Published in final edited form as:

Schizophr Res. 2010 August ; 121(1-3): 1–14. doi:10.1016/j.schres.2010.05.033.

Disorganization and Reality Distortion in Schizophrenia: A Meta-Analysis of the Relationship between Positive Symptoms and Neurocognitive Deficits

Joseph Ventura, Ph.D.¹, April D. Thames, Ph.D.¹, Rachel C. Wood, M.A.¹, Lisa H. Guzik, B.A.^{2,3}, and Gerhard S. Helleman, Ph.D.¹

¹UCLA Department of Psychiatry and Biobehavioral Sciences

²Albert Einstein College of Medicine, Yeshiva University, NY

³Nathan S. Kline Institute for Psychiatric Research, Orangeburg, NY

Abstract

Background—Factor analytic studies have shown that in schizophrenia patients, disorganization (conceptual disorganization, bizarre behavior) is a separate dimension from other types of positive symptoms such as reality distortion (delusions and hallucinations). Although some studies have found that disorganization is more strongly linked to neurocognitive deficits and poor functional outcomes than reality distortion, the findings are not always consistent.

Methods—A meta-analysis of 104 studies (combined $n = 8,015$) was conducted to determine the magnitude of the relationship between neurocognition and disorganization as compared to reality distortion. Additional analyses were conducted to determine whether the strength of these relationships differed depending on the neurocognitive domain under investigation.

Results—The relationship between reality distortion and neurocognition was weak ($r = -.04$; $p = .03$) as compared to the moderate association between disorganization and neurocognition ($r = -.23$; $p < .01$). In each of the six neurocognitive domains that were examined, disorganization was more strongly related to neurocognition (r 's range from $-.20$ to $-.26$) than to reality distortion (r 's range from $.01$ to $-.12$).

Conclusions—The effect size of the relationship between neurocognition and disorganization was significantly larger than the effect size of the relationship between neurocognition and reality

© 2010 Elsevier B.V. All rights reserved.

Address correspondence to: Joseph Ventura, Ph.D., UCLA Department of Psychiatry, 300 Medical Plaza, Room 2243, Los Angeles CA 90095-6968, Voice: (310) 206-5225, Fax : (310) 206-3651, jventura@ucla.edu.

Joseph Ventura conceived of the study design, data analysis plan, conducted literature searches, supervised the conduct of the study, and wrote the manuscript. Dr. Helleman conducted the data analysis and commented on drafts of the manuscript. Dr. Thames preformed literature searches, created tables, and commented on drafts of the manuscript. Ms. Wood preformed literature searches, created tables, and commented on drafts of the manuscript. Ms. Guzik conducted literature searches, organized study papers, and created tables. All authors have contributed to and approved the final manuscript.

The authors report no conflict of interest

The findings from this meta-analysis were presented in part at the 11th bi-annual meeting of the International Congress on Schizophrenia Research, Ventura, J., Thames, A.D., Helleman, G.S. Disorganization in Schizophrenia: Positive Symptom or Neurocognitive Deficit. March 28 – April 1, 2007, San Diego, California.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

distortion. These results hold across several neurocognitive domains. These findings support a dimensional view of positive symptoms distinguishing disorganization from reality distortion.

Keywords

meta-analysis; schizophrenia; neurocognition; positive symptoms; disorganization; reality distortion

Introduction

Researchers studying the effects of “first generation” antipsychotic medications have usually relied on positive symptom severity, typically defined as “psychotic relapse,” to evaluate the efficacy of new medications. In many of those studies, positive symptoms such as hallucinations and delusions were combined with conceptual disorganization to form a positive symptom factor (Guy 1976). Over time, several factor analytic studies supported using a three factor model that included positive symptoms, sometimes referred to as reality distortion, negative symptoms, and disorganization. As a result, disorganization has emerged as separate domain worthy of consideration (Bilder et al. 1985; Liddle 1987; Arndt et al. 1991; Toomey et al. 1997; Brekke et al. 2005; Cuesta et al. 2007). In fact, several researchers have suggested that we should consider completely separating symptom dimensions in studying the course and outcome of schizophrenia, i.e., viewing reality distortion (delusions and hallucinations) as independent from disorganization (e.g., conceptual disorganization, bizarre behavior). Furthermore, symptoms of disorganization have been identified as risk factors for a worse course of illness (Shenton et al. 1992; Reed et al. 2002; Metsanen et al. 2004; Metsanen et al. 2006). Providing additional support for a separate examination of positive symptoms, some evidence suggests that disorganization might be a stronger predictor of community functioning than reality distortion (Norman et al. 1999; Ventura et al. 2009).

Several cross-sectional studies have suggested that performance on neurocognitive tests is only weakly correlated with positive symptoms (Roy and DeVriendt 1994; Davidson and McGlashan 1997; Rund et al. 1997; Addington and Addington 1999; Addington and Addington 2000; Brazo et al. 2002; Brazo et al. 2005; Ventura et al. 2009). Studies examining disorganization have found stronger ties to neurocognition than for reality distortion (Nieuwenstein et al. 2001; Dibben et al. 2008; de Gracia Dominguez et al. 2009). Neurocognitive domains such as executive functions have been more robustly linked to disorganization than reality distortion (Aleman et al. 1999; Nieuwenstein et al. 2001; Dibben et al. 2008). Understanding how the relationship of disorganization to neurocognition is different from that of reality distortion might help in understanding the factors that can contribute to a patient’s poor cognitive functioning and ultimately poor functional outcome.

Given the importance of neurocognition to the course and outcome of schizophrenia, hypotheses about the existence of a symptom-based “cognitive disorganization” factor have been proposed. For instance, Bryson and colleagues (Bryson et al. 1999) found that performance on neurocognitive tests was related to cognitive disorganization when using data collected with the Positive and Negative Syndrome Scale (PANSS). Furthermore, in a 5-factor model created using PANSS data, investigators identified a “cognitive factor” (Lindenmayer et al. 1995). Yet, several of the PANSS symptom items that load on this cognitive factor, e.g., conceptual disorganization, mannerisms and posturing, are typically thought of as symptoms associated with disorganization in schizophrenia. The interchangeable use of such labels as “disorganization” and “cognitive disorganization” underscores the importance of clarifying the construct of disorganization and differentiating

these components from other types of positive symptoms in relationship to neurocognitive functioning.

Several meta-analytic studies have found differential relationships between positive symptoms and neurocognitive functioning when examining disorganization versus reality distortion, or when combining both symptom clusters. Aleman and colleagues (Aleman et al. 1999) conducted a meta-analysis of 70 studies that compared the performance of schizophrenic patients and healthy controls on measures of verbal and nonverbal memory impairment. The authors concluded that positive symptoms did not have a moderating effect on memory in schizophrenia. However, positive symptoms that were comprised of reality distortion and disorganization were combined and the separate effects of disorganization were not reported. In a 2001 meta-analysis, disorganization was shown to have a significant positive correlation with Wisconsin Card Sorting Test (WCST) perseverations (average $r = .25$), but not with attention (average $r = .06$) as measured by the Continuous Performance Test (CPT) (Nieuwenstein, Aleman et al. 2001). However, symptoms of reality distortion did not correlate significantly with either of the two neurocognitive measures. In a meta-analysis of 88 studies (Dibben, Rice et al. 2008) a small-to-moderate effect was found for the relationship between executive function and disorganization (effect size $r = -.17$) as compared to reality distortion (effect size $r = .01$). Recently, (de Gracia Dominguez et al. 2009) in a meta-analysis of 58 studies found that IQ and several neurocognitive domains were more correlated with disorganization than was reality distortion. These meta-analytic studies consistently found that disorganization was related to neurocognition, but that reality distortion was not. However, relatively little is known about how these two types of symptoms affect various domains of neurocognition such as those defined in the MATRICS project (Nuechterlein et al. 2004). Those domains were identified by examining several factor analytic studies and include working memory, attention/vigilance, verbal memory, visual memory, reasoning and problem solving, and speed of processing, each of which are worthy of separate study.

