 65.11, p < .001, CFI = .610, RMSEA = .216$). As one of the indicators had a squared multiple correlation estimate of zero (occupational functioning), it was eliminated, but this did not improve model fit. Subsequently, a series of models were tested by eliminating the indicator with the lowest squared multiple correlation.

Final Model. A model with prosocial activities, recreation activities, and performance of independent living behaviors produced the best fit for the data ($\chi^2(2, N=79) = 3.40, p = .183, CFI = .978, RMSEA = .095$), and these three indicators seemed to fit well together conceptually, as all measure frequency of behavior performance in different domains. Thus, these three indicators produced a model of adequate fit for the construct of functional outcome.

Structural Equation Modeling Analyses

These three measurement models were then used in the proposed structural models (See Figures 3 and 4, Appendix C) in order to test the study hypotheses. However, both Model A (i.e., direct effects model) and B (i.e., mediational model) produced negative variances when tested in the schizophrenia and HFA samples. As the most consistent negative variance occurred in the error variance for the prosocial scale, it was decided that functional outcome should be re-specified as an observed variable. Thus, a composite of the standardized values for the three indicators of functional outcome (prosocial, recreation, and performance of independent behavior subscales) was created. This composite replaced the latent variable for

functional outcome in both Model A and B. However, negative variances were still obtained in the HFA sample in both the neurocognition and social cognition latent variables.

Accordingly, it was decided that composites for neurocognition and social cognition should also be created. These composites were then used to test the models within a path analysis framework (See Figures 5 and 6, Appendix C).

Path Analyses

Schizophrenia Sample. Models A and B and their corresponding nested models were tested in the schizophrenia sample. The results are displayed in Table 2 (Appendix C). The full model for both Models A and B is a saturated model, which results in the χ^2 statistic and corresponding degrees of freedom to be equal to zero. In addition, Model A and Model B are chi-square equivalent; thus, the fit statistics, parameter coefficients, and corresponding p -values are equivalent for the two models, with two exceptions. First, the parameter estimate for the path between neurocognition and social cognition differ, as it is specified as a correlation in Model A, but a regression path in Model B. Second, an indirect effect is estimated in Model B for the indirect (i.e., mediational) impact of neurocognition on functional outcome via social cognition. Thus, the main results for these two models will be discussed together.

The coefficient for the relationship between social cognition and functional outcome is positive, and can be interpreted as a regression coefficient (i.e., for every one unit increase in social cognition, there is a .275 unit increase in functional outcome). However, it should be noted this coefficient is not significant in the full model. A significant, but negative direct relationship between neurocognition and functional outcome was found in both Model A and B ($\beta = -.318, p = .024$). In contrast, the indirect effect of neurocognition on functional outcome

was positive ($\beta=.133, p=.028$), and this caused the total effect of neurocognition on functional outcome to be lower than its direct effect in Model B ($\beta=-.185, p=.069$). Finally, the estimates of the relationship between neurocognition and social cognition were significant and positive for both Model A and Model B ($\beta=4.56$ and $.486$, respectively).

Examination of the nested models revealed that removing the relationship between neurocognition and social cognition (path a, $p<.001$) or the relationship between neurocognition and functional outcome (path b, $p=.028$) resulted in significantly poorer fit statistics for the model. Removing the path between social cognition and functional outcome did not result in significantly poorer fit (path c, $p=.152$), but it did reduce the strength of the relationship between neurocognition and functional outcome ($\beta=-.185, p=.090$) and the amount of variance in functional outcome accounted for by the model (10.4% versus 6.1%; Table 3, Appendix C). These results suggest that the full Models A and B appear to explain the data better than the nested models (i.e., removing any of the proposed relationships in these models results in poorer fit).

In sum, the findings described above indicate a significant and negative relationship between neurocognition and functional outcome, a weak, positive relationship between social cognition and functional outcome, and a possible mediational effect of neurocognition on functional outcome via social cognition.

Test of Model A and B with Latent Variables. Within the schizophrenia sample, it was possible to maintain latent variables for the constructs of neurocognition and social cognition. Because of the aforementioned problems with measurement error with the social cognition instruments in particular, Models A and B were examined with latent variables specified for neurocognition and social cognition for the purpose of comparison with the path

analysis. Again, these models are χ^2 equivalent, thus the fit statistics, regression coefficients, and corresponding p -values are the same for both models, with the exception of the relationship between neurocognition and social cognition, and estimates of the indirect and total effects within Model B.

The same general pattern of findings emerges with this approach (Table 4, Appendix C). Social cognition, consistent with the path models, has a positive, but nonsignificant relationship with functional outcome. The direct relationship between neurocognition and functional outcome is negative, but nonsignificant within these models. Consistent with the path models, the indirect effect of neurocognition on functional outcome is positive ($\beta=1.96$, $p=.277$), and the total effect of neurocognition on functional outcome is thereby reduced ($\beta=-.590$, $p=.136$). Estimates of the relationship between neurocognition and social cognition are positive and significant within both models, but the amount of variance in social cognition explained by neurocognition appears to be greater with the latent variables compared to the composite variables (42.7% versus 81.0%; Table 3, Appendix C). Thus, the same general pattern of findings is observed in the latent models as the path models: 1) there is a negative relationship between neurocognition and functional outcome; 2) there is a positive relationship between social cognition and functional outcome; and, 3) the indirect effect of neurocognition on functional outcome via social cognition is positive. However, in the latent models, the coefficients for the direct and indirect effects for neurocognition are not significant.

HFA Sample. As the nested models were not suggestive of better fit than the full models, the schizophrenia and HFA groups were compared on the full Models A and B only (Table 2, Appendix C). Examination of the coefficients revealed somewhat different estimates than in

the schizophrenia sample. The relationship between social cognition and functional outcome was nonsignificant and negative ($\beta=-.199, p=.355$), whereas the direct relationship between neurocognition and functional outcome was nonsignificant and positive ($\beta=.171, p=.397$). The indirect relationship in Model B between neurocognition and functional outcome was quite small and negative in the HFA sample ($\beta=-.083, p=.113$). In addition, the amount of variance in functional outcome accounted for by the models in the HFA sample appears smaller than that accounted for in the schizophrenia sample (Table 3). Conversely, the relationship between neurocognition and social cognition was significant and positive in both Models A and B, which was consistent with the models in the schizophrenia sample. Despite apparent differences, tests of structural invariance in both models revealed the two samples to have equivalent structural relationships in Model A ($p=.120$) and Model B ($p=.209$). The two groups also did not differ on the means of the composites ($p=.213$).

The two approaches used to compare schizophrenia and HFA on these models yield inconsistent results. First, inspection of the parameter coefficients across the two samples leads to the following conclusions: 1) the relationship between neurocognition and functional outcome is positive and nonsignificant in HFA in contrast to a negative and significant relationship in the schizophrenia sample; 2) the relationship between social cognition and functional outcome is negative and nonsignificant, whereas this relationship is positive and nonsignificant in the schizophrenia sample; 3) the indirect (i.e., mediational) effect of neurocognition on functional outcome via social cognition is small and negative in HFA, in contrast to a significant and positive mediational effect in schizophrenia; and, 4) substantially less variance in functional outcome is accounted for in HFA versus schizophrenia. The second approach for comparing schizophrenia and HFA involved statistically comparing the

structural relationships (i.e., paths) across groups. This approach indicates the schizophrenia and HFA samples do *not* differ in any of the relationships among constructs.

Supplemental Analyses

Given the unexpected negative relationship between neurocognition and functional outcome, as well as the finding that little variance was explained in functional outcome by either neuro- or social cognition, some additional analyses were performed. Specifically, correlations among the composite variables, as well as the constituent measures which comprise these constructs, were examined in both samples.

Correlations among the composites revealed a similar pattern of findings as that observed within the path models. Specifically, positive and strong relationships were observed between neurocognition and social cognition composites in both samples (see Table 5, Appendix C). This relationship appears to be weaker in the HFA sample, which is supported by fewer significant associations between specific measures of neurocognition and social cognition within HFA (Table 6, Appendix C).

A weak non-significant negative relationship was found between neurocognition and functional outcome in the schizophrenia sample, whereas no association was observed between these constructs in the HFA sample (Table 5). A weak, non-significant negative relationship between social cognition and functional outcome was found in the HFA sample, compared to no association in the schizophrenia sample. These findings are supported by the individual relationships between specific measures of neuro- and social cognition with the three subscales comprising functional outcome (Table 7, Appendix C). Again, these correlational relationships, particularly among the composites, replicate the relationships suggested by the regression coefficients observed in the path models.

CHAPTER V

DISCUSSION

The primary aim of this dissertation was to explore two models that described the relationships among neurocognition, social cognition, and functional outcome in schizophrenia and HFA. Consistent with expectations, a strong positive relationship was found between neurocognition and social cognition in both models and both samples. However, contrary to hypotheses, little variance in functional outcome was accounted for by the models in either sample. Modest support was found for a mediational relationship between neurocognition and functional outcome via social cognition within the schizophrenia sample, although contrary to expectations, the direct relationship between neurocognition and functional outcome was negative. There was little support for significant relationships between neurocognition or social cognition with functional outcome in the HFA sample. These findings, and my interpretation of them, are discussed below.

Consistent with previous work in schizophrenia, a strong relationship between neurocognition and social cognition was found in both the schizophrenia and HFA samples. Within schizophrenia, neurocognition accounted for 42.7% of the variance in social cognition in the path model and 80% of the variance in the SEM model, which is suggestive of a large (but not complete) amount of overlap between these constructs. This finding is consistent with previous studies, particularly those that examined the relationship between composites or latent variables (Brekke et al., 2005; Sergi et al., in press; Vauth et al., 2004). It also lends support, to some extent, for evidence that deficits in social cognition in

schizophrenia are partially accounted for by a generalized performance deficit (discussed in Penn et al., 1997).

Although neurocognition accounted for a large proportion of the variance in social cognition in the HFA sample as well (20%), this relationship is considerably smaller than that observed in the schizophrenia sample. As there have been no studies, to my knowledge, examining the association between neurocognition and social cognition in HFA, it is difficult to compare these findings to previous research in this area. However, these findings suggest that neurocognition and social cognition are relatively independent in autism, or at least among individuals with HFA, underscoring the notion that social cognitive deficits are a core feature of autism.

Contrary to hypotheses, relatively little variance was accounted for in functional outcome by the models in the group with schizophrenia. In other studies using similar methodologies and analytic procedures, approximately 18-25% of the variance in functional outcome was explained by neurocognition and social cognition (Brekke et al., 2005; Sergi et al., in press, Vauth et al., 2004), which is about twice the amount of variance accounted for in this study. There was evidence, however, that the indirect relationship of neurocognition on functional outcome via social cognition was positive, which is consistent with the hypothesis that social cognition is an important mediating factor (Brekke et al., 2005; Sergi et al., in press; Vauth et al., 2004).

Within HFA, neither social cognition nor neurocognition demonstrated a significant direct relationship with functional outcome, nor did social cognition serve as a mediator of the relationship between neurocognition and outcome. These findings were confirmed by the lack of significant correlational relationships between the composites or specific measures

among these constructs. Although this pattern differs from that observed in the schizophrenia sample, the group comparison analyses did not support different structural relationships between HFA and schizophrenia. However, this is likely a result of the limited statistical power in the current study, as the χ^2 statistic is particularly sensitive to sample size (Fan, Thompson, & Wang, 1999; Hu & Bentler, 1995).

One unexpected finding was the significant negative relationship between neurocognition and functional outcome in the schizophrenia sample. As there was no support for outliers underlying this negative relationship, alternate explanations were considered. It is possible that poor neurocognitive functioning limits one's ability to self-reflect and report on one's own behavior on the SFS, which is a self-report instrument. Thus, those with deficient neurocognitive abilities may over-report their actual behaviors, perhaps due to memory difficulties. Alternately, this negative relationship could be an artifact of the three subscales used in the analyses, as examination of the relationship between neurocognition and the other subscales revealed *no* relationship between these variables rather than a negative one. However, the three subscales included in the analyses do not appear markedly different from other functional outcome measures used in schizophrenia research, particularly those evaluating community involvement or self-care skills. It is also possible that an unobserved confounding variable was responsible for this unexpected relationship. As null or unpredicted findings are difficult to explain, there may be multiple reasons and interpretations for these results. Thus, the preceding points are necessarily speculative in nature.

Since the findings regarding the relationship between neurocognition and social cognition replicate previous research, but the lack of functional significance of these domains does not,

it is possible that the null findings may be due to problems with how functional outcome was assessed. In previous research using similar analytic techniques, Sergi et al. (in press) and Brekke et al. (2005) used the Role Functioning Scale (Goodman et al., 1993), an interviewer-rated assessment of social relationships, independent living skills, and work functioning, and Vauth et al. (2004) used the Work Personality Profile (Bolton & Roessler, 1986) which is comprised of ratings by job coaches of social skills and personal presentation at work. Thus, the most salient difference between these studies and the current dissertation is that they used interview-based assessments of functional outcome, while this study relied on self-report. Therefore, as noted above, self-report may be problematic, and should be supplemented with additional measures of functional outcome (Dickerson, 1997). Such multiple measures should not only include interview-based assessments, but also performance-based evaluations, such as role plays. In fact, performance based assessments might provide the most theoretically relevant link to neurocognition and social cognition in that they assess whether individuals are *capable* of performing certain behaviors in specific situations (McKibbin, Brekke, Sires, Jeste, & Patterson, 2004). Broader based domains of functional outcome (e.g., recreational functioning) are not always strongly related to performance based assessments (Cohen et al., 2006; Dickerson et al., 2000; Penn et al., 1995) and in addition, they may be influenced by factors outside the individual's control, such as level of social support, financial means, personal resources (e.g., having an automobile), etc. (Brekke et al., 2005).

It is also possible that exploring the relationships between neurocognition, social cognition and functional outcome can be explained by other factors. Specifically, the relationships between neurocognition, social cognition, and functional outcome may be reflective of a

shared underlying mechanism (e.g., brain or genetic abnormalities). A more powerful approach may be to directly examine brain-behavior relationships (i.e., relate social behavior directly to brain abnormalities), rather than assessing the relationship between behavior and “surface-level” deficits which are a byproduct of neural abnormalities (i.e., the relationship between functional outcome and neurocognition). Thus, future work might consider evaluating the relationship between neural activity and volume with functional outcomes, or to consider to the causal paths between pathophysiology, domains of cognition, and functional outcome.