Several studies that employed attribution scales and attentional or information processing tasks derived from human experimental psychology provide evidence suggesting that cognitive functions are linked with neurocognitive processes that are associated with positive symptoms (Frith et al. 1992; Hemsley 1993; Bentall et al. 2001; Blackwood et al. 2001; Dibben et al. 2008; Guillem et al. 2008). There are links between certain information processing abnormalities such as poor signal detection, and cognitive misattributional processes, such as “overgeneralization” that underlie delusional thinking. Information processing or attentional disturbances are theoretically related not only to the formation, but the maintenance of delusional beliefs. Patterns of performance of acute schizophrenic patients in these experiments are consistent with cognitive “psychological” models. Knowing more about the differential magnitude of the relationship between reality distortion and neurocognition (as measured by objective tests) could help explain the interrelationship of these variables.

The aim of this meta-analysis was to replicate and expand the examination of the relative strength of the relationship of neurocognition and reality distortion as compared to disorganization across a wide range of neurocognitive domains. Seven domains of cognitive functioning were identified after a thorough review of published factor analyses (Nuechterlein et al. 2004). We aimed to systematically examine relationships between six domains of neurocognition (verbal memory, attention/vigilance, reasoning and problem solving, speed of processing, visual memory, and working memory) and domains of positive symptoms (reality distortion and disorganization). We hypothesize a larger effect size for the relationship between disorganization and neurocognition as compared to the effect size of the relationship between reality distortion and neurocognition. Furthermore, we expected

that combining reality distortion and disorganization into a single dimension would show an intermediate effect size between the relatively pure domains (i.e., reality distortion and disorganization).

Methods

Procedures

We conducted a literature search of the following databases: *PsychInfo*, *PsychAbstracts*, *EBSCOhost*, *PubMed*, and *Google Scholar* covering the period from January 1, 1977 to December 31, 2008. Searches were restricted to articles published in the English language. We used the following key search terms (some terms were combined): *neurocognition*, *neuropsychology*, *schizophrenia*, *disorganization symptoms*, *positive symptoms*, *formal thought disorder*. We also used the search options in PubMed and Google Scholar that allow for a search of papers with related topics. In addition, the reference lists of published articles identified by this method were then screened to locate additional relevant studies.

Using these methods, 176 articles were identified as potentially relevant to this topic. These studies were then evaluated using the following inclusion criteria: (1) Study must have used empirical methods and been published in a peer reviewed journal; (2) study must have contained descriptions of study measures and operational definitions of variables; (3) study must have used structured assessments of symptoms with established scales or standardized methods of symptom assessment; (4) study must have assessed neurocognitive functioning using standardized batteries; (5) study must have been cross-sectional (as defined by an assessment interval of 90 days or less); (6) all participants in the study must have been diagnosed with schizophrenia or schizoaffective disorder according to DSM criteria; (7) statistics reported must have been correlation coefficients or other statistics that could be converted into correlations so that an effect size and z score could be calculated; (8) study data must not have been included or published previously in another paper.

Seventy-two papers did not meet these criteria and were excluded from the study. A total of 104 studies met the inclusion criteria (see Table 1), with a combined total sample of 8,015 patients. The aggregate sample characteristics were as follows: 69% of patients were male, the mean age was 37.5 years, and the mean education was 12.1 years. From the data base of 104 studies, we identified those that reported relationships between neurocognition and reality distortion ($N = 50$) and studies that reported relationships between neurocognition and disorganization ($N = 69$) (see Table 1). Additionally, we identified 40 studies that combined reality distortion with disorganization, e.g., the PANSS positive symptoms scale. Studies that combined reality distortion and disorganization were coded and analyzed separately to determine whether those studies reported stronger effect sizes between positive symptoms (broadly defined) and neurocognition than reality distortion alone. Studies of both inpatients and outpatients were included. Data from all of the 104 studies were compiled in a database containing: (1) the author(s) and year of publication; (2) demographic information; (3) description of the neuropsychological tests used, e.g., California Verbal Learning Test (CVLT), and the neurocognitive domain assessed by each test; (4) symptom measures, e.g., Scale for the Assessment of Positive Symptoms (SAPS), and the symptom types examined by these measures, e.g. disorganization; and (4) study statistics, e.g., correlation coefficients.

Defining Neurocognition and Positive Symptoms

For the current study, *neurocognition* was operationally defined as cognitive functions, such as verbal memory and working memory that are objectively measurable with standardized neuropsychological tests, such as the WAIS Digit Span Test (Table 2). One of the primary goals of the NIMH Measurement and Treatment Research to Improve Cognition in

Schizophrenia (MATRICS) was to develop a reliable and valid consensus cognitive battery. An essential step in the process was to identify the major separable cognitive deficits in schizophrenia. After evaluating the empirical evidence that consisted of the examination of factor analytic studies, seven separable domains were identified that were replicable across studies (Nuechterlein et al. 2004). The current study included 6 of the 7 MATRICS domains of cognitive functioning: Speed of Processing, Attention/Vigilance, Working Memory, Verbal Memory, Reasoning and Problem Solving, and Visual Memory. Social cognition was excluded from the current analyses because it is not a traditional domain of neurocognition, and at this point there are relatively fewer studies that address the relationship between positive symptoms and social cognition. The dimension of *reality distortion* included positive symptoms consisting of delusions, e.g., suspiciousness, and hallucinations, e.g., auditory, as measured by items from structured symptom scales, e.g. PANSS, BPRS (Table 2). The dimension of *disorganization* included positive symptom items, such as conceptual disorganization, formal thought disorder, mannerisms and posturing, and bizarre behavior, as measured by structured assessment scales, e.g., PANSS, SAPS (for a review, see (Bryson et al. 1999). The *combined* category was comprised of studies of neurocognition in which symptoms of reality distortion and disorganization were combined, e.g., by using the PANSS positive symptom scale which includes delusions, hallucinations, and conceptual disorganization, or the SAPS total score which combines delusions, hallucinations, and formal thought disorder.

Data Analysis Procedures

For the main analysis we combined all six domains of neurocognitive functioning and created one composite neurocognitive variable to represent neurocognition. We examined the relationship between disorganization and neurocognition, and then reality distortion and neurocognition. We were primarily interested in the differences in effect size magnitude between reality distortion and disorganization on neurocognition. We also examined the relationship between neurocognition and combined positive symptoms, i.e., reality distortion and disorganization. We note that for several published studies, combining the categories of reality distortion and disorganization amounted to adding only one item to the cluster of symptoms, e.g., conceptual disorganization.

The first step for these analyses was to transform the observed (published) correlations in each study using Fisher's r-to-z transformation. Where indicated, multiple results were averaged from the same domain, e.g., several tests of working memory were combined into a single observation for a given study. The correlation coefficients were then combined into a single estimate of the population correlation by averaging them weighted by sample size (Hedges and Olkin 1984). Based on these combined correlation coefficients, the studies were then tested for homogeneity by calculating a Q-statistic. When examining separate neurocognitive domains, heterogeneity was evident in most of the domains (see appendix). Heterogeneity of measures is a known problem in the field. We tested for association of the heterogeneity for the following variables: age, education, gender ratio, inpatient or outpatient status, and sample size. The heterogeneity of the studies was related in expected ways to heterogeneity of education, gender, and sample size. In the appendix the alternative estimates for the overall effect sizes based on the homogeneous subset studies are shown. Although a few studies were identified as outliers in some of the neurocognitive domains, we found it difficult to justify excluding one study for not being a valid source of information for a given domain, and yet valid for another. Using this rationale, the study results are based on parameter estimates from all studies. For comparison purposes, parameter estimates based on the homogeneous subset studies are provided (see appendix). Although the significance of the reported p-values is potentially inflated, the data presented

here can be considered as being a reasonably robust representation of the relationships between the variables of interest.

Results

Neurocognition and Positive Symptoms

To address the primary question posed in this study, we examined separately the relationship between neurocognition and reality distortion, and the relationship between neurocognition and disorganization (see Table 3). The cross-sectional relationship between reality distortion and the composite neurocognition score was statistically significant but the effect size was weak ($r = -.04$, $p = .03$). The effect size of the cross-sectional relationship between disorganization and the composite neurocognition score was moderate and statistically significant ($r = -.23$, $p < .01$). We also examined the relationship between neurocognition and the combined category of reality distortion and disorganization symptoms. A meta-analysis of those studies ($N = 40$, subjects = 4,654) showed a statistically significant but weak effect for positive symptoms and neurocognition ($r = -.05$, $p < .01$). Contrary to our hypothesis, the combined category of positive symptoms did not yield intermediate correlations with the composite neurocognition score or the separate domains of neurocognition.

Neurocognitive Domains and Positive Symptoms

A number of published studies included in this study examined specific relationships between symptoms and several key domains of neurocognitive functioning. Here is a breakdown of the total number of studies in each domain: speed of processing ($N = 60$), reasoning and problem solving ($N = 58$), working memory ($N = 33$), visual memory ($N = 18$), verbal memory ($N = 32$), and attention/vigilance ($N = 29$). The results indicate that more domains of neurocognition were related to disorganization as compared to reality distortion (Table 3). In each of the six MATRICS domains that were examined, neurocognition was more highly correlated with disorganization (r 's range from $-.20$ to $-.26$) than was the case for reality distortion (r 's range from $-.01$ to $-.12$). In addition, for disorganization, moderate effects were found for attention/vigilance ($r = -.25$), reasoning and problem solving ($r = -.24$), and speed of processing ($r = -.26$) compared to weaker relationships with reality distortion ($r = -.12$, $r = -.06$, $r = -.03$, respectively). Of the six MATRICS neurocognitive domains that were examined, attention/vigilance was the most highly correlated to reality distortion ($r = -.12$, $p < .01$), still a small effect size but larger than the effects of the remaining domains which were near zero (r 's range from $.01$ to $-.06$; Table 3).

Discussion

Meta-analytic techniques were used to examine studies of positive symptoms defined as reality distortion and disorganization in relationship to neuropsychological functioning in schizophrenia. Consistent with the previous literature, our results demonstrated a moderate ($r = -.23$) relationship between disorganization and neurocognition, while the relationship between neurocognition and reality distortion was relatively weak ($r = -.04$). We found evidence that disorganization was related to all domains of cognitive functioning we examined, whereas reality distortion showed no such broad association. Our findings suggest that disorganization represents a separate set of positive symptoms from reality distortion with independent links to neurocognition. Our findings support theory and results from several studies in schizophrenia suggesting that positive symptom factors should be considered separately (Grube et al. 1998; Peralta and Cuesta 1999; Bell and Mishara 2006).

Our analyses suggest that for many of the previous studies which combined different types of positive symptoms, the observed relationships between positive symptom factors and the other study variables might have obscured important findings. For example, the PANSS positive symptom cluster combines hallucinations, delusions, excitement, and hostility, with conceptual disorganization. Yet, several investigators (Toomey et al. 1997; Grube et al. 1998; Peralta and Cuesta 1999; Stuart et al. 1999; Peralta and Cuesta 2001) have suggested that perhaps studies should consider correlating variables of interest with single symptom items, such as hallucinations. Our analysis support the necessity of at least distinguishing between the two broad constructs of reality distortion and disorganization. In addition, disorganization and cognitive disorganization appear to be related symptom concepts that overlap. Disorganization usually includes conceptual disorganization, mannerisms and posturing, disorientation, and bizarre behavior whereas cognitive disorganization includes those items and stereotyped thinking, difficulties in abstract thinking, poor attention, and inappropriate affect. The two symptom groups are most likely highly correlated even though they contain slightly different symptoms most of which are correlated with neurocognitive deficits. To validate the concept of cognitive disorganization, future meta-analyses would need to separately examine these two clusters of symptoms to determine their intercorrelation and relationship to neurocognition.

The notion that disorganization is a separate positive symptom factor is also supported by studies examining the relationship between positive symptoms and community-based functioning. Several studies indicated that the relationship of disorganization to community-based functioning is relatively strong (Reed et al. 2002; Smith et al. 2002; Evans et al. 2004; Takahashi et al. 2005), while a meta-analysis showed that the relationship between reality distortion and community-based functioning was weak (estimated $r = -.03$; (Ventura et al. 2009). Thus, while symptoms such as hallucinations and delusions might not consistently interfere with a person's ability to socialize or to perform at work, the data suggest that disorganization symptoms might be more closely linked to impairments in day-to-day functioning. Patients might learn to compensate for reality distortion symptoms in various ways, e.g., ignoring beliefs about aliens during a social interaction or while working in a retail clothing store, but disorganization symptoms might cause more of a disruption in daily functioning, e.g. disorganized speech interfering with functional aspects of communication.

We found that reality distortion was relatively more highly correlated with attentional deficits ($r = -.12$, $p < .01$) than other domains of neurocognition (r 's ranging from .01 to -.06). This association between attentional deficits and reality distortion is consistent with findings and theory from a series of studies conducted in the late 1980s and early 1990s by British researchers such as Richard Bentall, Chris Firth, and David Hemsley (for a review see, Blackwood et al. 2001). According to experiments in human psychology, positive symptoms such as delusions and/or hallucinations, are believed to be associated with attentional and information processing deficits. These sorts of distortions in cognitive processing are thought to be related to misattributions and altered perceptions of environmental cues, such as reliance on internal states, and situational context. Delusions are believed to be associated with an attentional bias toward threatening information and a tendency to misattribute meaning, which usually occurs in accordance with a patient's set of rigid expectations (Frith 1979; Magaro 1980; Bentall et al. 1991; Frith et al. 1992; Hemsley 1993). For example, delusional patients have been shown to be overconfident in their responses and require less information before "jumping to a conclusion" (Garety et al. 1991). In addition, hallucinations have been associated with impairments in attentional processes and perceptions that lead to the intrusion of unintended information into conscious awareness (Bentall and Slade 1985; Bentall et al. 1991). Finally, reality distortion was not associated with deficits in most of the neurocognitive domains we examined, which is in

accordance with the British theorists and predictions by Liddle and colleagues (Liddle and Morris 1991).