Study Limitations

As discussed above, the primary limitation for this study was possibly the use of the SFS. This may be particularly the case for the participants with HFA, as the SFS has not been validated in this clinical group (although the reliability estimates for the SFS was generally very good for this group in the present study). However, it should be noted that the psychometric properties of the SFS have been well-established in schizophrenia (Birchwood et al., 1990; Dickerson et al., 1997), and that some researchers believe that more objective indicators such as frequency of behaviors (as measured in the SFS) may be especially appropriate for disorders like schizophrenia (Kee et al., 2003). It is also possible that the battery used to assess neurocognition and social cognition could have been bolstered by additional measures that have shown a strong association with functional outcomes, such as memory (Green, 1996; Green et al., 2000). Within the domain of social cognition, many of the measures used in the current study have not been validated in schizophrenia, and the measure most consistently associated with functional outcome, facial affect perception, was

not part of the battery. Thus, the inclusion of a facial affect perception task may have allowed for a better comparison with previous research in the area.

Finally, as noted earlier, the small sample size of both samples in this dissertation may have limited the ability to detect effects (Fan et al., 1999; Hu & Bentler, 1995). In addition, the small sample size precluded use of the proposed SEM analyses in favor of path analysis given problems encountered with negative variances.

Conclusions

This dissertation aimed to explore two models of the relationships among neurocognition, social cognition, and functional outcome in schizophrenia and HFA. This project sought to extend previous research by assessing both a direct effects and a mediational model, and by examining across two clinical samples. The findings support a strong relationship between neurocognition and social cognition in both samples, particularly for the schizophrenia group. The relationships between neurocognition and social cognition with functional outcome were inconsistent with previous studies, which may be explained in part by measurement issues associated with the SFS. Modest support was found for social cognition serving as a mediator between neurocognition and functional outcome in the schizophrenia sample, which is consistent with previous research in this area. Although the groups did not have significantly different structural relationships among these variables, the regression estimates and the correlational structure support the possibility of differing strength of relationships among these constructs in HFA versus schizophrenia.

APPENDIX A

CONSENT FORM FOR SCHIZOPHRENIA PARTICIPANTS

THE UNIVERSITY OF NORTH CAROLINA
AT
CHAPEL HILL

CONSENT TO PARTICIPATE IN A RESEARCH STUDY

February 24, 2005

*Social Cognition and Social Functioning in Autism
and Schizophrenia*
(Schizophrenia version)

Principal Investigator: David L. Penn, Ph.D.
UNC-CH Department of Psychology
Davie Hall, CB #3270
Chapel Hill, NC 27599-3270
dpenn@email.unc.edu
(919) 843-7514

Co-Investigators: Joe Piven, M.D., Kevin Pelphrey, Ph.D., Shannon M. Couture, M.A.,
and Diana Perkins, M.D.

You are being asked to participate in a research study. The person listed above is in charge of the study; other people may help him or act for him.

Your participation is voluntary. You may refuse to participate or decide to leave the study at any point and for any reason without affecting the treatment that you've been receiving prior to this study.

Details about this study are discussed below. It is important that you understand this information so that you can decide in an informed manner whether you want to participate. You are encouraged to ask Dr. Penn or any staff that may be assisting him, any questions that you have about the study at any time.

What is the purpose of this study?

The purpose of this study is to compare the cognitive (e.g., memory skills), social cognitive (e.g., ability to identify others' emotions), and social skills of persons with autism, schizophrenia, or no history of either disorder.

How many people will participate in this study?

This study is part of a broader project of 100 individuals. For this study, 40 individuals with schizophrenia and/or schizoaffective disorder and 30 individuals without schizophrenia and/or schizoaffective disorder will participate.

How long will your participation last?

You will be asked to complete a battery of tasks that will last approximately 3 - 4 hours. You can complete these tasks over one or two meetings.

What will happen if you take part in the study?

This is what will happen during the study:

1. You will be interviewed about your current and past symptoms, as well as current and past drug/alcohol use. All information pertaining to this interview will be strictly confidential. Also, we may review your charts or talk to your physician regarding the following information: Diagnosis, medications, and history of psychiatric hospitalizations. We will also ask you for information pertaining to: Age, ethnicity, years of education, and marital status.
2. You will complete a battery of tasks. These tasks involve three different areas: Cognitive skills, social-cognitive skills, and social functioning. Cognitive tasks assess memory, attention, and problem solving skills. Social-cognitive tasks assess the ability to perceive and make sense of one's own and others' behavior. For the social functioning assessment, you will be asked to complete a short questionnaire.
3. We are also interested in how you view some of the social scenes in this study. For these tests, you will sit in a chair and view various faces and other social objects on a computer screen. To test how you look at the objects, we will measure your eye movements by recording tiny reflections of light in your eyes as you look at different parts of the pictures. The procedure also involves videotaping your eye and part of your face to make sure we are tracking your eye properly. No one except for the study coordinators will ever see this videotape.
4. For your participation in this study, you will receive \$12.50/hour. If you decide to withdraw from the study before it is completed, your compensation will be pro-rated (at 15 minute intervals). This prorating of compensation will also apply if it is determined that you do not meet any of the study criteria (after signing the consent form).
5. Also, if available, we will gather information regarding your most recent diagnostic interview and symptom assessment from the following studies: Efficacy and Tolerability of Olanzapine, Quetiapine, and Risperidone in the Treatment of First Episode Psychosis: A Randomized Double Blind 52 Week Comparison (IRB# 02-PSYCH-7), Brain MRI/MRS Changes in First Episode of Schizophrenia (IRB# GCRC1890), and Adherence, Coping, and Education (ACE) Therapy: Cognitive Behavioral Therapy for First Episode Schizophrenia (IRB# 00-PSYCH-381). This information will only be available to Dr. Penn and members of his research staff.

Are there any reasons you should not participate?

You should not participate in this study if you are under 18 or older than 45 years of age, do not have a diagnosis of schizophrenia or schizoaffective disorder, and have shown

problematic drug or alcohol use in the past three months (e.g., using drugs and alcohol in excess, having difficulty stopping drug and alcohol use, using drugs and alcohol in risky situations such as driving a car, and needing greater amounts of the drug or alcohol to get the desired effect).

What are the possible risks or discomforts?

We are not aware of any risks that this study poses to you. During the measurement of your eye movements, you will be asked to put your chin in a chin rest. You may remove your chin from the chin rest in between tasks if you find this uncomfortable

What are the possible benefits of participating in the study?

From this study, we hope to learn about the similarities and differences in cognitive, social-cognitive, and social functioning between persons with autism and schizophrenia.

How will your privacy be protected?

No specific individuals will be identified in any report or publication about this study. All materials will be kept in locked cabinets, and will only be accessible to the investigators listed above and trained research assistants. Any identifying information (i.e., name) will be recorded on a separate list from your data. A master set of identification numbers will be kept in a separate location in a locked file cabinet away from any identifying information.

What if you have questions about the study?

If you have any questions or concerns, you may contact the principal investigator listed at the beginning of this consent form. If you have any questions about your rights as a participant in this research, you may also contact the UNC-Chapel Hill Academic Affairs Institutional Review Board at (919) 962-7761 or aa-irb@unc.edu.

PARTICIPANT’S AGREEMENT:

I have read the information provided above, the study has been explained to me, and my questions have been answered. I voluntarily agree to participate in this study. I understand that I may leave the study at any time without affecting any treatment I'm currently receiving. I have also been given a copy of this form for my records.

Date

Participant’s Signature

Date

Participant’s Printed Name

Date

Signature of Person Obtaining Consent

Date

Printed Name of Person Obtaining Consent

HIPAA AUTHORIZATION FORM FOR SCHIZOPHRENIA PARTICIPANTS

HIPAA Authorization for Use and Disclosure of Health Information for Research Purposes

University of North Carolina-Chapel Hill

IRB Study # PSYC 05-016

UNC-Chapel Hill Principal Investigator (Researcher): David Penn, Ph.D. Department of Psychology, Davie Hall, CB#3270, University of North Carolina-Chapel Hill, Chapel Hill, NC 27599-3270

Co-Investigators: Joe Piven, M.D., Kevin Pelphrey, Ph.D., Shannon Couture, M.A., and Diana Perkins, M.D.

Sponsor: Johnson and Johnson Corporation

This is a permission called a “HIPAA authorization.” It is required by “The Health Insurance Portability and Accountability Act of 1996” (known as “HIPAA”) for us to get information from your medical records or health insurance records to use in this research study.

1. If you sign this HIPAA authorization form you are giving your permission for the following people or groups to give the researchers certain health information about you:
*UNC Hospitals, Department of Psychiatry
Carramore
OPC Mental Health Center*

2. If you sign this HIPAA authorization form, this is the health information about you that the people or groups listed in #1 may give to the researchers to use in this research study:

Diagnosis, medications, current and past alcohol and drug use, age, ethnicity, gender, education, social functioning history, and history of psychiatric hospitalizations

3. The people or groups listed in #1 may give this health information to the researcher listed at the top of this form (UNC-Chapel Hill Principal Investigator) or to another researcher working on this research study.

4. The health information you allow the researchers to get may be seen or used by people who do not have to follow HIPAA rules. You can ask the researchers any questions you have about how they will protect your personal information in this research study.

5. If you do not sign this HIPAA authorization form you cannot be in this research study, but if you do not sign this HIPAA authorization form the people or groups listed in #1 will not change your right to treatment, payment, enrollment or eligibility for anything that is not part of this research study just because you did not sign this HIPAA authorization form.

6. This HIPAA authorization will stop at the conclusion of the study.
7. You have the right to stop this HIPAA authorization at any time. HIPAA rules are that you must stop this HIPAA authorization in writing. You may give your written stop of this HIPAA authorization directly to the people or groups listed in #1 or you may give it to the researcher and tell the researcher to send it to any person or group the researcher has given a copy of this HIPAA authorization. Stopping this HIPAA authorization will not stop information sharing that has already happened.
8. You will be given a copy of this signed HIPAA authorization.

Signature of Research Subject

Date

Print Name of Research Subject

For Personal Representative of the Research Participant (if applicable)

Print Name of Personal Representative: _____

Please explain your authority to act on behalf of this Research Subject:

I am giving this permission by signing this HIPAA Authorization on behalf of the Research Participant.

Signature of Personal Representative

Date

CONSENT FORM FOR HFA PARTICIPANTS

University of North Carolina-Chapel Hill
Consent to Participate in a Research Study
A1 Adult with Autism

Medical IRB Study: 02-PSYCH-284
Consent Form Version Date: April 5, 2005

Title of Study: Family Study: The Neuropsychological Basis of Autism

Principal Investigator: Joseph Piven, M.D.
UNC-CH Department: Psychiatry
Phone number: (919) 843-8641

Co-Investigators: Ralph Adolphs, Ph.D. (University of Iowa), Francesca Happé, Ph.D. (Institute of Psychiatry, King's College, University of London), David Penn, Ph.D. (University of North Carolina-Chapel Hill) and Marcia Van Riper, Ph.D., R.N. (University of North Carolina-Chapel Hill)

Sponsor: National Institutes of Health

You are being asked to take part in a research study. The investigators listed above are in charge of the study; other professional persons may help them or act for them.

What are some general things you should know about research studies?

Research studies are designed to gain scientific knowledge that may help other people in the future. You may or may not receive any direct benefit from participating. There may also be risks associated with participating in research studies.

Your participation is voluntary. You may refuse to participate, or you may withdraw your consent at any time, and for any reason, without jeopardizing your future care at this institution or your relationship with your doctor. If you are a patient with an illness, you do not have to participate in research in order to receive treatment.

Details about this particular study are discussed below. It is important that you understand this information so that you can decide in a free and informed manner whether you want to participate. You will be given a copy of this consent form. You are urged to ask the investigators named above, or staff members who may assist them, any questions you have about this study at any time.

What is the purpose of this study?

The broad autism phenotype (BAP) is defined by characteristics (or traits) that are much milder but qualitatively similar to the defining features of autism. By examining these mild characteristics we hope to discover behavioral, language and/or learning trends among family members of individuals with autism that might give us important information in discovering what might cause autism, including possible genetic causes.

In this project we propose to examine individuals with autism and some of their relatives as well as relatives of individuals with Down syndrome and individuals with no developmental disability in their family on selected neuropsychological (brain, learning and thinking) measures of social understanding, central coherence and executive function. These are three principal cognitive (learning) frameworks that have been suggested as ways to explain the neuropsychological basis of autism. These neuropsychological characteristics will be looked at in relationship to our clinically-based interview measures of the broad autism phenotype. We hope that in doing this we will learn more about the neuropsychological profile of relatives of people with autism. We also want to see how the neuropsychological profiles of people with autism look compared to individuals with no developmental disability in their family. We may then be able to use this information in future medical, educational and therapeutic research of autism. Individuals with autism and their relatives as well as relatives of individuals with Down syndrome and individuals with no developmental disability in their family will be compared in these three thinking and learning areas, to a unique sample of individuals with injuries to specific parts of the brain. We know how certain parts of the brain typically work and we know certain tests that tap into the skills stored in those brain areas. Because of this, we hope that comparing test results from people who have known damage to these areas (for example, someone who had a part of their brain damaged from an accident) to test results from people in different groups might give us a better idea of how that area of the brain is working in individuals with autism and their family members. Additionally, we will look for patterns of these characteristics in individuals and families.

This research has potential importance in several areas. If we are able to see certain trends in multiple families in behavior, learning and language we may be able to use the information to help look for genes that may contribute to causing autism. Additionally, by looking at the results from tests that examine how certain areas of the brain work we might be able to learn more about what areas of the brain in individuals who have autism are working as would be expected and the areas that are not working typically. Finally, by getting specific information about the most subtle ways that autism appears, we may be able to expand our understanding of autism spectrum disorders. This expanded knowledge may ultimately lead to better detection, educational and treatment methods.

We are inviting you to participate in this research project because you have a diagnosis of autism.

How many subjects will participate in this study?

A total of approximately 85 individuals with autism and 180 relatives of individuals with autism (i.e. fathers, mothers and siblings) as well as 60 relatives of people with Down

syndrome (i.e. fathers, mothers, and siblings) and 55 people without a developmental disability will participate in this study.

What will happen if you take part in the study? How long will your participation last?

Because this study involves your parents they will need to agree to participate too. Before you participate in this study you should ask your parents if they would be willing to learn more about the study. We would be happy to talk with them about the study and what their participation would entail. They will be doing many of the same activities and tests as you will be doing. We would also ask that they give us some information about you as a young person. They will have to sign their own consents and may drop out of the study at any time. Your specific test results will not be shared with them and their results will not be shared with you.

If your parents do not want to be in this study then we will not include you in this study. With your permission, we will keep your name on file as a possible participant for other studies. You do not have to be in any other studies.

If you and your parents decide to take part in this study, the following will occur:

First, we will need to interview you to get some basic information about you and your family (approximately 30 minutes). We will ask to get some of your medical and educational records. These records will be used to provide information about your diagnosis, cognitive function and general medical history, including specific genetic testing that you may have had done in the past. The forms allowing us to access those records will take about 30 minutes to complete. We will have your parents complete a questionnaire about you describing you as a child and what you are like now. It takes about 30 minutes to complete.

After this is complete, we will then schedule a time with your parents to do a detailed interview about your development and behavior. The interview takes about 2 hours to complete. This is the first step that will help us determine where you are in the wide range of autism spectrum disorders. It is called the screening testing. We are looking for a sample of this broad range, so that the individuals in our study are very similar to each other. We may determine at this point that you do not fit in that group. In that case, you will be finished with participating in the study and you will not complete any more testing.

For our next task with you, if you fit in the group we are looking for, we will then make an appointment with you to begin testing at a time convenient to you. We will begin with a “warm up” period in which you get to know the person doing the testing. Then, we will begin the cognitive testing and structured interview. The testing will involve looking at pictures, books, and videos. We will also ask you to solve some problems involving blocks, pictures, and lines. Additionally we will test for your understanding of certain words and concepts. We will talk with you about a variety of subjects (interests, friends, school/job and so on). Some individuals may complete the testing at this point and will be done with the study. This will complete the screening testing.

Next we will schedule an appointment to complete the cognitive testing. This session will also begin with a “warm up” period in which you get to know the person doing the testing. The testing will involve solving some problems with blocks, pictures, lines, faces and rings. You will do some of the testing looking at a computer screen at faces, videos and other pictures. We will ask you to complete some sentences and name some words. While you are looking at the computer screen, we will be recording your eye movements on video. To do this, you will wear a device like a baseball cap that will illuminate your eye. The device may seem unusual to you but poses no known risk and has been used with infants. We will also ask you some questions about your style of relating to other people. Finally, we will conduct a brief physical examination. We will look at your hands, skins, arms, legs and face. This examination should not hurt. All parts of the assessment can be done in two or three days for a total of six hours. We can split up the testing so you can do your best job on each activity. The cognitive tests and structured play/interview will examine learning styles, intelligence, and social understanding. Breaks will be taken throughout testing procedures. Additionally, the person doing the testing will be specially trained in conducting these tests with people with autism. Testing sessions will be videotaped. Videotaped material will allow us to assess how participants complete certain tasks. For example, we will watch how a person’s eyes move while looking at pictures. Additionally, the tapes will be reviewed by the study director to be sure that the same procedures are being used with each participant.

All testing and interviews can be completed at your home or in our offices on the University of North Carolina at Chapel Hill campus.

Are there any reasons you should not participate?

You should not participate in this study if any of the following apply: you have a known medical condition associated with autism (i.e., Fragile X syndrome or tuberous sclerosis) or known central nervous system injury (e.g., cerebral palsy).

What are the possible risks or discomforts?

People sometimes feel tired or uncomfortable during testing. Any person that feels fatigued, tired, uncomfortable, or in any way upset during any of the sessions, may ask to stop for a rest break or have testing discontinued. The eye-scanning device may feel unusual or different to wear and time will be given for you to get used to it or ask questions about it.

The interview being given is not, and does not take the place of, a full psychiatric evaluation. If any particular question makes you uncomfortable, you may discuss its importance with the researcher. You may choose not to answer any question with which you still feel uncomfortable.

If you tell your family doctor that your family has participated in this study, or if you tell your doctor about any specific aspects relating to your participation, this information may then become part of your medical record with this doctor. Insurance companies routinely have access to such records. An insurance company might consider participation in a family study an indication of higher risk because it implies that there is a family history of a genetic

condition. This might then hurt your family's access to health or other insurance. This is a risk for the entire family, nuclear and extended, and not just a risk for the individual with autism. We will not release information about you or your family to your doctor unless you authorize us to do so.

In addition, there may be uncommon or previously unrecognized risks that might occur.

What are the possible benefits of participating?

You will not receive any direct benefit from this project, but individuals who might develop autism their family members, and future generations may benefit from knowledge gained as part of this study. We do not want any potential volunteer to think that this research project offers any form of treatment. We hope that our research will make a significant contribution to the rapidly increasing literature on autism. This knowledge provides a framework for more effective educational programs, medical treatment and forms a basis for a more complete understanding of the assets, as well as difficulties, found in people with developmental disorders. The people who take part in research make an invaluable contribution to furthering our understanding of these conditions.

We do not expect to discover any information of direct clinical relevance to the condition or treatment during the next few years. If later on, diagnostic tests or new ways to treat the condition are discovered, this information should be obtained from properly licensed clinical labs or clinics, and will not come from the research team.

Subjects and their families will receive results of the study through a family newsletter, and individual feedback will be given upon request.

What if we learn about new risks?

Any new information that may make you change your mind about being in this study will be given to you, as it becomes available.

How will your private information be protected?

Records of all participation in this research project will be maintained and kept confidential and will not be released without your prior written authorization.

Any information we get from this study about you including your identity will be kept confidential. We will take the following steps to ensure confidentiality. A research number will be assigned to you and your name will not be used. A linkage file joining the code with a name will be maintained in a secure location, accessible only to researchers working on this study. The results from the interviews and testing will not be released or shared in any way with your relatives, with insurance companies, or any third party not involved in research unless you request that we do so in writing. Remember, however, that if you tell your physician that you are participating in a family study of autism, that fact might make it into

the medical record and, hence, to insurance companies. When results of this study are published, your name will not be used.

Video and audio materials will be generated during the course of this study. These records will be used for “blind” rating information by other members of the research team. Blind rating means that the person watching or listening to the tape does not know anything about your family. We will also use the tapes to learn about the way your eyes move when looking at pictures. The tapes will be stored at the University of North Carolina in the same manner as all other data, in locked research files by an assigned identification number. The tapes will be maintained as a permanent part of your study file and will not be destroyed unless you request.

The information you provide us for this research study will be sent to one of the National Institute of Health’s funded data collection centers, along with all the data gathered in this research project. The information will continue to be kept confidential and protected and will not be shared with anyone not involved in research. Other researchers may have access to this data, but none of the information will include your name or identifying information. The UNC STAART (Studies To Advance Autism Research and Treatment) Center, of which our research group is part, will be the only place where your name and identifying information will be kept.

You may be contacted during the study and in the future about other research projects. Dr. Piven may not be the Principal Investigator of those studies but may agree to distribute information for another investigator. Your name will not be disclosed to any other investigator unless you request after learning about the study. You are not obligated to participate in other studies conducted by Dr. Piven or any other investigator.

Will it cost you anything if you participate?

You will not be charged for any tests that are being performed for the purposes of this study. There will be no costs to you, especially if we come to your home, if you decide to participate.

If during the course of testing we determine that you have a condition for which we recommend treatment or follow-up a referral will be made. You or your insurance company will be responsible for paying for testing/services received outside of this research project.

Will you be paid for participating?

You will receive \$30 for completing the screening testing, and your parent will receive \$30 for completing the interview that is part of the screening.

You will be paid \$50 for completion of the study. If you withdraw before your part in the study is complete or are withdrawn by the Principal Investigator you will be paid based on the amount of direct testing that was completed.

Who is sponsoring this study?

This research is funded by the National Institutes of Health. This means that the research team is being compensated by the sponsor for conducting this study. The researchers do not, however, hold a direct financial interest in the sponsor.

What if you want to stop before your participation in the study is complete?

You can withdraw from this study at any time, without penalty. The investigators also have the right to stop your participation at any time. Withdrawal may include the destruction of all tapes and records if you wish.

All participation is voluntary. There is no penalty to anyone who decides not to participate. Nor will anyone be penalized if he or she decides to stop participation at any time during the research project.

What if you have questions about this study?

You have the right to ask, and have answered, any questions you may have about this research. If you have further questions you should call Joseph Piven, M.D. at (919) 843-8641 or (800) 793-5715.

What if you have questions about your rights as a subject?

This research has been reviewed and approved by the Committee on the Protection of the Rights of Human Subjects (Medical IRB) at the University of North Carolina at Chapel Hill. If your family has any questions or concerns regarding your rights as a research subject, please contact the Chairman of the Committee at (919) 966-1344.

Subject's Agreement:

I have read the information provided above. I voluntarily agree to participate in this study.

Signature of Research Subject

Date

HIPAA AUTHORIZATION FORM FOR HFA PARTICIPANTS

ADDENDUM TO CONSENT FORM FOR PARTICIPATING IN A RESEARCH STUDY (HIPAA Authorization for use of Protected Health Information)

University of North Carolina at Chapel Hill

IRB Study Number: 02-PSYCH-284

Version Date of This Form: April 5, 2005

Title of Study: Family Study: The Neuropsychological Basis of Autism

Principal Investigator: Joseph Piven, M.D.

UNC-CH Department: Psychiatry

Mailing Address: Campus Box 3366 University of North Carolina at Chapel Hill, Chapel Hill NC 27599-3366

Co-Investigators: Ralph Adolphs, PhD (University of Iowa), Francesca Happé PhD (Institute of Psychiatry, King's College, University of London), David Penn, Ph.D. (University of North Carolina-Chapel Hill) and Marcia Van Riper, Ph.D., R.N. (University of North Carolina-Chapel Hill)

Sponsor: National Institute of Health

What is the purpose of this form?

You have been asked to take part in a research study. The consent form for this study describes your participation, and that information still applies. This extra form is required by the federal "Health Insurance Portability and Accountability Act" (HIPAA). The purpose is to get your permission (authorization) to use health information about you that is created by or used in connection with the research. If you are signing on behalf of someone other than yourself, this permission applies to that person's health records.

What if I don't want my personal health information to be used in this research study?

You may refuse to give this permission. A decision not to sign this form will not change your ability to get health care outside of this research study. However, you may not be able to participate in this research study unless you sign this permission form. You should discuss this, and any other questions, with the investigators.

Who will be allowed to use my personal health information for this research? And why?

The investigators named above and their assistants will be allowed to see and to use your health information for this research study. We may use it to check on your progress during the study, or analyze it along with information from all other subjects. Sometimes research information is shared with collaborators at other institutions, or with labs running additional tests. Your records may also be reviewed by other employees of the University of North

Carolina at Chapel Hill, representatives of the research sponsor or funding agency, or by the U.S. Food and Drug Administration (FDA), in order to check for quality and safety.

What personal health information am I allowing to be used for this research study?

The information we might use includes: Information contained in your medical records that relates to diagnoses made, results of lab tests or psychological tests, interviews and office or hospital visits as well as x-ray and other imaging reports.

Where will investigators go to find my personal health information?

We may ask to see your personal information in records at hospitals, clinics or doctor's offices where you have received care in the past, including but not limited to facilities in the UNC Health Care System. Based on what we know at this time, the places we will seek access to your records include:

What are the privacy protections for my health information used in this research study?

The federal privacy regulations (HIPAA) apply to personal health information in the records of health care providers and other groups that share such information. There are some differences in how these regulations apply to research, as opposed to regular health care. One difference is that you may not be able to look at your own records that relate to this research study, at least until the study is over. The HIPAA privacy protections may no longer apply, once your personal health information has been shared with others who may be involved in this research.

How long does this permission allow my personal health information to be used?

If you decide to be in this research study, your permission to access and use your health information in this study will not expire, unless you revoke or cancel it. Otherwise, we will use your information as long as it is needed for the study.

What if I change my mind after I give this permission?

You have the right to cancel this permission to use your personal health information for research. In this case, we will not get any more of your health information for use in this research. However, canceling this authorization will not reverse uses of your personal health information that have already happened, or uses that have already been promised and cannot reasonably be reversed. If you want to cancel this permission, you must put this in writing and deliver to the Principal Investigator at the mailing address listed at the top of this form. You should clearly state that you want to cancel this permission to use your personal health information in this particular research study (attaching a copy of this form would be very helpful).

SUBJECT'S AUTHORIZATION

I have read the information provided above. By signing this form, I am giving permission for my personal health information to be used in research as described above. I will be given a copy of this authorization form after I have signed it.

_____ Printed Name of Research Subject (or Authorized Representative*)	_____ Signature	_____ Date
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_____ Printed Name of Person Obtaining Authorization	_____ Signature	_____ Date
--	--------------------	---------------

*Only if consent/authorization by someone other than immediate subject was approved by IRB. If used, also include description of Representative's relationship to subject, and their authority to act on subject's behalf (parent, legal guardian, etc). IRB Version 3-7-03

APPENDIX B

SOCIAL FUNCTIONING SCALE

This questionnaire asks you about various social activities that you may have engaged in over the past **one month**. Please circle the appropriate response. Please choose only one response for each question.

1. What time do you get up on the average weekday?
 - Before 9am
 - 9 – 11am
 - 11am – 1pm
 - After 1pm

2. How many hours of the day do you spend alone (e.g. alone in a room, walking out alone, listening to the radio or watching TV alone, etc.)?
 - 0-3 hours (very little time spent alone)
 - 3-6 hours (some of the time)
 - 6-9 hours (quite a lot of the time)
 - 9-12 hours (A great deal of the time)
 - 12 or greater hours (Practically all of the time)

3. How often will you start a conversation at home?
 - Almost never
 - Rarely
 - Sometimes
 - Often

4. How often do you leave the house (for any reason)?
 - Almost never
 - Rarely
 - Sometimes
 - Often

5. How do you react to the presence of strangers (Please choose only one response)?
 - Avoid them
 - Feel nervous
 - Accept them
 - Like them

- 6) How many friends do you have at the moment? (people who you see regularly, do activities with, etc.)
 - No friends
 - One friend
 - Two friends

- Three or more friends
- 7) Do you have a boy / girlfriend or are you married?
- Yes
 - No
- 8). How often are you able to carry out a sensible or rational conversation?
- Almost never
 - Rarely
 - Sometimes
 - Often
- 9) How easy or difficult do you find it talking to people at the moment?
- Very easy
 - Quite easy
 - Average
 - Quite difficult
 - Very difficult

Please use the scale below to answer the following questions. Place the number of the response in the blank space provided to indicate how often you have done the following things in the **past month**.