There are several limitations to this study that warrant mentioning, some of which are common to all meta-analytic investigations (Rosenthal 1991; Lipsey and Wilson 2001). For example, the study sample was not randomly selected. Also, we believe based on theoretical considerations that several domains of neurocognition are an underlying cause of the severity of disorganization, but the data examined in this meta-analysis was cross-sectional rather than longitudinal in design, thus the choice regarding which variables are conceptualized as “cause” and which to consider an “effect” is essentially arbitrary. Additionally, neurocognition is not a homogenous concept and its definition in this meta-analysis is influenced by how common a particular set of neurocognitive tests appear in the published literature. For example, our reasoning and problem solving domain is defined largely by the WCST. Also, we note the possibility that measurement overlap resulted in an inflated correlation between neurocognition and disorganization symptoms. For example, the PANSS includes an item that assesses difficulties in abstract thinking in the disorganization factor. Despite the fact that each of these study limitations suggest that caution should be used in interpreting the results, our findings still provide some direction for future research on neurocognition and disorganization. We want to emphasize that a meta-analysis cannot replace focused empirical research.

The strong relationship between neurocognition and disorganization would profit from further examination. If causality is validated through longitudinal research, this relationship would have implications for intervention in schizophrenia. Considering the central role that neurocognitive deficits play in relationship to daily functioning in schizophrenia, it is not surprising that cognitive deficits have emerged as important targets for new treatments (Green and Nuechterlein 1999; Carpenter and Gold 2002; Carpenter 2004; Gold 2004). If neurocognition is related to disorganization, then perhaps improvement in community functioning could be mediated by improvements in disorganization. Also, our finding that attentional deficits were most closely related to reality distortion is supportive of interventions which improve attentional control, e.g., attentional training, or interventions that specifically target the cognitive component of delusions and hallucinations, such as Cognitive Behavior Theory for psychosis.

Appendix 1

Meta Analysis Diagnostics

Reality distortion	r	Type of N	Critical N	Q statistic	p	Significant study characteristics	Number of Studies dropped for homogeneity	r
Verbal Memory	-.01	S	59101	17.35	.36			
Visual Memory	.01	S	59398	8.13	.62			
Working Memory	-.00	S	3840748	10.32	.92			
Reasoning and Problem solving	-.06	FD	485	32.05	.23			
Speed of processing	-.03	S	3033	67.59	<.01	Gender, Sample Size	Bell et al., 1994	.01
Attention	-.12	FD	1295	5.61	.85			
Combined Category	r	Type of N	Critical N	Q statistic	p	Significant study characteristics	Number of Studies dropped for homogeneity	r
Verbal Memory	-.07	FD	5493	19.17	.12			

Reality distortion	r	Type of N	Critical N	Q statistic	p	Significant study characteristics	Number of Studies dropped for homogeneity	r
Visual Memory	-.15	FD	1443	8.42	.39			
Working Memory	-.06	FD	1895	30.58	<.01	Education	Bressi et al., 1996 Pukrop et al., 2003	-.06
Reasoning and Problem solving	-.03	S	898	54.44	<.01	(*)	Braff et al., 1991 Bryson, Bell, Grieg, 1999	-.01
Speed of processing	-.02	S	8439	26.05	.19			
Attention	.04	FD	187	21.00	.14			
Disorganization	r	Type of N	Critical N	Q statistic	p	Significant study characteristics	Number of Studies dropped for homogeneity	r
Verbal Memory	-.20	FD	22907	45.94	<.01	(*)	Eckman and Shean, 2000, Mohamed et al., 1999	-.19
Visual Memory	-.20	FD	9286	27.95	.01	Gender	Mohamed et al., 1991	-.23
Working Memory	-.20	FD	7989	20.51	.43			
Reasoning and Problem solving	-.24	FD	74399	77.03	<.01	Sample Size	Franke et al., 1992, Klingberg, Wittorf, Wiedemann, 2006, Nestor et al., 1998	-.28
Speed of processing	-.26	FD	101862	64.68	.01	(*)	Eckman & Shean, 2000, Mohamed et al., 1991, Hofer et al., 2007	-.25
Attention	-.25	FD	31184	40.32	<.01	(*)	Mohamed et al., 1999	-.27

Note: 1) Only 2 studies were outliers in more than one of the neurocognitive domains: Eckman and Shean, 2000 (2 domains) and Mohamed et al., 1999 (4 domains) whereas all other studies showed discrepancies only in one domain. 2) for Type of N, S = number of studies with the same effect size required to get a significant result and FD = number of unpublished studies with an r of 0 required to make this result not significant (file drawer problem). 3) for Significant Study Characteristics an (*) indicates that study heterogeneity was not associated with any of the study parameters.

Acknowledgments

This research was supported in part by National Institute of Mental Health Grants R21MH07391 (PI: Joseph Ventura, Robert Bilder, Co-PI, Steven Reise, Co-PI), MH37705 (P.I.: Keith H. Nuechterlein, Ph.D.), and P50 MH066286 (P.I.: Keith H. Nuechterlein, Ph.D.).

Funding Source The funding source did not play role in the design, implementation, results, or publication of this paper.

References

- Addington J, Addington D. Visual attention and symptoms in schizophrenia: a 1-year follow-up. *Schizophr Res.* 1998; 34:95–9. [PubMed: 9824881]
- Addington J, Addington D. Neurocognitive and social functioning in schizophrenia. *Schizophrenia Bulletin.* 1999a; 25:173–182. [PubMed: 10098920]
- Addington J, Addington D. Neurocognitive and social functioning in schizophrenia. *Schizophrenia Bulletin.* 1999b; 25:173–82. [PubMed: 10098920]
- Addington J, Addington D. Neurocognitive and social functioning in schizophrenia: A 2.5 year follow-up study. *Schizophrenia Research.* 2000; 44:47–56. [PubMed: 10867311]

- Addington J, Addington D, Gasbarre L. Distractibility and symptoms in schizophrenia. *Journal of Psychiatry and Neuroscience*. 1997; 22:180. [PubMed: 9183116]
- Addington J, Addington D, Maticka-Tyndale E. Cognitive functioning and positive and negative symptoms in schizophrenia. *Schizophr Res*. 1991; 5:123–34. [PubMed: 1931805]
- Aleman A, Hijman R, de Haan EHF, Kahn RS. Memory impairment in schizophrenia: A meta-analysis. *American Journal of Psychiatry*. 1999; 156:1358–1366. [PubMed: 10484945]
- Allen DN, Anastasiou A, Goldstein G, Gilbertson M, van Kammen DP. Influence of haloperidol on the relationship of frontal lobe function to psychomotor poverty and disorganization syndromes. *Psychiatry research*. 2000; 93:33–39. [PubMed: 10699226]
- Arndt S, Alliger RJ, Andreasen NC. The distinction of positive and negative symptoms. The failure of a two-dimensional model. *Br J Psychiatry*. 1991; 158:317–22. [PubMed: 2036528]
- Barch DM, Carter CS, Perlstein W, Baird J, Cohen JD, Schooler N. Increased Stroop facilitation effects in schizophrenia are not due to increased automatic spreading activation. *Schizophrenia research*. 1999; 39:51–64. [PubMed: 10480667]
- Basso MR, Nasrallah HA, Olson SC, Bornstein RA. Neuropsychological correlates of negative, disorganized and psychotic symptoms in schizophrenia. *Schizophr Res*. 1998; 31:99–111. [PubMed: 9689714]
- Baxter RD, Liddle PF. Neuropsychological deficits associated with schizophrenic syndromes. *Schizophrenia research*. 1998; 30:239–249. [PubMed: 9589518]
- Bell MD, Lysaker PH, Milstein RM, Beam-Goulet JL. Concurrent validity of the cognitive component of schizophrenia: relationship of PANSS scores to neuropsychological assessments. *Psychiatry Res*. 1994; 54:51–58. [PubMed: 7701028]
- Bell MD, Mishara AL. Does negative symptom change relate to neurocognitive change in schizophrenia? Implications for targeted treatments. *Schizophrenia Research*. 2006; 81:17–27. [PubMed: 16297601]
- Bentall RP, Baker GA, Havers S. Reality monitoring and psychotic hallucinations. *Br J Clin Psychol*. 1991; 30(Pt 3):213–22. [PubMed: 1933040]
- Bentall RP, Corcoran R, Howard R, Blackwood N, Kinderman P. Persecutory delusions: a review and theoretical integration. *Clin Psychol Rev*. 2001; 21:1143–92. [PubMed: 11702511]
- Bentall RP, Kaney S, Dewey ME. Paranoia and social reasoning: an attribution theory analysis. *Br J Clin Psychol*. 1991; 30(Pt 1):13–23. [PubMed: 2021784]
- Bentall RP, Slade PD. Reality testing and auditory hallucinations: a signal detection analysis. *Br J Clin Psychol*. 1985; 24(Pt 3):159–69. [PubMed: 4052663]
- Berman I, Viegner B, Merson A, Allan E, Pappas D, Green AI. Differential relationships between positive and negative symptoms and neuropsychological deficits in schizophrenia. *Schizophr Res*. 1997; 25:1–10. [PubMed: 9176922]
- Bilder RM, Goldman RS, Robinson D, Reiter G, Bell L, Bates JA, Pappadopoulos E, Willson DF, Alvir JMJ, Woerner MG, Geisler S, Kane JM, Lieberman JA. Neuropsychology of first-episode schizophrenia: Initial characterization and clinical correlates. *American Journal of Psychiatry*. 2000; 157:549–59. [PubMed: 10739413]
- Bilder RM, Mukherjee S, Rieder RO, Pandurangi AK. Symptomatic and neuropsychological components of defect states. *Schizophr Bull*. 1985a; 11:409–19. [PubMed: 4035304]
- Bilder RM, Mukherjee S, Rieder RO, Pandurangi AK. Symptomatic and neuropsychological components of defect states. *Schizophrenia Bulletin*. 1985b; 11:409–419. [PubMed: 4035304]
- Blackwood NJ, Howard RJ, Bentall RP, Murray RM. Cognitive neuropsychiatric models of persecutory delusions. *Am J Psychiatry*. 2001; 158:527–39. [PubMed: 11282685]
- Bowie CR, Harvey PD, Moriarty PJ, Parrella M, White L, Davis KL. A comprehensive analysis of verbal fluency deficit in geriatric schizophrenia. *Arch Clin Neuropsychol*. 2004; 19:289–303. [PubMed: 15010092]
- Bozikas VP, Kosmidis MH, Kioperlidou K, Karavatos A. Relationship between psychopathology and cognitive functioning in schizophrenia. *Compr Psychiatry*. 2004; 45:392–400. [PubMed: 15332203]

- Braff DL, Heaton R, Kuck J, Cullum M, Moranville J, Grant I, Zisook S. The generalized pattern of neuropsychological deficits in outpatients with chronic schizophrenia with heterogeneous Wisconsin Card Sorting Test results. *Arch Gen Psychiatry*. 1991; 48:891–8. [PubMed: 1929758]
- Brazo P, Delamillieure P, Morello R, Halbecq I, Marié RM, Dollfus S. Impairments of executive/attentional functions in schizophrenia with primary and secondary negative symptoms. *Psychiatry Research*. 2005; 133:45–55. [PubMed: 15698676]
- Brazo P, Marié RM, Halbecq I, Benali K, Segard L, Delamillieure P, Langlois-Théry S, Van Der Elst A, Thibaut F, Petit M. Cognitive patterns in subtypes of schizophrenia. *European Psychiatry*. 2002; 17:155–162. [PubMed: 12052576]
- Brebion G, Smith MJ, Amador X, Malaspina D, Gorman JM. Clinical correlates of memory in schizophrenia: differential links between depression, positive and negative symptoms, and two types of memory impairment. *Am J Psychiatry*. 1997; 154:1538–43. [PubMed: 9356561]
- Breier A, Schreiber JL, Dyer J, Pickar D. National Institute of Mental Health longitudinal study of chronic schizophrenia: prognosis and predictors of outcome. *Archives of General Psychiatry*. 1991; 48:239. [PubMed: 1671741]
- Brekke JS, Kay DD, Kee KS, Green MF. Biosocial pathways to functional outcome in schizophrenia. *Schizophrenia Research*. 2005; 80:213–225. [PubMed: 16137859]
- Brekke JS, Raine A, Thomson C. Cognitive and psychophysiological correlates of positive, negative, and disorganized symptoms in the schizophrenia spectrum. *Psychiatry Res*. 1995; 57:241–50. [PubMed: 7501734]
- Bressi S, Miele L, Bressi C, Astori S, Gimosti E, Linciano AD, Sessini M, Invernizzi G. Deficit of central executive component of working memory in schizophrenia. *New Trends in Experimental and Clinical Psychiatry*. 1996; 12:243–252.
- Bryson G, Bell M, Greig T, Kaplan E. Internal consistency, temporal stability and neuropsychological correlates of three cognitive components of the Positive and Negative Syndrome Scale (PANSS). *Schizophr Res*. 1999; 38:27–35. [PubMed: 10427608]
- Caligiuri MP, Hellige JB, Cherry BJ, Kwok W, Lulow LL, Lohr JB. Lateralized cognitive dysfunction and psychotic symptoms in schizophrenia. *Schizophr Res*. 2005; 80:151–61. [PubMed: 16125374]
- Cameron AM, Oram J, Geffen GM, Kavanagh DJ, McGrath JJ, Geffen LB. Working memory correlates of three symptom clusters in schizophrenia. *Psychiatry research*. 2002; 110:49–61. [PubMed: 12007593]
- Carpenter WT. Clinical constructs and therapeutic discovery. *Schizophrenia Research*. 2004; 72:69–73. [PubMed: 15531408]
- Carpenter WT, Gold JM. Another view of therapy for cognition in schizophrenia. *Biological Psychiatry*. 2002; 51:969–971. [PubMed: 12062880]
- Carter C, Robertson L, Nordahl T, Chaderjian M, Kraft L, O'Shoro-Celaya L. Spatial working memory deficits and their relationship to negative symptoms in unmedicated schizophrenia patients. *Biological Psychiatry*. 1996; 40:930–932. [PubMed: 8896783]
- Cohen AS, Docherty NM. Symptom-oriented versus syndrome approaches to resolving heterogeneity of neuropsychological functioning in schizophrenia. *Journal of Neuropsychiatry and Clinical Neurosciences*. 2005; 17:384. [PubMed: 16179662]
- Collins AA, Remington GJ, Coulter K, Birkett K. Insight, neurocognitive function and symptom clusters in chronic schizophrenia. *Schizophr Res*. 1997; 27:37–44. [PubMed: 9373893]
- Cuesta MJ, Peralta V. Cognitive disorders in the positive, negative, and disorganization syndromes of schizophrenia. *Psychiatry Res*. 1995; 58:227–35. [PubMed: 8570778]
- Cuesta MJ, Peralta V, Caro F, de Leon J. Schizophrenic syndrome and Wisconsin Card Sorting Test dimensions. *Psychiatry research*. 1995; 58:45–51. [PubMed: 8539311]
- Cuesta MJ, Ugarte MD, Goicoa T, Eraso S, Peralta V. A taxometric analysis of schizophrenia symptoms. *Psychiatry Res*. 2007; 150:245–53. [PubMed: 17316823]
- Daban C, Amado I, Bayle F, Gut A, Willard D, Bourdel MC, Loo H, Olie JP, Millet B, Krebs MO, Poirier MF. Correlation between clinical syndromes and neuropsychological tasks in unmedicated patients with recent onset schizophrenia. *Psychiatry Res*. 2002; 113:83–92. [PubMed: 12467948]
- Davidson L, McGlashan TH. The Varied Outcomes of Schizophrenia. *Can J Psychiatry*. 1997; 42:34–43. [PubMed: 9040921]