- | Never | Rarely | Sometimes | Often |
|--|---------------|------------------|--------------|
| 0 | 1 | 2 | 3 |
| 10. Bought items from stores (without help). | | | _____ |
| 11. Washing pots, tidying up, etc. | | | _____ |
| 12. Taking regular showers and baths. | | | _____ |
| 13. Washing own clothes. | | | _____ |
| 14. Looking for a job (if unemployed; if employed enter 3 in blank). | | | _____ |
| 15. Doing food shopping. | | | _____ |
| 16. Preparing and cooking a meal. | | | _____ |
| 17. Leaving the house alone. | | | _____ |

Please use the scale below to answer the following questions. Place the number of the response in the blank space provided to indicate how often you have done the following things in the **past month**.

- | Never
0 | Rarely
1 | Sometimes
2 | Often
3 | |
|---|---------------------------|------------------------------|--------------------------|-------|
| 18. Using buses, trains, cars, etc. | | | | _____ |
| 19. Using money. | | | | _____ |
| 20. Budgeting. | | | | _____ |
| 21. Choosing and buying clothes for self. | | | | _____ |
| 22. Taking care of personal appearance. | | | | _____ |
| 23. Playing musical instruments. | | | | _____ |
| 24. Sewing, knitting. | | | | _____ |
| 25. Gardening, growing plants. | | | | _____ |
| 26. Reading books or magazines. | | | | _____ |
| 27. Watching television. | | | | _____ |
| 28. Listening to CDs, tapes, or the radio. | | | | _____ |
| 29. Cooking. | | | | _____ |
| 30. Home “handyman” projects. | | | | _____ |
| 31. Fixing things (car, bike, household materials, etc.). | | | | _____ |
| 32. Walking, hiking, running. | | | | _____ |
| 33. Driving or cycling (biking) for recreation. | | | | _____ |
| 34. Swimming. | | | | _____ |
| 35. Hobby (e.g., collecting things) | | | | _____ |
| 36. Shopping for recreation. | | | | _____ |

Please use the scale below to answer the following questions. Place the number of the response in the blank space provided to indicate how often you have done the following things in the past month.

Never	Rarely	Sometimes	Often
--------------	---------------	------------------	--------------

0

1

2

3

- 37. Artistic activities (painting, crafts, etc.). _____
- 38. Going to the movies. _____
- 39. Going to the theater or to a concert. _____
- 40. Watching an indoor sport (basketball, ice hockey). _____
- 41. Watching an outdoor sport (football, soccer). _____
- 42. Visiting an art gallery or museum. _____
- 43. Visiting an exhibition or fair. _____
- 44. Visiting places of interest/tourist attractions. _____
- 45. Going to meetings, talks, lectures, etc. _____
- 46. Attending an evening class. _____
- 47. Visiting relatives in their homes. _____
- 48. Being visited by relatives. _____
- 48. Visiting friends (including boy / girlfriend). _____
- 50. Playing a musical instrument. _____
- 51. Going to a party. _____
- 52. Attending formal occasions. _____
- 53. Going to a dance club. _____
- 54. Going to a bar. _____
- 55. Playing an indoor sport (e.g., basketball, ice hockey). _____
- 56. Playing an outdoor sport (e.g., football, baseball). _____

Please use the scale below to answer the following questions. Place the number of the response in the blank space provided to indicate how often you have done the following things in the past month.

Never	Rarely	Sometimes	Often
0	1	2	3

- 57. Gone to a club/society meeting (e.g., gardening club). _____
- 58. Eating out in a restaurant. _____
- 59. Going to a coffee shop. _____
- 60. Going to a church or temple activity. _____

When answering the following questions, consider how able you are at doing the following activities. In other words, can you do the activity by yourself or do you need help? Use the scale below to answer the following questions. “Adequately” means you can do the activity without help; “Need help” means you can do the activity with help from other people; “Unable” means you cannot do the activity, even if you have help from others; “Not known” means you have never done the activity or do not know if you can.

Not known	Unable	Need help	Adequately
0	1	2	3

- 61. Use public transportation (bus, train) _____
- 62. Handling money. _____
- 63. Budgeting. _____
- 64. Cooking for self. _____
- 65. Weekly food shopping. _____
- 66. Looking for a job (put 3 in the blank if you are employed). _____
- 67. Washing own clothes. _____
- 68. Personal hygiene. _____
- 69. Cleaning, tidying, etc. _____

When answering the following questions, consider how able you are at doing the following activities. In other words, can you do the activity by yourself or do you need help? Use the scale below to answer the following questions. “Adequately” means you can do the activity without help; “Need help” means you can do the activity with help from other people; “Unable” means you cannot do the activity, even if you have help from others; “Not known” means you have never done the activity or do not know if you can.

- | | | | |
|------------------|---------------|------------------|-------------------|
| Not known | Unable | Need help | Adequately |
| 0 | 1 | 2 | 3 |
70. Buying things from stores. _____
71. Leaving the house alone. _____
72. Choosing and buying clothes. _____
73. Caring for personal appearance. _____
74. Please circle the option that best describes your current employment:
- Full time student
 - Part time student
 - Employed full time (40 hours per week)
 - Employed part time (10-35 hours per week)
 - Employed in industrial therapy, rehabilitation, or retraining courses.
 - Stay at home mom or dad.
 - Unemployed
75. If unemployed or not in school, have you had a job or been enrolled in school within the last six months?
- Yes
 - No
76. If unemployed, how often do you make attempts to find a new job?
- Almost never
 - Rarely
 - Sometimes
 - Often
77. If you have not been employed for six months or more, do you think you are capable of some sort of employment?
- Definitely Yes
 - Would have difficulty
 - Definitely No

APPENDIX C
TABLES AND FIGURES

Table 1. Demographic Characteristics

<i>Mean (SD)</i>	Schizophrenia	HFA
Age*	27.5 (6.3)	21.0 (5.9)
Years of Education	13.1 (2.5)	12.4 (2.0)
IQ	98.0 (16.6)	102.9 (17.7)
<i>% (Count)</i>		
Gender (male)	88.9% (40)	81.8% (27)
Ethnicity*		
Caucasian	71.1% (32)	96.7% (29)
African-American	26.7% (12)	3.3% (1)
Other	2.2% (1)	0% (0)

Note. HFA=High-Functioning Autism; * $p < .05$.

Table 2. Path Analysis Results for Model A and B for Schizophrenia and HFA Samples

Model Fit							
<i>Schizophrenia</i>	χ^2	<i>df</i>	<i>p</i>	CFI	RMSEA		
Full Model A	0	0	N/A	1.00	<.001		
a=0, no covariation	24.5	1	<.001	.108	.731		
b=0, no NC→FO	4.84	1	.028	.854	.295		
c=0, no SC→FO	2.06	1	.152	.960	.155		
Full Model B	0	0	N/A	1.00	<.001		
a=0, no mediation	24.5	1	<.001	.108	.731		
b=0, no NC→FO	4.84	1	.028	.854	.295		
c=0, no SC→FO	2.06	1	.152	.960	.155		
<i>HFA</i>							
Full Model A	0	0	N/A	1.00	<.001		
Full Model B	0	0	N/A	1.00	<.001		
Parameter Estimates							
<i>Schizophrenia</i>	SC↔NC	<i>p</i>	SC→FO	<i>p</i>	NC→FO	<i>p</i>	
Full Model A	4.56	<.001	.275	.147	-.318	.024	
a=0, no covariation	N/A		.275	.055	-.318	.003	
b=0, no NC→FO	4.56	<.001	-.005	.972	N/A		
c=0, no SC→FO	4.56	<.001	N/A		-.185	.090	
<i>HFA</i>							
Full Model A	2.46	.019	-.199	.367	.171	.405	
<i>Schizophrenia</i>	NC→SC	<i>p</i>	SC→FO	<i>p</i>	NC→FO	<i>p</i>	Ind NC→FO
Full Model B	.486	<.001	.275	.147	-.318	.024	.133
a=0, no mediation	N/A		.275	.055	-.318	.003	N/A
b=0, no NC→FO	.486	<.001	-.005	.972	N/A		-.003
c=0, no SC→FO	.486	<.001	N/A		-.185	.090	N/A
<i>HFA</i>							
Full Model B	2.46	.019	-.199	.367	.171	.405	-.083

Note. CFI=Comparative Fit Index, RMSEA=Root Mean Squared Error of Approximation, SC=Social Cognition, NC=Neurocognition, FO=Functional Outcome, Ind=Indirect Effect, HFA=High-Functioning Autism.

Table 3. Magnitude of Variance Accounted for by Models.

	<i>Model A</i>	<i>Model B</i>	<i>Model B</i>
Schizophrenia-Path model	Variance in FO	Variance in FO	Variance in SC
Full model	10.4%	10.4%	42.7%
No NC/SC relationship	22.3%	22.3%	N/A
No NC→FO path	0%	0%	42.7%
No SC→FO path	6.1%	6.1%	42.7%
Schizophrenia-LV model			
Full model	17.8%	17.8%	81.0%
No NC/SC relationship	22.5%	22.5%	N/A
No NC→FO path	2.2%	2.2%	81.8%
No SC→FO path	3.6%	3.6%	77.8%
HFA-path model			
Full model	3.3%	3.3%	20.0%

Note. NC=Neurocognition, SC=Social Cognition, FO=Functional Outcome, LV=Latent Variable.

Table 4. Latent Variable Results for Model A and B for Schizophrenia Sample

Model Fit							
	χ^2	<i>df</i>	<i>p</i>	CFI	RMSEA		
Full Model A	15.6	18	.623	1.00	<.001		
a=0, no covariation	43.2	19	.001	.729	.170		
b=0, no NC→FO	17.5	19	.557	1.00	<.001		
c=0, no SC→FO	16.8	19	.601	1.00	<.001		
Full Model B	15.6	18	.623	1.00	<.001		
a=0, no mediation	43.2	19	.001	.729	.170		
b=0, no NC→FO	17.5	19	.557	1.00	<.001		
c=0, no SC→FO	16.8	19	.601	1.00	<.001		
Parameter Estimates							
	SC↔ NC	<i>p</i>	SC→FO	<i>p</i>	NC→FO	<i>p</i>	
Full Model A	.580	<.001	2.51	.427	-2.55	.331	
a=0, no covariation	N/A		1.04	.126	-1.07	.014	
b=0, no NC→FO	.599	<.001	-.452	.369	N/A		
c=0, no SC→FO	.593	<.001	N/A		-.494	.231	
	NC→ SC	<i>p</i>	SC→FO	<i>p</i>	NC→FO	<i>p</i>	Ind NC→FO
Full Model B	.780	<.001	2.51	.427	-2.55	.331	1.96
a=0, no mediation	.780	<.001	2.51	.427	-2.55	.331	1.96
b=0, no NC→FO	N/A		1.04	.126	-1.07	.014	N/A
c=0, no SC→FO	.780	<.001	-.452	.369	N/A		-.352

Note. CFI=Comparative Fit Index, RMSEA=Root Mean Squared Error of Approximation, SC=Social Cognition, NC=Neurocognition, FO=Functional Outcome, Ind=Indirect Effect.

Table 5. Correlations among Composites in Schizophrenia and HFA Samples.

	Social Cog Composite <i>r</i> (<i>p</i>)	Functional Outcome Composite <i>r</i> (<i>p</i>)
Schizophrenia Sample		
Social Cog Composite	.	-.005 (.973)
Neurocog Composite	.654** (.000)	-.248 (.101)
HFA Sample		
Social Cog Composite	.	-.109 (.551)
Neurocog Composite	.448** (.008)	.087 (.635)

Note. Social Cog=Social Cognition, Neurocog=Neurocognition, HFA=High-functioning Autism, ** $p < .01$

Table 6. Correlations among Neurocognitive and Social Cognitive Measures in HFA and Schizophrenia.

Schizophrenia Sample	Movie Stills	Point Light	Eyes Test
IQ	.424**	.398**	.628**
General Perception	.400**	.308*	.384**
Executive Function	.264	.322*	.305*
Verbal Fluency	.296*	.381*	.549**
HFA Sample			
IQ	.522**	.498**	.753**
General Perception	.315	.033	.189
Executive Function	.306	.027	.244
Verbal Fluency	-.068	-.015	.316

Note. HFA=High-Functioning Autism, ** $p < .01$, * $p < .05$, Bonferroni corrected alpha=.004, Bold-faced items significant at Bonferroni level.

Table 7. Correlations between Neurocognitive and Social Cognitive Measures with Functional Outcome

Schizophrenia Sample	Prosocial	Recreation	Independ Perf
IQ	-.327*	-.055	.068
General Perception	-.536**	-.261	.077
Executive Function	-.246	-.089	-.026
Verbal Fluency	-.202	.004	-.080
Movie Stills	-.064	.038	.297*
Point Light	-.210	-.036	.270
Eyes Test	-.341*	-.068	.249
HFA Sample			
IQ	-.384*	-.025	-.046
General Perception	-.022	.153	.249
Executive Function	-.077	.346	.308
Verbal Fluency	-.142	.107	-.014
Movie Stills	-.021	.228	.193
Point Light	-.322	-.011	-.088
Eyes Test	-.513**	-.084	-.063

Note. HFA=High-Functioning Autism, Independ Perf=Independence Performance subscale of SFS, ** $p < .01$, * $p < .05$, Bonferroni corrected alpha=.002, Bold-faced items significant at Bonferroni level.

Figure 1. Model A: Conceptual

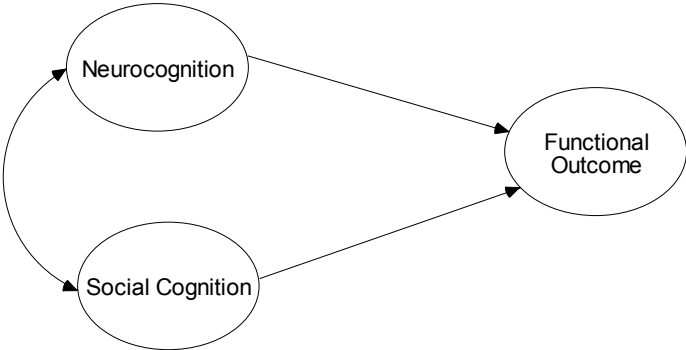


Figure 2. Model B: Conceptual

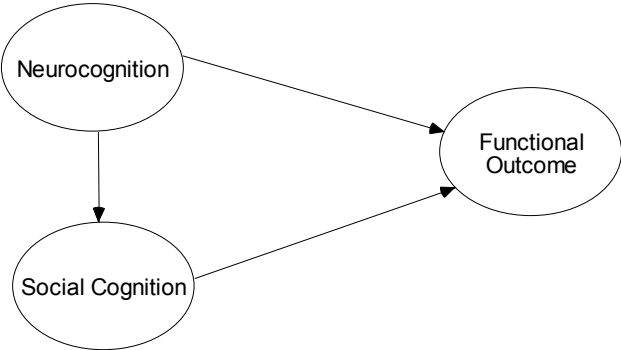


Figure 3. Model A: Latent Variables

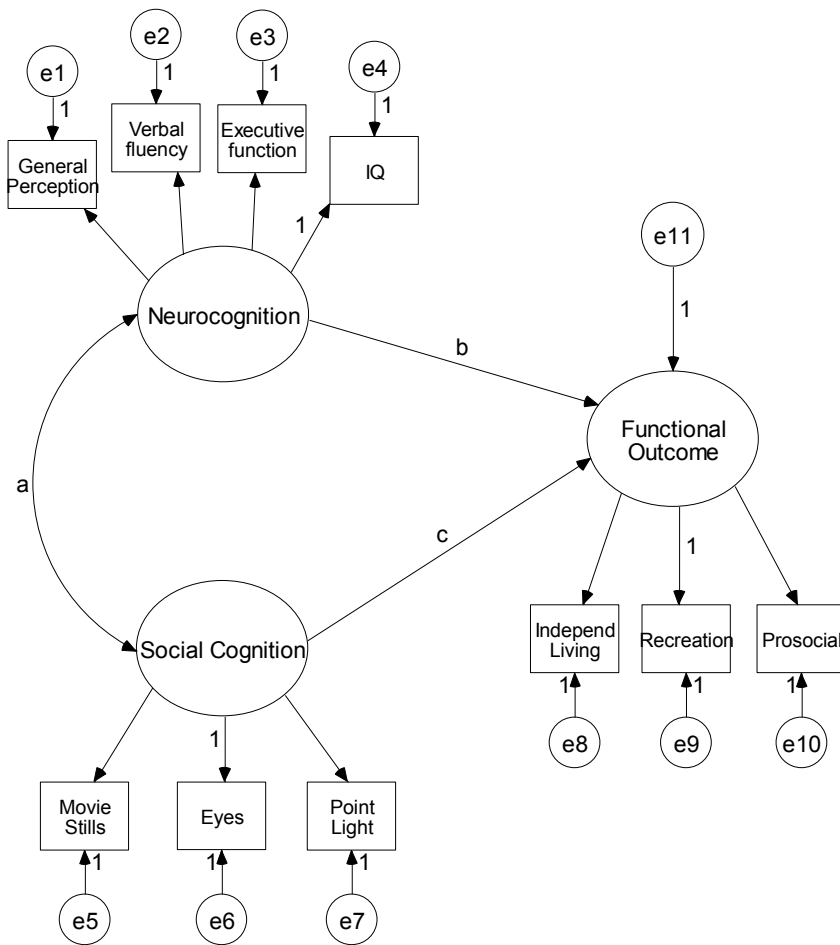


Figure 4. Model B: Latent Variables

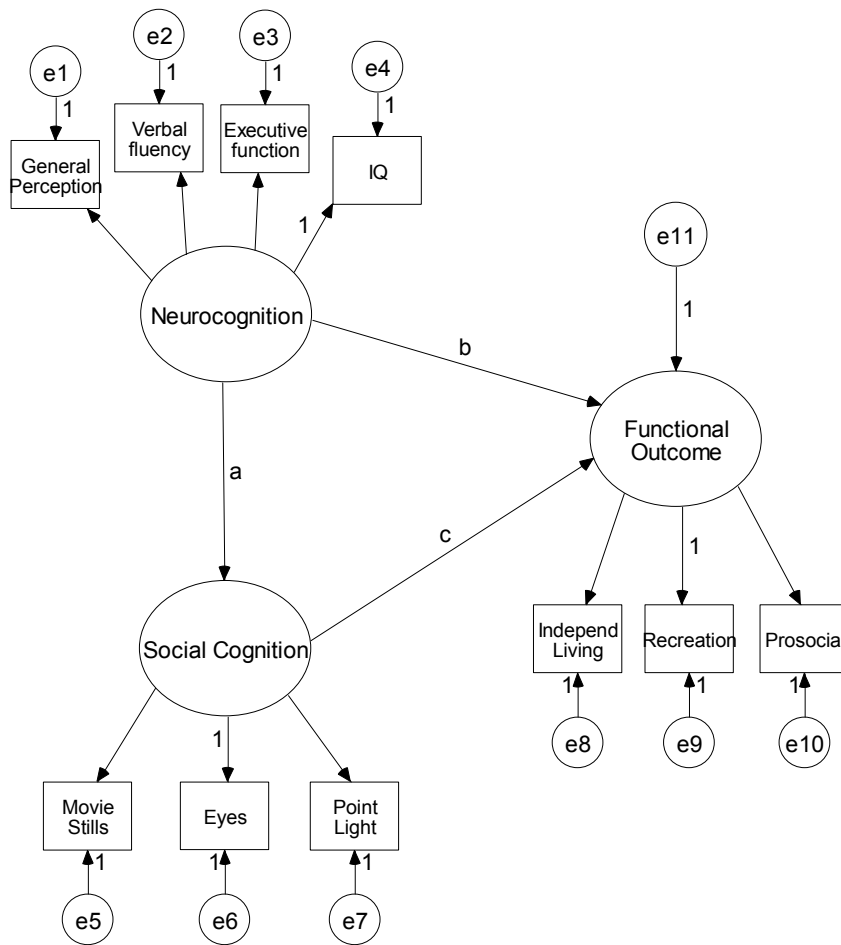


Figure 5. Model A: Path Model

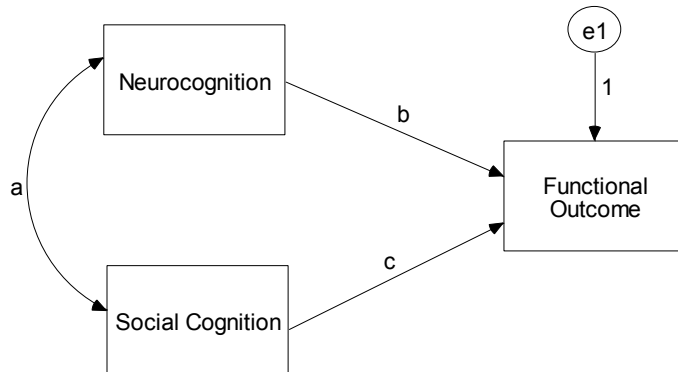
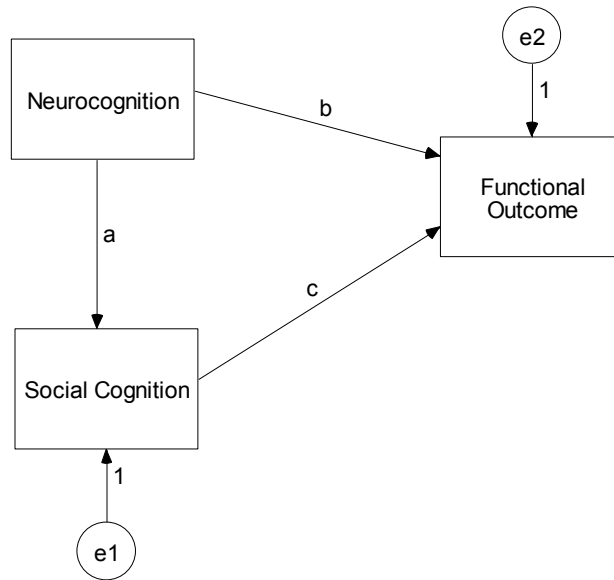


Figure 6. Model B: Path Model



References

- Abdi, Z., & Sharma, T. (2004). Social cognition and its neural correlates in schizophrenia and autism. *CNS Spectrums, 9*(5), 335-343.
- Addington, J., & Addington, D. (1998). Facial affect recognition and information processing in schizophrenia and bipolar disorder. *Schizophrenia Research, 32*, 171-181.
- Addington, J., & Addington, D. (1999). Neurocognitive and social functioning in schizophrenia. *Schizophrenia Bulletin, 25*(1), 173-182.
- Addington, J., & Addington, D. (2000). Neurocognitive and social functioning in schizophrenia: A 2.5 year follow-up study. *Schizophrenia Research, 44*, 47-56.
- Addington, J., McCleary, L., & Munroe-Blum, H. (1998). Relationship between cognitive and social dysfunction in schizophrenia. *Schizophrenia Research, 34*(1-2), 59-66.
- Addington, J., Saeedi, H., & Addington, D. (2005). The course of cognitive functioning in first episode psychosis: Changes over time and impact on outcome. *Schizophrenia Research, 78*, 35-43.
- Adolphs, R. (2001). The neurobiology of social cognition. *Current Opinion in Neurobiology, 11*(2), 231-239.
- Adolphs, R., Baron-Cohen, S., & Tranel, D. (2002). Impaired recognition of social emotions following amygdala damage. *Journal of Cognitive Neuroscience, 14*(8), 1264-1274.
- Adolphs, R., Sears, L., & Piven, J. (2001). Abnormal processing of social information from faces in autism. *Journal of Cognitive Neuroscience, 13*(2), 232-240.
- Adolphs, R., & Tranel, D. (2003). Amygdala damage impairs emotion recognition from scenes only when they contain facial expressions. *Neuropsychologia, 41*, 1281-1289.
- Adolphs, R., Tranel, D., & Damasio, A. R. (1998). The human amygdala in social judgment. *Nature, 393*, 470-474.
- Adolphs, R., Tranel, D., Hamann, S., Young, A.W., Calder, A.J., Phelps, E.A., et al. (1999). Recognition of facial emotion in nine individuals with bilateral amygdala damage. *Neuropsychologia, 37*, 1111-1117.
- American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders*, (4th ed). Washington D.C.: American Psychiatric Association.

- American Psychiatric Association. (2000). *Diagnostic and Statistical Manual of Mental Disorders*, (4th ed., Text Revision). Washington, D.C.: American Psychiatric Association.
- Anderson, S.W., Bechara, A., Damasio, H., Tranel, D., Damasio, A.R. (1999). Impairment of social and moral behavior related to early damage in the human prefrontal cortex. *Nature Neuroscience*, 2(11), 1032-1037.
- Appelo, M.T., Woonings, F.M., VanNieuwenhuizen, C.J., Emmelkamp, P.M.G., Sloof, C.J., & Louwerens, J.W. (1992). Specific skills and social competence in schizophrenia. *Acta Psychiatrica Scandinavica*, 85(6), 419-422.
- Arbuckle, J.L. (2000). Customizing longitudinal and multiple-group structural modeling procedures. In K. U. Schnabel & T. Little (Eds.), *Modeling longitudinal and multilevel data: Practical issues, applied approaches, and specific examples* (pp. 241-248, 269-281). Mahwah, NJ: Lawrence Erlbaum Associates.
- Archer, J., Hay, D.C., & Young, A.W. (1992). Face processing in psychiatric conditions. *Journal of Clinical Psychology*, 31, 45-61.
- Archer, J., Hay, D.C., & Young, A.W. (1994). Movement, face processing and schizophrenia: evidence of a differential deficit in expression analysis. *British Journal of Clinical Psychology*, 33, 517-528.
- Asarnow, R.F., & Asarnow, J.R. (1994). Childhood-onset schizophrenia: Editors' introduction. *Schizophrenia Bulletin*, 20, 591-597.
- Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology*, 51(6), 1173-1182.
- Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Cambridge, MA: The MIT Press.
- Baron-Cohen, S., Jolliffe, T., Moritmore, C., & Robertson, M. (1997). Another advanced test of theory of mind: Evidence from very high functioning adults with autism or Asperger Syndrome. *Journal of Child Psychology and Psychiatry*, 38(7), 813-822.
- Baron-Cohen, S., O'Riordan, M., Stone, V., Jones, R., & Plaisted, K. (1999). Recognition of faux pas by normally developing children with Asperger syndrome or high functioning autism. *Journal of Autism and Developmental Disorders*, 29(5), 407-418.
- Baron-Cohen, S., Spitz, A., & Cross, P. (1993). Can children with autism recognize surprise? *Cognition and Emotion*, 7, 507-516.

- Baron-Cohen, S., & Wheelwright, S. (2003). The friendship questionnaire: An investigation of adults with Asperger syndrome or high-functioning autism, and normal sex differences. *Journal of Autism and Developmental Disorders*, 33(5), 509-517.
- Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y., & Plumb, I. (2001). The "reading the mind in the eyes" test revised version: A study with normal adults and adults with Asperger Syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry*, 42(2), 241-251.
- Baron-Cohen, S., Wheelwright, S., & Jolliffe, T. (1997). Is there a "language of the eyes"? Evidence from normal adults and adults with autism or Asperger syndrome. *Visual Cognition*, 4, 311-332.
- Bauminger, N., Shulman, C., & Agam, G. (2003). Peer interaction and loneliness in high-functioning children with autism. *Journal of Autism and Developmental Disorders*, 33(5), 489-507.
- Bell, M. D., & Bryson, G. (2001). Work rehabilitation in schizophrenia: Does cognitive impairment limit improvement? *Schizophrenia Bulletin*, 27(2), 269-279.
- Bellack, A.S., Morrison, R.L., Wixted, J.T., & Mueser, K.T. (1990). An analysis of social competence in schizophrenia. *British Journal of Psychiatry*, 156, 809-818.
- Bellack, A.S., Sayers, M., Mueser, K.T., & Bennett, M. (1994). Evaluation of social problem solving in schizophrenia. *Journal of Abnormal Psychology*, 103(2), 371-378.
- Benton, A. L., Hamsher, K., & Sivan, A.B. (1983). *Multilingual aphasia examination* (3rd ed.). Iowa City, IA: AJA Associates.
- Benton, A., Hamsher, K., Varney, N., & Spreen, O. (1983). *Contributions to Neuropsychological Assessment*. New York: Oxford University Press.
- Birchwood, M., Smith, J., Cochrane, R., Wetton, S., & Copestake, S. (1990). The social functioning scale: The development and validation of a new scale of social adjustment for use in family intervention programmes with schizophrenic patients. *British Journal of Psychiatry*, 157, 853-859.
- Bishop, D.V.M., Maybery, M., Maley, A., Wong, D., Hill, W., & Hallmayer, J. (2004). Using self-report to identify the broad phenotype in parents of children with autistic spectrum disorders: A study using the autism-spectrum quotient. *Journal of Child Psychology and Psychiatry*, 45(8), 1431-1436.
- Blair, R.J.R., & Cipolotti, L. (2000). Impaired social response reversal: A case of 'acquired sociopathy.' *Brain*, 123, 1122-1141.