- de Gracia Dominguez M, Viechtbauer W, Simons C, van Os J, Krabbendam L. Are psychotic psychopathology and neurocognition orthogonal? A systematic review of their associations. *Psychological bulletin*. 2009; 135:157–171. [PubMed: 19210058]
- Dibben CR, Rice C, Laws K, McKenna PJ. Is executive impairment associated with schizophrenic syndromes? A meta-analysis. *Psychol Med*. 2008:1–12.
- Docherty NM. Cognitive impairments and disordered speech in schizophrenia: thought disorder, disorganization, and communication failure perspectives. *Journal of Abnormal Psychology*. 2005; 114:269–278. [PubMed: 15869357]
- Docherty NM, Gordinier SW. Immediate memory, attention and communication disturbances in schizophrenia patients and their relatives. *Psychological Medicine*. 1999; 29:189–197. [PubMed: 10077307]
- Donohoe G, Corvin A, Robertson IH. Evidence that specific executive functions predict symptom variance among schizophrenia patients with a predominantly negative symptom profile. *Cognit Neuropsychiatry*. 2006; 11:13–32. [PubMed: 16537231]
- Eckman PS, Shean GD. Impairment in test performance and symptom dimensions of schizophrenia. *Journal of psychiatric research*. 2000; 34:147–153. [PubMed: 10758257]
- Evans JD, Bond GR, Meyer PS, Kim HW, Lysaker PH, Gibson PJ, Tunis S. Cognitive and clinical predictors of success in vocational rehabilitation in schizophrenia. *Schizophr Res*. 2004; 70:331–42. [PubMed: 15329308]
- Franke P, Maier W, Hain C, Klingler T. Wisconsin Card Sorting Test: an indicator of vulnerability to schizophrenia? *Schizophr Res*. 1992; 6:243–9. [PubMed: 1571316]
- Frith CD. Consciousness, information processing and schizophrenia. *Br J Psychiatry*. 1979; 134:225–35. [PubMed: 509004]
- Frith CD, Friston KJ, Liddle PF, Frackowiak RS. PET imaging and cognition in schizophrenia. *J R Soc Med*. 1992; 85:222–4. [PubMed: 1433065]
- Garety PA, Hemsley DR, Wessely S. Reasoning in deluded schizophrenic and paranoid patients. Biases in performance on a probabilistic inference task. *J Nerv Ment Dis*. 1991; 179:194–201. [PubMed: 2007889]
- Glahn DC, Cannon TD, Gur RE, Ragland JD, Gur RC. Working memory constrains abstraction in schizophrenia. *Biological Psychiatry*. 2000; 47:34–42. [PubMed: 10650447]
- Gold JM. Cognitive deficits as treatment targets in schizophrenia. *Schizophrenia Research*. 2004; 72:21–8. [PubMed: 15531404]
- Good KP, Rabinowitz J, Whitehorn D, Harvey PD, DeSmedt G, Kopala LC. The relationship of neuropsychological test performance with the PANSS in antipsychotic naïve, first-episode psychosis patients. *Schizophrenia research*. 2004; 68:11–19. [PubMed: 15037335]
- Gooding DC, Tallent KA. Nonverbal working memory deficits in schizophrenia patients: evidence of a supramodal executive processing deficit. *Schizophr Res*. 2004; 68:189–201. [PubMed: 15099602]
- Green MF, Nuechterlein KH. Should schizophrenia be treated as a neurocognitive disorder? *Schizophrenia Bulletin*. 1999; 25:309–18. [PubMed: 10416733]
- Grube B, Bilder R, Goldman R. Meta-analysis of symptom factors in schizophrenia. *Schizophrenia Research*. 1998a; 31:113–120. [PubMed: 9689715]
- Grube BS, Bilder RM, Goldman RS. Meta-analysis of symptom factors in schizophrenia. *Schizophrenia Research*. 1998b; 31:113–120. [PubMed: 9689715]
- Guillem F, Bicu M, Bloom D, Wolf MA, Desautels R, Lalinec M, Kraus D, Debruille JB. Neuropsychological impairments in the syndromes of schizophrenia: a comparison between different dimensional models. *Brain Cogn*. 2001; 46:153–9. [PubMed: 11527317]
- Guillem F, Pampoulova T, Rinaldi M, Stip E. Temperament and executive dysfunctions in schizophrenia. *Schizophr Res*. 2008; 104:175–84. [PubMed: 18640010]
- Guy, W. *Assessment Manual for Psychopharmacology ECDEU*. Rockville, MD: U.S. Department of Health and Human Services; 1976.
- Hammer MA, Katsanis J, Iacono WG. The relationship between negative symptoms and neuropsychological performance. *Biol Psychiatry*. 1995; 37:828–30. [PubMed: 7647170]