- Blakemore, S.J., & Frith, C.D. (2004). How does the brain deal with the social world? *Neuroreport: For Rapid Communication of Neuroscience Research*, *15*(1), 119-128.
- Blanchard, J. J., & Neale, J. M. (1994). The neuropsychological signature of schizophrenia: Generalized or differential deficit? *American Journal of Psychiatry*, *151*, 40-48.
- Bolte, S., & Poustka, F. (2003). The recognition of facial affect in autistic and schizophrenic subjects and their first-degree relatives. *Psychological Medicine*, *33*, 907-915.
- Bolte, S., Rudolf, L., & Poustka, F. (2002). The cognitive structure of higher functioning autism and schizophrenia: A comparative study. *Comprehensive Psychiatry*, *43*(4), 325-330.
- Bolton, B., & Roessler, R. (1986). The work personality profile: Factor scales, reliability, validity, and norms. *Vocational Evaluation & Work Adjustment Bulletin*, *19*, 143-149.
- Bowen, L., Wallace, C.J., Glynn, S., Nuechterlein, K.H., Lutzker, J.R., & Kuehnell, T.G. (1994). Schizophrenic individuals' cognitive functioning and performance in interpersonal interactions and skills training procedures. *Journal of Psychiatric Research*, *28*(3), 289-301.
- Bowler, D. M. (1992). "Theory of Mind" in Asperger's syndrome. *Journal of Child Psychology and Psychiatry*, *33*(5), 877-893.
- Bozikas, V.P., Kosmidis, M.H., Anezoulaki, D., Giannakou, M., & Karavatos, A. (2004). Relationship of affect recognition with psychopathology and cognitive performance in schizophrenia. *Journal of the International Neuropsychological Society*, *10*, 549-558.
- Brekke, J.S., Kay, D.D., Kee, K.S., & Green, M.F. (2005). Biosocial pathways to functional outcome in schizophrenia. *Schizophrenia Research*, *80*, 213-225.
- Brekke, J.S., & Long, J.D. (2000). Community-based psychosocial rehabilitation and prospective change in functional, clinical, and subjective experience variables in schizophrenia. *Schizophrenia Bulletin*, *26*(3), 667-680.
- Brekke, J.S., Raine, A., Ansel, M., Lencz, T., & Bird, L. (1997). Neuropsychological and psychophysiological correlates of psychosocial functioning in schizophrenia. *Schizophrenia Bulletin*, *23*(1), 19-28.
- Brothers, L. (1990). The social brain: A project for integrating primate behavior and neurophysiology in a new domain. *Concepts in Neuroscience*, *1*, 27-61.

- Brune, M. (2003). Theory of mind and the role of IQ in chronic disorganized schizophrenia. *Schizophrenia Research*, 60, 57-64.
- Brune, M. (2005a). Emotion recognition, 'theory of mind,' and social behavior in schizophrenia. *Psychiatry Research*, 133, 135-147.
- Brune, M. (2005b). "Theory of mind" in schizophrenia: A review of the literature. *Schizophrenia Bulletin*, 31(1), 21-42.
- Brunet, E., Sarfati, Y., & Hardy-Boyle, M. (2003). Reasoning about physical causality and other's intentions in schizophrenia. *Cognitive Neuropsychiatry*, 8(2), 129-139.
- Bryson, G., Bell, M.D., Kaplan, E., Greig, T.C., & Lysaker, P.H. (1998). Affect recognition in deficit syndrome schizophrenia. *Psychiatry Research*, 77, 113-120.
- Bryson, G., Bell, M.D., & Lysaker, P.H. (1997). Affect recognition in schizophrenia: A function of global impairment or a specific cognitive deficit. *Psychiatry Research*, 71, 105-113.
- Byrne, B. (2001). *Structural equation modeling with AMOS: Basic concepts, applications, and programming*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Buitelaar, J.K., van der Wees, M., Swaab-Barneveld, H., & Jan van der Gaag, R. (1999). Verbal memory and performance IQ predict theory of mind and emotion recognition ability in children with autistic spectrum disorders and in psychiatric control children. *Journal of Child Psychology and Psychiatry*, 40(6), 869-881.
- Capps, L., Yirmiya, N., & Sigman, M. (1992). Understanding of simple and complex emotions in non-retarded children with autism. *Journal of Child Psychology and Psychiatry*, 33(7), 1169-1182.
- Cather, C., Penn, D.L., Otto, M. W., Yovel, I., Mueser, K.T., & Goff, D. (2005). A pilot study of functional cognitive behavior therapy (fCBT) for chronic schizophrenia. *Schizophrenia Research*, 74, 201-209.
- Celani, G., Battacchi, M.W., & Arcidiacono, L. (1999). The understanding of the emotional meaning of facial expressions in people with autism. *Journal of Autism and Developmental Disorders*, 29(1), 57-66.
- Charman, T., Swettenham, J., Baron-Cohen, S., Cox, A., Baird, G., & Drew, A. (1998). An experimental investigation of social-cognitive abilities in infants with autism: Clinical implications. *Infant Mental Health Journal*, 19(2), 260-275.
- Cohen, A.S., Forbes, C.B., Mann, M.C., & Blanchard, J.J. (2006). Specific cognitive deficits and differential domains of social functioning impairment in schizophrenia. *Schizophrenia Research*, 81, 227-238.

- Cools, R., Brouwer, W.H., deJong, R., & Slooff, C. (2000). Flexibility, inhibition and planning: Frontal dysfunctioning in schizophrenia. *Brain and Cognition*, 43, 108-112.
- Corcoran, R. (2001). Theory of mind and schizophrenia. In D.L. Penn & P.W. Corrigan (Eds.), *Social cognition and schizophrenia* (pp. 149-174). Washington, D.C.: American Psychological Association.
- Corcoran, R., Mercer, G., & Frith, C.D. (1995). Schizophrenia, symptomatology and social inference: Investigating "theory of mind" in people with schizophrenia. *Schizophrenia Research*, 17, 5-13.
- Cornblatt, B., Obuchowski, M., Roberts, S., Pollack, S., & Erlenmeyer-Kimling, L. (1999). Cognitive and behavioral precursors of schizophrenia. *Development and Psychopathology*, 11, 487-508.
- Corrigan, P. W., Edwards, A. B., Green, A., Diwan, S. L., & Penn, D. L. (2001). Prejudice, social distance, and familiarity with mental illness. *Schizophrenia Bulletin*, 27(2), 219-225.
- Corrigan, P. W., & Toomey, R. (1995). Interpersonal problem solving and information processing in schizophrenia. *Schizophrenia Bulletin*, 21(3), 395-403.
- Craig, J. S., Hatton, C., Craig, F. B., & Bentall, R. P. (2004). Persecutory beliefs, attributions and theory of mind: Comparison of patients with paranoid delusions, Asperger's syndrome and healthy controls. *Schizophrenia Research*, 69(1), 29-33.
- Cramer, P., Weegman, M., & O'Neil, M. (1989). Schizophrenia and the perception of emotions: how accurately do schizophrenics judge the emotional states of others? *British Journal of Psychiatry*, 155, 225-228.
- Cutting, J., & Murphy, D. (1990). Impaired ability of schizophrenics, relative to manics or depressives, to appreciate social knowledge about their culture. *British Journal of Psychiatry*, 157, 355-358.
- Dahlgren, S.O., & Trillingsgaard, A. (1996). Theory of mind in non-retarded children with autism and Asperger's syndrome: A research note. *Journal of Child Psychology and Psychiatry*, 37(6), 759-763.
- Davidson, R.J. (2000). Affective style, psychopathology, and resilience: Brain mechanisms and plasticity. *American Psychologist*, 55(11), 1196-1214.
- Davidson, M., Reichenberg, A., Rabinowitz, J., Weiser, M., & Kaplan, Z. (1999). Behavioral and intellectual markers for schizophrenia in apparently healthy male adolescents. *American Journal of Psychiatry*, 156(9), 1328-1335.
- Day, J.C., Bentall, R.P., & Roberts, C. (2005). Attitudes toward antipsychotic

- medication: The impact of clinical variables and relationships with health professionals. *Archives of General Psychiatry*, 62, 717-724.
- Deruelle, C., Rondan, C., Gepner, B., & Tardif, C. (2004). Spatial frequency and face processing in children with autism and Asperger syndrome. *Journal of Autism and Developmental Disorders*, 34(2), 199-210.
- Dickerson, F. (1997). Assessing clinical outcomes: The community functioning of persons with serious mental illness. *Psychiatric Services*, 48, 897-902.
- Dickerson, F., Boronow, J.J., Ringel, N., & Parente, F. (1996). Neurocognitive deficits and social functioning in outpatients with schizophrenia. *Schizophrenia Research*, 21, 75-83.
- Dickerson, F., Parente, F., & Ringel, N. (2000). The relationship among three measures of social functioning in outpatients with schizophrenia. *Journal of Clinical Psychology*, 58(12), 1509-1519.
- Doody, G.A., Gotz, M., Johnstone, E.C., Frith, C.D., & Cunningham Owens, D.G. (1998). Theory of mind and psychoses. *Psychological Medicine*, 28, 397-405.
- Drury, V.M., Robinson, E.J., & Birchwood, M. (1998). 'Theory of mind' skills during an acute episode of psychosis and following recovery. *Psychological Medicine*, 28, 1101-1112.
- Duncan, J. (1986). Disorganization of behavior after frontal lobe damage. *Cognitive Neuropsychology*, 3, 271-290.
- Dworkin, R.H., Cornblatt, B.A., Friedmann, R., Kaplansky, L.M., Lewis, J.A., Rinaldi, A., et al. (1993). Childhood precursors of affective vs. social deficits in adolescents at risk for schizophrenia. *Schizophrenia Bulletin*, 19, 563-577.
- Dykens, E., Volkmar, F., & Glick, M. (1991). Thought disorder in high-functioning autistic adults. *Journal of Autism and Developmental Disorders*, 21(3), 291-301.
- Edwards, J., Jackson, H., & Pattison, P.E. (2002). Emotion recognition via facial expression and affective prosody in schizophrenia: A methodological review. *Clinical Psychology Review*, 22, 789-832.
- Evans, J.D., Bond, G.R., Meyer, P.S., Kim, H.W., Lysaker, P.H., Gibson, P.J., & Tunis, S. (2004). Cognitive and clinical predictors of success in vocational rehabilitation in schizophrenia. *Schizophrenia Research*, 70, 331-342.
- Fan, X., Thompson, B., & Wang, L. (1999). Effects of sample size, estimation methods, and model specification on structural equation modeling fit indexes. *Structural Equation Modeling*, 6(1), 56-83.

- Feinberg, T.E., Rifkin, A., Schaffer, C., & Walker, E. (1986). Facial discrimination and emotional recognition in schizophrenia and affective disorders. *Archives of General Psychiatry*, *43*, 276–279.
- Fine, C., Lumsden, J., Blair, R.J.R. (2001). Dissociation between “theory of mind” and executive functions in a patient with early left amygdala damage. *Brain*, *124*, 287-298.
- First, M.B., Spitzer, R.L., Gibbon, M., & Williams, J.B.W. (1995). *Structured Clinical Interview for DSM-IV Axis I Disorders - Patient edition (SCID-I/P, Version 2.0)*. New York: Biometrics Research Department, New York State Psychiatric Institute.
- Fiske, S.T., & Taylor, S. (1991). *Social cognition* (2nd ed.). New York: McGraw-Hill.
- Frith, C.D. (1992). *The cognitive neuropsychology of schizophrenia*. Hillsdale, NJ: Erlbaum.
- Frith, C.D., & Corcoran, R. (1996). Exploring theory of mind in people with schizophrenia. *Psychological Medicine*, *26*, 521–530.
- Gabel, W., & Wolwer, W. (1992). Facial expression and emotional face recognition in schizophrenia and depression. *European Archives of Psychiatry and Clinical Neuroscience*, *242*, 46–52.
- Garety, P., Fowler, D., & Kuipers, E. (1997). London-East Anglia randomized controlled trial of cognitive-behavior therapy for psychosis. *British Journal of Psychiatry*, *171*, 420-426.
- Ghaziuddin, M. (2005). A family history study of Asperger syndrome. *Journal of Autism and Developmental Disorders*, *35*(2), 177-182.
- Goldstein, G., Johnson, C.R., & Minshew, N.J. (2001). Attentional processes in autism. *Journal of Autism and Developmental Disorders*, *31*(4), 443-440.
- Goodman, S.H., Sewell, D.R., & Cooley, E.L. (1993). Assessing levels of adaptive functioning: The role functioning scale. *Community Mental Health Journal*, *29*, 119-131.
- Gosselin, P., Kirouac, G., & Doré, F.Y. (1995). Components and recognition of facial expression in the communication of emotion by actors. *Journal of Personality and Social Psychology*, *68*, 83–96.
- Green, M.F. (1996). What are the functional consequences of neurocognitive deficits in schizophrenia? *American Journal of Psychiatry*, *153*, 321-330.
- Green, M.F., Kern, R.S., Braff, D.L., & Mintz, J. (2000). Neurocognitive deficits and