- Harvey PD, Green MF, Bowie C, Loebel A. The dimensions of clinical and cognitive change in schizophrenia: evidence for independence of improvements. *Psychopharmacology*. 2006; 187:356–363. [PubMed: 16783539]
- Hedges LV, Olkin I. Nonparametric estimators of effect size in meta-analysis. *Psychological bulletin*. 1984; 96:573–580.
- Hemsley DR. A simple (or simplistic?) cognitive model for schizophrenia. *Behav Res Ther*. 1993; 31:633–45. [PubMed: 8216165]
- Heydebrand G, Weiser M, Rabinowitz J, Hoff AL, DeLisi LE, Csernansky JG. Correlates of cognitive deficits in first episode schizophrenia. *Schizophrenia research*. 2004; 68:1–9. [PubMed: 15037334]
- Himelhoch S, Taylor SF, Goldman RS, Tandon R. Frontal lobe tasks, antipsychotic medication, and schizophrenia syndromes. *Biological Psychiatry*. 1996; 39:227–229. [PubMed: 8837987]
- Hofer A, Baumgartner S, Bodner T, Edlinger M, Hummer M, Kemmler G, Rettenbacher MA, Fleischhacker WW. Patient outcomes in schizophrenia II: the impact of cognition. *European Psychiatry*. 2005; 20:395–402. [PubMed: 16171654]
- Hofer A, Niedermayer B, Kemmler G, Rettenbacher MA, Trebo E, Widschwendter CG, Fleischhacker WW. Cognitive impairment in schizophrenia: Clinical ratings are not a suitable alternative to neuropsychological testing. *Schizophrenia research*. 2007; 92:126–131. [PubMed: 17350807]
- Howanitz E, Cicalese C, Harvey PD. Verbal fluency and psychiatric symptoms in geriatric schizophrenia. *Schizophr Res*. 2000; 42:167–9. [PubMed: 10785575]
- Izawa R, Yamamoto S. Spatio-temporal disintegration of visual perception in schizophrenia as revealed by a novel cognitive task, the Searchlight Test. *Schizophrenia research*. 2002; 53:67–74. [PubMed: 11728839]
- Keefe RS, Bilder RM, Harvey PD, Davis SM, Palmer BW, Gold JM, Meltzer HY, Green MF, Miller del D, Canive JM, Adler LW, Manschreck TC, Swartz M, Rosenheck R, Perkins DO, Walker TM, Stroup TS, McEvoy JP, Lieberman JA. Baseline neurocognitive deficits in the CATIE schizophrenia trial. *Neuropsychopharmacology*. 2006; 31:2033–46. [PubMed: 16641947]
- Kerns JG, Berenbaum H, Barch DM, Banich MT, Stolar N. Word production in schizophrenia and its relationship to positive symptoms. *Psychiatry Res*. 1999; 87:29–37. [PubMed: 10512152]
- Klingberg S, Wittorf A, Wiedemann G. Disorganization and cognitive impairment in schizophrenia: independent symptom dimensions? *Eur Arch Psychiatry Clin Neurosci*. 2006; 256:532–40. [PubMed: 17164977]
- Langdon R, Coltheart M, Ward PB, Catts SV. Disturbed communication in schizophrenia: the role of poor pragmatics and poor mind-reading. *Psychological Medicine*. 2002; 32:1273–1284. [PubMed: 12420896]
- Lees Roitman SE, Keefe RSE, Harvey PD, Siever LJ, Mohs RC. Attentional and eye tracking deficits correlate with negative symptoms in schizophrenia. *Schizophrenia research*. 1997; 26:139–146. [PubMed: 9323344]
- Leeson VC, Barnes TRE, Harrison M, Matheson E, Harrison I, Mutsatsa SH, Ron MA, Joyce EM. The relationship between IQ, memory, executive function, and processing speed in recent-onset psychosis: 1-year stability and clinical outcome. *Schizophrenia Bulletin*. 2008
- Liddle PF. Schizophrenic syndromes, cognitive performance and neurological dysfunction. *Psychol Med*. 1987a; 17:49–57. [PubMed: 3575577]
- Liddle PF. The symptoms of chronic schizophrenia. A re-examination of the positive-negative dichotomy. *Br J Psychiatry*. 1987b; 151:145–51. [PubMed: 3690102]
- Liddle PF, Morris DL. Schizophrenic syndromes and frontal lobe performance. *Br J Psychiatry*. 1991; 158:340–5. [PubMed: 2036532]
- Lindenmayer JP, Grochowski S, Hyman RB. Five factor model of schizophrenia: replication across samples. *Schizophr Res*. 1995; 14:229–34. [PubMed: 7766534]
- Lipsey, MW.; Wilson, DB. *Practical Meta-Analysis*. Sage Pubns; 2001.
- Liu SK, Hwu HG, Chen WJ. Clinical symptom dimensions and deficits on the Continuous Performance Test in schizophrenia. *Schizophr Res*. 1997; 25:211–9. [PubMed: 9264176]
- Løberg EM, Jørgensen HA, Green MF, Rund BR, Lund A, Diseth Å, Øie M, Hugdahl K. Positive symptoms and duration of illness predict functional laterality and attention modulation in schizophrenia. *Acta Psychiatrica Scandinavica*. 2006; 113:322–331. [PubMed: 16638077]

- Lucas S, Fitzgerald D, Redoblado-Hodge MA, Anderson J, Sanbrook M, Harris A, Brennan J. Neuropsychological correlates of symptom profiles in first episode schizophrenia. *Schizophrenia research*. 2004; 71:323–330. [PubMed: 15474902]
- Maeda K, Kasai K, Uetsuki M, Hata A, Araki T, Rogers MA, Yamasue H, Iwanami A. Increased positive thought disorder with illness duration in patients with schizophrenia. *Psychiatry Clin Neurosci*. 2007; 61:687–90. [PubMed: 18081634]
- Magaro, PA. *Cognition in Schizophrenia and Paranoia: The Integration Process*. Hillsdale NJ: Lawrence Erlbaum; 1980.
- Mahurin RK, Velligan DI, Hazleton B, Davis JM, Eckert S, Miller AL. Trail making test errors and executive function in schizophrenia and depression. *The Clinical Neuropsychologist*. 2006; 20:271–288. [PubMed: 16690547]
- Metsanen M, Wahlberg KE, Hakko H, Saarento O, Tienari P. Thought Disorder Index: a longitudinal study of severity levels and schizophrenia factors. *J Psychiatr Res*. 2006; 40:258–66. [PubMed: 15907939]
- Metsanen M, Wahlberg KE, Saarento O, Tarvainen T, Miettunen J, Koistinen P, Lakso K, Tienari P. Early presence of thought disorder as a prospective sign of mental disorder. *Psychiatry Res*. 2004; 125:193–203. [PubMed: 15051180]
- Minzenberg MJ, Poole JH, Vinogradov S, Shenaut GK, Ober BA. Slowed lexical access is uniquely associated with positive and disorganized symptoms in schizophrenia. *Cognit Neuropsychiatry*. 2003; 8:107–27. [PubMed: 16571554]
- Mohamed S, Paulsen JS, O'Leary D, Arndt S, Andreasen N. Generalized cognitive deficits in schizophrenia: a study of first-episode patients. *Archives of General Psychiatry*. 1999; 56:749. [PubMed: 10435610]
- Morice R, Delahunty A. Frontal/executive impairments in schizophrenia. *Schizophrenia Bulletin*. 1996; 22:125–137. [PubMed: 8685655]
- Moritz S, Heeren D, Andresen B, Krausz M. An analysis of the specificity and the syndromal correlates of verbal memory impairments in schizophrenia. *Psychiatry Res*. 2001a; 101:23–31. [PubMed: 11223116]
- Moritz S, Mersmann K, Kloss M, Jacobsen D, Andresen B, Krausz M, Pawlik K, Naber D. Enhanced semantic priming in thought-disordered schizophrenic patients using a word pronunciation task. *Schizophr Res*. 2001b; 48:301–5. [PubMed: 11295382]
- Morrison-Stewart SL, Williamson PC, Corning WC, Kutcher SP, Snow WG, Merskey H. Frontal and non-frontal lobe neuropsychological test performance and clinical symptomatology in schizophrenia. *Psychological Medicine*. 1992; 22:353–359. [PubMed: 1615102]
- Mortimer AM, Bentham P, McKay AP, Quemada I, Clare L, Eastwood N, McKenna PJ. Delusions in schizophrenia: A phenomenological and psychological exploration. *Cognitive Neuropsychiatry*. 1996; 1:289–303.
- Nelson MD, Saykin AJ, Flashman LA, Riordan HJ. Hippocampal volume reduction in schizophrenia as assessed by magnetic resonance imaging: a meta-analytic study. *Archives of General Psychiatry*. 1998; 55:433–40. [PubMed: 9596046]
- Nestor PG, Shenton ME, Wible C, Hokama H, O'Donnell BF, Law S, McCarley RW. A neuropsychological analysis of schizophrenic thought disorder. *Schizophr Res*. 1998; 29:217–25. [PubMed: 9516662]
- Ngan ETC, Liddle PF. Reaction time, symptom profiles and course of illness in schizophrenia. *Schizophrenia research*. 2000; 46:195–201. [PubMed: 11120431]
- Nienow TM, Docherty NM, Cohen AS, Dinzeo TJ. Attentional Dysfunction, Social Perception, and Social Competence: What Is the Nature of the Relationship? *Journal of Abnormal Psychology*. 2006; 115:408. [PubMed: 16866582]
- Nieuwenstein MR, Aleman A, de Haan EH. Relationship between symptom dimensions and neurocognitive functioning in schizophrenia: a meta-analysis of WCST and CPT studies. Wisconsin Card Sorting Test. Continuous Performance Test. *J Psychiatr Res*. 2001; 35:119–25. [PubMed: 11377441]