- functional outcome in schizophrenia: Are we measuring the "right stuff"? *Schizophrenia Bulletin*, 26(1), 119-136.
- Green, M.F., Kern, R.S., & Heaton, R.K. (2004). Longitudinal studies of cognition and functional outcome in schizophrenia: Implications for MATRICS. *Schizophrenia Research*, 72, 41-51.
- Green, M.F., & Nuechterlein, K.H. (1999). Should schizophrenia be treated as a neurocognitive disorder? *Schizophrenia Bulletin*, 25(2), 309-318.
- Green, M.F., Olivier, B., Crawley, J.N., Penn, D.L., & Silverstein, S. (2005). Social cognition in schizophrenia: Recommendations from the MATRICS new approaches conference. *Schizophrenia Bulletin*, 31, 882-887.
- Greig, T.C., Bryson, G., & Bell, M.D. (2004). Theory of mind performance in schizophrenia: Diagnostic, symptom, and neuropsychological correlates. *The Journal of Nervous and Mental Disease*, 192, 12-18.
- Gumley, A., O'Grady, M., & McNay, L. (2003). Early intervention for relapse in schizophrenia: Results of a 12-month randomized controlled trial of cognitive behavioral therapy. *Psychological Medicine*, 33, 419-431.
- Hans, S.L., Auerbach, J.G., Asarnow, J.R., Styr, B. & Marcus, J. (2000). Social adjustment of adolescents at risk for schizophrenia: The Jerusalem infant development study. *Journal of the American Academy of Child and Adolescent Psychiatry*, 39(11), 1406-1414.
- Heberlein, A., Tranel, D., Damasio, H., & Adolphs, R. (2001). Damage to right somatosensory cortex impairs recognition of basic emotions, but not of personality traits, from biological motion stimuli. *Society for Neuroscience Abstract*.
- Heimberg, C. Gur, R.E., Erwin, R.J., Shtasel, D.L., & Gur, R.C. (1992). Facial emotion discrimination: III. Behavioural findings in schizophrenia. *Psychiatric Research*, 42, 253-265.
- Heinrichs, R.W., & Zakzanis, K.K. (1998). Neurocognitive deficit in schizophrenia: A quantitative review of the evidence. *Neuropsychology*, 12(3), 426-445.
- Hellewell, J.S.E., Connell, J., & Deakin, J.F.W. (1994). Affect judgement and facial recognition memory in schizophrenia. *Psychopathology*, 27, 255-261.
- Herold, R., Tenyi, T., Lenard, K., & Trixler, M. (2002). Theory of mind deficit in people with schizophrenia during remission. *Psychological Medicine*, 32, 1125-1129.
- Hoff, A.L., & Kremen, W.S. (2002). Is there a cognitive phenotype for schizophrenia:

- The nature and course of the disturbance in cognition? *Current Opinion in Psychiatry*, 15(1), 43-48.
- Hooker, C., & Park, S. (2002). Emotion processing and its relationship to social functioning in schizophrenia patients. *Psychiatry Research*, 112, 41-50.
- Hoyle, R.H. (1995). The structural equation modeling approach: Basic concepts and fundamental issues. In R.H. Hoyle (Ed.), *Structural Equation Modeling: Concepts, Issues, and Applications*, (pp.1-16), London: Sage Publications.
- Hu, L., & Bentler, P.M. (1998). Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychological Methods*, 3(4), 424-453.
- Hughes, C., Leboyer, M., & Bouvard, M. (1997). Executive function in parents of children with autism. *Psychological Medicine*, 27, 209-220.
- Jansari, A., Tranel, D., & Adolphs, R. (2000). A valence-specific lateral bias for discriminating emotional facial expressions in free field. *Cognition and Emotion*, 14(3), 341-353.
- Janssen, I., Krabbendam, L., Jolles, J., & van Os, J. (2003). Alterations in theory of mind in patients with schizophrenia and non-psychotic relatives. *Acta Psychiatrica Scandinavica*, 108, 110-117.
- Johnston, P.J., Katsikitis, M., & Carr, V. (2001). A generalised deficit can account for problems in facial emotion recognition in schizophrenia. *Biological Psychiatry*, 58, 203-227.
- Jones, W., Bellugi, U., Lai, Z., Chiles, M., Reilly, J., Lincoln, A., et al. (2000). II. Hypersociability in Williams Syndrome. *Journal of Cognitive Neuroscience*, 12, 30-46.
- Joseph, P.L., Sturgeon, D.A., & Leff, J. (1992). The perception of emotion by schizophrenic patients. *British Journal of Psychiatry*, 161, 603-609.
- Kaland, N., Moller-Neilsen, A., Callesen, K., Mortensen, E.L., Gottlieb, D., & Smith, L. (2002). A new “advanced” test of theory of mind: Evidence from children and adolescents with Asperger syndrome. *Journal of Child Psychology and Psychiatry*, 43(4), 517-528.
- Kanwisher, N. (2000). Domain specificity in face perception. *Nature Neuroscience*, 3(8), 759-763.
- Kaufman, A.S. (1994). *Intelligent testing with the WISC-III*. New York: Wiley.

- Kay, S.R., Fiszbein, A., & Opler, L.A. (1987). The positive and negative syndrome scale (PANSS) for schizophrenia. *Schizophrenia Bulletin*, *13*(2), 261-276.
- Kee, K.S., Green, M.F., Mintz, J., & Brekke, J.S. (2003). Is emotion processing a predictor of functional outcome in schizophrenia? *Schizophrenia Bulletin*, *29*(3), 487-497.
- Kee, K.S., Kern, R.S., & Green, M.F. (1998). Perception of emotion and neurocognitive functioning in schizophrenia: What's the link? *Psychiatry Research*, *81*, 57-65.
- Kerr, S.L., & Neale, J.M. (1993). Emotion perception in schizophrenia: Specific deficit or further evidence of generalized poor performance? *Journal of Abnormal Psychology*, *102*(2), 312-318.
- Kim, J., Doop, M.L., Blake, R., & Park, S. (2005). Impaired visual recognition of biological motion in schizophrenia. *Schizophrenia Research*, *77*, 299-307.
- King, S., & Dixon, M.J. (1996). The influence of expressed emotion, family dynamics, and symptom type on the social adjustment of schizophrenic young adults. *Archives of General Psychiatry*, *53*, 1098-1104.
- Kington, J.M., Jones, L.A., Watt, A.A., Hopkin, E.J., & Williams, J. (2000). Impaired eye expression recognition in schizophrenia. *Journal of Psychiatric Research*, *34*, 341-347.
- Kleinmans, N., Akshoomoff, N., & Delis, D.C. (2005). Executive functions in autism and Asperger's disorder: Flexibility, fluency, and inhibition. *Developmental Neuropsychology*, *27*(3), 379-401.
- Klin, A., Jones, W., Schultz, R., Volkmar, F., & Cohen, D. (2002). Defining and quantifying the social phenotype in autism. *American Journal of Psychiatry*, *159*, 895-908.
- Kline, J.S., Smith, J.E., & Ellis, H.C. (1992). Paranoid and nonparanoid schizophrenic processing of facially displayed affect. *Journal of Psychiatric Research*, *26*, 169-182.
- Kohler, C., Bilker, W.B., Hagoort, M., Gur, R.E., & Gur, R.C. (2000). Emotion recognition deficit in schizophrenia: Association with symptomatology and cognition. *Biological Psychiatry*, *48*, 127-136.
- Kohler, C., Turner, T., Bilker, W.B., Brensinger, C.M., Siegel, S.J., Kanes, S.J., Gur, R.E., & Gur, R.C. (2003). Facial emotion recognition in schizophrenia: Intensity effects and error pattern. *American Journal of Psychiatry*, *160*(10), 1768-1774.
- Konstantareas, M. M., & Hewitt, T. (2001). Autistic disorder and schizophrenia:

- Diagnostic overlaps. *Journal of Autism and Developmental Disorders*, 31(1), 19-28.
- Kurtz, M.M., Moberg, P.J., Gur, R.C., & Gur, R.E. (2001). Approaches to cognitive remediation of neuropsychological deficits in schizophrenia: A review and meta-analysis. *Neuropsychology Review*, 11(4), 197-210.
- Lancaster, R.S., Evans, J.D., Bond, G.R., & Lysaker, P.H. (2003). Social cognition and neurocognitive deficits in schizophrenia. *The Journal of Nervous and Mental Disease*, 191(5), 295-299.
- Langdon, R., Davies, M., & Colthart, M. (2002). Understanding minds and understanding communicated meanings in schizophrenia. *Mind and Language*, 17, 68-104.
- Langdon, R., Michie, P.T., Ward, P.B., McConaghy, N., Catts, S.V., & Colthart, M. (1997). Defective self and/or other mentalising in schizophrenia: A cognitive neuropsychological approach. *Cognitive Neuropsychiatry*, 2(3), 167-193.
- Lee, K.H., Farrow, T.F.D., Spence, S.A., & Woodruff, P.W.R. (2004). Social cognition, brain networks, and schizophrenia. *Psychological Medicine*, 34, 391-400.
- Lenzenweger, M.F., & Dworkin, R.H. (1996). The dimensions of schizophrenia phenomenology: Not one or two, at least three, perhaps four. *British Journal of Psychiatry*, 168, 432-440.
- Lenzenweger, M.F., Dworkin, R.H., & Wethington, E. (1991). Examining the underlying structure of schizophrenic phenomenology: Evidence for a three process model. *Schizophrenia Bulletin*, 17, 515-524.
- Lord, C., Risi, S., Lambrecht, L., Cook, E., Leventhal, B., Pickles, A., & Rutter, M. (2000). The ADOS-G (Autism Diagnostic Observation Schedule-Generic): A standard measure of social-communication deficits associated with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, 30, 205-223.
- Lord, C., Rutter, M., & LeCouteur, A. (1994). Autism Diagnostic Interview-Revised: a revised version of a diagnostic interview for caregivers of individuals with possible pervasive developmental disorders. *Journal of Autism and Developmental Disorders*, 24, 659-685.
- Loveland, K.A., Tunali-Kotoski, B., Chen, Y.R., Ortegon, J., Pearson, D.A., Brelsford, K.A., & Gibbs, M.C. (1997). Emotion recognition in autism: Verbal and nonverbal information. *Development and Psychopathology*, 9, 579-593.
- Lysaker, P.H., Bryson, G., Davis, L.W., & Bell, M.D. (2005). Relationship of impaired processing speed and flexibility of abstract thought to improvements in work performance over time in schizophrenia. *Schizophrenia Research*, 75, 211-218.

- MacCallum, R.C., Widaman, K.F., Zhang, S., & Hong, S. (1999). Sample size in factor analysis. *Psychological Methods, 4*(1), 84-99.
- Majewska, B., Tranel, D., Damasio, A., & Adolphs, R. (2001). Emotion recognition from face and context following bilateral amygdala damage. *Abstract at the Annual Meeting of the Society for Neuroscience*.
- Mandal, M.K., & Palchoudhury, S. (1989). Identifying the components of facial emotion and schizophrenia. *Psychopathology, 22*, 295-300.
- Mandal, M. K., Pandey, R., & Prasad, A. B. (1998). Facial expressions of emotions and schizophrenia: A review. *Schizophrenia Bulletin, 24*(1), 399-412.
- Mandal, M.K., & Rai, A. (1987). Responses to facial emotion and psychopathology. *Psychiatry Research, 20*, 317-323.
- Matese, M., Matson, J.L., & Sevin, J. (1994). Comparison of psychotic and autistic children using behavioral observation. *Journal of Autism and Developmental Disorders, 24*(1), 83-94.
- Matson, J.L., Mayville, E., Lott, J.D., Bielecki, J., & Logan, R. (2003). A comparison of social and adaptive functioning in persons with psychosis, autism, and severe or profound mental retardation. *Journal of Developmental and Physical Disabilities, 15*(1), 57-65.
- Mazza, M., DeRisio, A., Surian, L., Roncone, R., & Casacchia, M. (2001). Selective impairments of theory of mind in people with schizophrenia. *Schizophrenia Research, 47*, 299-308.
- McGurk, S.R., Moriarty, P.J., Harvey, P.D., Parrella, M., White, L., & Davis, K.L. (2000). The longitudinal relationship of clinical symptoms, cognitive functioning, and adaptive life in geriatric schizophrenia. *Schizophrenia Research, 42*, 47-55.
- McGurk, S. R., Mueser, K. T., Harvey, P. D., LaPuglia, R., & Marder, J. (2003). Cognitive and symptom predictors of work outcomes for clients with schizophrenia in supported employment. *Psychiatric Services, 54*, 1129-1135.
- McKibbin, C.L., Brekke, J.S., Sires, D., Jeste, D.V., & Patterson, T.L. (2004). Direct assessment of functional abilities: Relevance to persons with schizophrenia. *Schizophrenia Research, 72*, 53-67.
- Meltzer, H.Y., & McGurk, S.R. (1999). The effects of clozapine, risperidone, and olanzapine on cognitive function in schizophrenia. *Schizophrenia Bulletin, 25*(2), 233-255.
- Mitchley, N., Barber, J., Gray, J.M., Brooks, D., & Livingston, M.G. (1998).

- Comprehension of irony in schizophrenia. *Cognitive Neuropsychiatry*, 3(2), 127-138.
- Morrison, R.L., Bellack, A.S., & Mueser, K.T. (1988). Deficits in facial-affect recognition and schizophrenia. *Schizophrenia Bulletin*, 14, 67–83.
- Mueser, K.T., Doonan, R., Penn, D.L., Blanchard, J.J., Bellack, A.S., Nishith, P., & DeLeon, J. (1996). Emotion recognition and social competence in chronic schizophrenia. *Journal of Abnormal Psychology*, 105(2), 271-275.
- Nicolson, R., & Rapoport, J.L. (1999). Childhood-onset schizophrenia: Rare but worth studying. *Biological Psychiatry*, 46, 1418-1428.
- Novic, J., Luchins, D.J., & Perline, R. (1984). Facial affect recognition in schizophrenia: is there a differential deficit?. *British Journal of Psychiatry*, 144, 533–537.
- Nuechterlein, K.H., Snyder, K.S., & Mintz, J. (1992). Paths to relapse: Possible transactional processes connecting patient illness onset, expressed emotion, and psychotic relapse. *British Journal of Psychiatry*, 161, 88-96.
- Orsmond, G.I., Krauss, M.W., & Seltzer, M.M. (2004). Peer relationships and social and recreational activities among adolescents and adults with autism. *Journal of Autism and Developmental Disorders*, 34(3), 245-256.
- Ostrom, T.M. (1984). The sovereignty of social cognition. In R.S. Wyer & T.K. Srull (Eds.), *Handbook of social cognition* (Vol. 1, pp. 1–37).
- Ozonoff, S., Pennington, B.F., & Rogers, S.J. (1991). Executive functioning deficits in high-functioning autistic individuals: Relationship to theory of mind. *Journal of Child Psychology and Psychiatry*, 32, 1081-1105.
- Ozonoff, S., & Strayer, D.L. (1997). Inhibitory function in non-retarded children with autism. *Journal of Autism and Developmental Disorders*, 27, 59-77.
- Ozonoff, S., Strayer, D.L., McMahon, W., & Filloux, F. (1994). Executive function abilities in autism: An information processing approach. *Journal of Child Psychology and Psychiatry*, 35, 1015-1031.
- Penn, D.L. (1991). Cognitive rehabilitation of social deficits in schizophrenia: A direction of promise or following a primrose path? *Psychosocial Rehabilitation Journal*, 15, 27-41.
- Penn, D.L., Addington, J., & Pinkham, A. (in press). Social cognitive impairments. In J.A. Lieberman, T.S. Stroup, & D.O. Perkins (Eds.), *American psychiatric association textbook of schizophrenia*. Arlington, VA: American Psychiatric Publishing Press, Inc.

- Penn, D.L., Combs, D.R., Ritchie, M., Francis, J., Cassisi, J., Morris, S., & Townsend, M. (2000). Emotion recognition in schizophrenia: Further investigation of generalized versus specific deficit models. *Journal of Abnormal Psychology, 109*(3), 512-516.
- Penn, D.L., Corrigan, P.W., Bentall, R.P., Racenstein, J.M., & Newman, L. (1997). Social cognition in schizophrenia. *Psychological Bulletin, 121*(1), 114-132.
- Penn, D.L., Mueser, K.T., Spaulding, W.D., Hope, D.A., & Reed, D. (1995). Information processing and social competence in chronic schizophrenia. *Schizophrenia Bulletin, 21*, 269-281.
- Penn, D.L., Ritchie, M., Francis, J., Combs, D., & Martin, J. (2002). Social perception in schizophrenia: The role of context. *Psychiatry Research, 109*(2), 149-159.
- Penn, D.L., Spaulding, W., Reed, D., & Sullivan, M. (1996). The relationship of social cognition to ward behavior in chronic schizophrenia. *Schizophrenia Research, 20*(3), 327-335.
- Penn, D.L., van der Does, A., Spaulding, W.D., Garbin, C., Linszen, D., & Dingemans, P. (1993). Information processing and social cognitive problem solving in schizophrenia: Assessment of interrelationships and changes over time. *Journal of Nervous and Mental Disease, 181*(1), 13-20.
- Perlick, D., Stastny, P., Mattis, S., & Teresi, J. (1992). Contribution of family, cognitive, and clinical dimensions to long-term outcome in schizophrenia. *Schizophrenia Research, 6*, 257-265.
- Phillips, M.L. (2003). Understanding the neurobiology of emotion perception: Implications for psychiatry. *British Journal of Psychiatry, 182*, 190-192.
- Phillips, M.L., Drevets, W.C., Rauch, S.L., & Lane, R.D. (2003). Neurobiology of emotion perception I: The neural basis of normal emotion perception. *Biological Psychiatry, 54*, 504-514.
- Pickup, G., & Frith, C.D. (2001). Theory of mind impairments in schizophrenia: Symptomatology, severity and specificity. *Psychological Medicine, 31*, 207-220.
- Pilling, S., Bebbington, P., Kuipers, E., Garety, P., Geddes, J., Martindale, B., Orbach, G., & Morgan, C. (2002). Psychological treatments in schizophrenia: II. Meta-analyses of randomized controlled trials of social skills training and cognitive remediation. *Psychological Medicine, 32*(5), 782-791.
- Pilowsky, T., Yirmiya, N., Arbelle, S., & Mozes, T. (2000). Theory of mind abilities of children with schizophrenia, children with autism, and normally developing children. *Schizophrenia Research, 42*, 145-155.
- Pinkham, A.E., & Penn, D.L. (in press). Neurocognitive and social cognitive predictors

- of interpersonal skill in schizophrenia. Manuscript submitted for publication.
- Pinkham, A.E., Penn, D.L., Perkins, D.O., Graham, K., & Siegel, M. (2006). Emotion perception and the course of psychosis: A cross-sectional comparison of individuals at risk, and early and chronic schizophrenia spectrum illness. Manuscript under review.
- Pinkham, A.E., Penn, D.L., Perkins, D.O., & Lieberman, J. (2003). Implications for the neural basis of social cognition for the study of schizophrenia. *American Journal of Psychiatry*, *160*, 815-824.
- Piven, J. (1999). Genetic liability for autism: The behavioural expression in relatives. *International Review of Psychiatry*, *11(4)*, 299-308.
- Piven, J., & Palmer, P. (1999). Psychiatric disorder and the broad autism phenotype: Evidence from a family study of multiple incidence autism families. *The American Journal of Psychiatry*, *156*, 557-563.
- Piven, J., Palmer, P., Jacobi, D., & Childress, D. (1997). Broader autism phenotype: Evidence from a family history of multiple-incidence autism families. *American Journal of Psychiatry*, *154*, 185-190.
- Pollice, R., Roncone, R., Falloon, I.R.H., Mazza, M., DeRisio, A., Necozone, S., Morosini, P., & Casacchia, M. (2002). Is theory of mind in schizophrenia more strongly associated with clinical and social functioning than with neurocognitive deficits? *Psychopathology*, *35*, 280-288.
- Poole, J.H., Tobias, F.C., & Vinogradov, S. (2000). The functional relevance of affect recognition errors in schizophrenia. *Journal of the International Neuropsychological Society*, *6*, 649-658.
- Prouteau, A., Verdoux, H., Briand, C., Lesage, A. D., Lalonde, P., Nicole, L., Reinhartz, D., & Stip, E. (2004). The crucial role of sustained attention in community functioning in outpatients with schizophrenia. *Psychiatry Research*, *129*, 171-177.
- Reeder, C., Newton, E., Frangou, S., & Wykes, T. (2004). Which executive skills should we target to affect social functioning and symptom change? A study of a cognitive remediation therapy program. *Schizophrenia Bulletin*, *30(1)*, 87-100.
- Reitan, R., & Wolfson, D. (1985). *The Halstead-Reitan Neuropsychological Battery*. Tucson, AZ: Neuropsychology Press.
- Rempfer, M.V., Hamera, E.K., Brown, C.E., & Cromwell, R.L. (2003). The relations between cognition and the independent living skill of shopping in people with schizophrenia. *Psychiatry Research*, *117*, 103-112.

- Revheim, N., Schechter, I., Kim, D., Silipo, G., Allingham, B., Butler, P., & Javitt, D. C. (in press). Neurocognitive and symptom correlates of daily problem-solving skills in schizophrenia. *Schizophrenia Research*.
- Roloff, M.E., & Berger, C.R. (1982). Social cognition and communication: An introduction. In M. Roloff & C. Berger (Eds.), *Social cognition and communication*. Beverly Hills, CA: Sage.
- Roncione, R., Falloon, I.R.H., Mazza, M., DeRisio, A., Pollice, R., Necozone, S., Morosini, P., & Casacchia, M. (2002). Is theory of mind in schizophrenia more strongly associated with clinical and social functioning than with neurocognitive deficits? *Psychopathology*, *35*(5), 280-288.
- Russell, J.A., Suzuki, N., & Ishida, N. (1993). Canadian, Greek, and Japanese freely produced emotion labels for facial expressions. *Motivation and Emotion*, *17*, 337-351.
- Rutherford, M.D., Baron-Cohen, S., & Wheelwright, S. (2002). Reading the mind in the voice: A study with normal adults and adults with Asperger syndrome and high functioning autism. *Journal of Autism and Developmental Disorders*, *32*(3), 189-194.
- Sachs, G., Steger-Wuchse, D., Krypsin-Exner, I., Gur, R.C., & Katschnig, H. (2004). Facial recognition deficits and cognition in schizophrenia. *Schizophrenia Research*, *68*(1), 27-35.
- Salem, J.E., Kring, A.M., & Kerr, S.L. (1996). More evidence for generalized poor performance in facial emotion perception in schizophrenia. *Journal of Abnormal Psychology*, *105*(3), 480-483.
- Sarfati, Y., Hardy-Bayle, M.-C., Besche, C., & Widlocher, D. (1997). Attribution of intentions to others in people with schizophrenia: A non-verbal exploration with comic strips. *Schizophrenia Research*, *25*, 199-209.
- Sarfati, Y., Hardy-Bayle, M.-C., Brunet, E., & Widlocher, D. (1999). Investigating theory of mind in schizophrenia: Influence of verbalization in disorganized and non-disorganized patients. *Schizophrenia Research*, *37*, 183-190.
- Schenkel, L., Spaulding, W., & Silverstein, S. M. (2005). Poor premorbid social functioning and theory of mind deficit in schizophrenia: Evidence of reduced context processing? *Journal of Psychiatric Research*, *39*, 499-508.
- Schneider, S.G., & Asarnow, R.F. (1987). A comparison of cognitive/neuropsychological impairments of nonretarded autistic and schizophrenic children. *Journal of Abnormal Child Psychology*, *15*(1), 29-45.
- Schneider, F., Gur, R.C., Gur, R.E., & Shtasel, D.L. (1995). Emotional processing in

- schizophrenia: Neurobehavioral probes in relation to psychopathology. *Schizophrenia Research*, 17, 67-75.
- Sergi, M.J., Rassovsky, Y., Nuechterlein, K.H., & Green, M.F. (in press). Social perception as a mediator of the influence of early visual processing on functional status in schizophrenia. *Schizophrenia Research*.
- Sheitman, B.B., Kraus, J.E., Bodfish, J.W., & Carmel, H. (2004). Are the negative symptoms of schizophrenia consistent with an autistic spectrum illness? *Schizophrenia Research*, 69(1), 119-120.
- Silver, H., & Shlomo, N. (2001). Perception of facial emotions in chronic schizophrenia does not correlate with negative symptoms but correlates with cognitive and motor dysfunction. *Schizophrenia Research*, 52(3), 265-273.
- Smith, T.E., Hull, J., Goodman, M., Hedayat-Harris, A., Willson, D.F., Israel, L., & Munich, R.L. (1999). The relative influences of symptoms, insight, and neurocognition on social adjustment in schizophrenia and schizoaffective disorder. *The Journal of Nervous and Mental Disease*, 187(2), 102-108.
- Smith, T.E., Hull, J., Romanelli, S., Fertuck, E., & Weiss, K.A. (1999). Symptoms and neurocognition as rate limiters in skills training for psychotic patients. *American Journal of Psychiatry*, 156, 1817-1818.
- Sponheim, S.R., Surerus-Johnson, C., Spont, M., & Dieperink, M.E. (2003). Generalized cognitive dysfunction, symptomatology, and specific cognitive processes in relation to the functioning of schizophrenia patients. *Schizophrenia Research*, 64, 191-193.
- Sporn, A.L., Addington, A.M., Gogtay, N., Ordonez, A.E., Gornick, M., Clasen, L., Greenstein, D., Tossell, J.W., Gochman, P., Lenane, M., Sharp, W.S., Straub, R. E., & Rapoport, J.L. (2004). Pervasive developmental disorder and childhood-onset schizophrenia: Comorbid disorder or a phenotypic variant of a very early onset illness? *Biological Psychiatry*, 55, 989-994.
- Sullivan, G., Marder, S.R., Liberman, R.P., Donahoe, C.P., & Mintz, J. (1990). Social skills and relapse history in outpatient schizophrenics. *Psychiatry*, 60, 340-345.
- Tager-Flusberg, Boshart, J., & Baron-Cohen, S. (1998). Reading the windows into the soul: Evidence for domain-specific sparing in Williams syndrome. *Journal of Cognitive Neuroscience*, 10(5), 631-639.
- Tien, A.Y., & Eaton, W.W. (1992). Psychopathologic precursors and sociodemographic risk factors for the schizophrenia syndrome. *Archives of General Psychiatry*, 49, 37-46.
- Toomey, R., Wallace, C.J., Corrigan, P.W., Schuldberg, D., & Green, M.F. (1997).

- Social processing correlates of nonverbal social perception in schizophrenia. *Psychiatry*, 60, 292-300.
- VanLancker, D.R., Cornelius, C., & Kreiman, J. (1989). Recognition of emotional-prosodic meanings in speech by autistic, schizophrenic, and normal children. *Developmental Neuropsychology*, 5, 207-226.
- Vauth, R., Rusch, N., Wirtz, M., & Corrigan, P. W. (2004). Does social cognition influence the relation between neurocognitive deficits and vocational functioning in schizophrenia? *Psychiatry Research*, 128, 155-165.
- Velligan, D.I., Bow-Thomas, C.C., Mahurin, R.K., Miller, A.L., & Halgunseth, L.C. (2000). Do specific neurocognitive deficits predict specific domains of community function in schizophrenia? *The Journal of Nervous and Mental Disease*, 188(8), 518-524.
- Velligan, D.I., Mahurin, R.K., Diamond, P.L., Hazleton, B.C., Eckert, S.L., & Miller, A.L. (1997). The functional significance of symptomatology and cognitive function in schizophrenia. *Schizophrenia Research*, 25, 21-31.
- Walker, E.F. (1994). Developmentally moderated expressions of the neuropathology underlying schizophrenia. *Schizophrenia Bulletin*, 20, 453-480.
- Walker, E., Marwit, S., & Emory, E. (1980). A cross-sectional study of emotion recognition in schizophrenics. *Journal of Abnormal Psychology*, 89(3), 428-436.
- Walker, E., McGuire, M., & Bettes, B. (1984). Recognition and identification of facial stimuli by schizophrenics and patients with affective disorders. *British Journal of Clinical Psychology*, 23, 37-44.
- Waterhouse, L., & Fein, D. (1984). Developmental trends in cognitive skills for children diagnosed as autistic and schizophrenic. *Child Development*, 55, 236-248.
- Wechsler, D. (1999). *Wechsler Abbreviated Scale of Intelligence (WASI) Manual*. San Antonio, TX: Psychological Corporation.
- Wolf, L.E., Cornblatt, B.A., Roberts, S.A., Shapiro, B., & Erlenmeyer, L. (2002). Wisconsin Card Sorting deficits in the offspring of schizophrenics in the New York High-Risk Project. *Schizophrenia Research*, 57, 173-182.
- Wolff, S. (1995). *Loners: The Real Life Path of Unusual Children*. London: Routledge.
- Yirmiya, N., & Shaked, M. (2005). Psychiatric disorders in parents of children with autism: A meta-analysis. *Journal of Child Psychology and Psychiatry*, 46(1), 69-83.
- Zhao, G., Liu, X., & Wang, G. (1995). Application of path analysis in the study of risk

factors in schizophrenia. *Chinese Mental Health Journal*, 9, 158-159.

Zuroff, D.C., & Colussy, S.A. (1986). Emotion recognition in schizophrenic and depressed inpatients. *Journal of Clinical Psychology*, 42(3), 411-417.