- Norman R, Malla A, Cortese L, Cheng S, Diaz K, McIntosh E, McLean T, Rickwood A, Voruganti L. Symptoms and cognition as predictors of community functioning: a prospective analysis. *American Journal of Psychiatry*. 1999; 156:400. [PubMed: 10080555]
- Norman RM, Malla AK, Morrison-Stewart SL, Helmes E, Williamson PC, Thomas J, Cortese L. Neuropsychological correlates of syndromes in schizophrenia. *The British Journal of Psychiatry*. 1997; 170:134. [PubMed: 9093501]
- Nuechterlein KH, Barch DM, Gold JM, Goldberg TE, Green MF, Heaton RK. Identification of separable cognitive factors in schizophrenia. *Schizophrenia Research*. 2004a; 72:29–39. [PubMed: 15531405]
- Nuechterlein KH, Barch DM, Gold JM, Goldberg TE, Green MF, Heaton RK. Identification of separable cognitive factors in schizophrenia. *Schizophrenia Research*. 2004b; 72:29–39. [PubMed: 15531405]
- O’Leary DS, Flaum M, Kesler ML, Flashman LA, Arndt S, Andreasen NC. Cognitive correlates of the negative, disorganized, and psychotic symptom dimensions of schizophrenia. *Journal of Neuropsychiatry and Clinical Neurosciences*. 2000; 12:4. [PubMed: 10678506]
- Pandurangi AK, Sax KW, Pelonero AL, Goldberg SC. Sustained attention and positive formal thought disorder in schizophrenia. *Schizophrenia research*. 1994; 13:109–116. [PubMed: 7986767]
- Parellada E, Catarineu S, Catafau A, Bernardo M, Lomena F. Psychopathology and Wisconsin Card Sorting Test performance in young unmedicated schizophrenic patients. *Psychopathology*. 2000; 33:14–18. [PubMed: 10601822]
- Park S, Puschel J, Sauter BH, Rentsch M, Hell D. Spatial working memory deficits and clinical symptoms in schizophrenia: a 4-month follow-up study. *Biol Psychiatry*. 1999; 46:392–400. [PubMed: 10435205]
- Park S, Puschel J, Sauter BH, Rentsch M, Hell D. Visual object working memory function and clinical symptoms in schizophrenia. *Schizophrenia research*. 2002; 59:261–268. [PubMed: 12414083]
- Peralta V, Cuesta M. How many and which are the psychopathological dimensions in schizophrenia? Issues influencing their ascertainment. *Schizophrenia Research*. 2001; 49:269–285. [PubMed: 11356588]
- Peralta V, Cuesta MJ. Dimensional structure of psychotic symptoms: an item-level analysis of SAPS and SANS symptoms in psychotic disorders. *Schizophrenia Research*. 1999; 38:13–26. [PubMed: 10427607]
- Perry W, Braff DL. A multimethod approach to assessing perseverations in schizophrenia patients. *Schizophr Res*. 1998; 33:69–77. [PubMed: 9783346]
- Ragland JD, Censits DM, Gur RC, Glahn DC, Gallacher F, Gur RE. Assessing declarative memory in schizophrenia using Wisconsin Card Sorting Test stimuli: the Paired Associate Recognition Test. *Psychiatry Res*. 1996; 60:135–45. [PubMed: 8723304]
- Reed RA, Harrow M, Herbener ES, Martin EM. Executive function in schizophrenia: is it linked to psychosis and poor life functioning? *J Nerv Ment Dis*. 2002; 190:725–32. [PubMed: 12436011]
- Rhinewine JP, Lencz T, Thaden EP, Cervellione KL, Burdick KE, Henderson I, Bhaskar S, Keehlisen L, Kane J, Kohn N, Fisch GS, Bilder RM, Kumra S. Neurocognitive profile in adolescents with early-onset schizophrenia: clinical correlates. *Biol Psychiatry*. 2005; 58:705–12. [PubMed: 16023084]
- Robert PH, Lafont V, Medecin I, Berthet L, Thaubly S, Baudu C, Darcourt G. Clustering and switching strategies in verbal fluency tasks: comparison between schizophrenics and healthy adults. *J Int Neuropsychol Soc*. 1998; 4:539–46. [PubMed: 10050358]
- Rocca P, Castagna F, Marchiaro L, Rasetti R, Rivoira E, Bogetto F. Neuropsychological correlates of reality distortion in schizophrenic patients. *Psychiatry Res*. 2006; 145:49–60. [PubMed: 17070602]
- Rosenthal, R. *Meta-Analytic Procedures for Social Research*. Sage Pubns; 1991.
- Rowe EW, Shean G. Card-sort performance and syndromes of schizophrenia. *Genetic, social, and general psychology monographs*. 1997; 123:197.
- Roy MA, DeVriendt X. Positive and negative symptoms in schizophrenia: a current overview. *Can J Psychiatry*. 1994; 39:407–14. [PubMed: 7987782]

- Rund BR, Landro NI, Orbeck AL. Stability in cognitive dysfunctions in schizophrenic patients. *Psychiatry Research*. 1997; 69:131–41. [PubMed: 9109181]
- Rund BR, Melle I, Friis S, Johannessen JO, Larsen TK, Midbøe LJ, Opjordsmoen S, Simonsen E, Vaglum P, McGlashan T. The course of neurocognitive functioning in first-episode psychosis and its relation to premorbid adjustment, duration of untreated psychosis, and relapse. *Schizophrenia research*. 2007; 91:132–140. [PubMed: 17258891]
- Rund BR, Melle I, Friis S, Larsen TK, Midboe LJ, Opjordsmoen S, Simonsen E, Vaglum P, McGlashan T. Neurocognitive dysfunction in first-episode psychosis: correlates with symptoms, premorbid adjustment, and duration of untreated psychosis. *Am J Psychiatry*. 2004; 161:466–72. [PubMed: 14992972]
- Shean G, Burnett T, Eckman FS. Symptoms of schizophrenia and neurocognitive test performance. *J Clin Psychol*. 2002; 58:723–31. [PubMed: 12205713]
- Shenton ME, Kikinis R, Jolesz FA, Pollak SD, LeMay M, Wible CG, Hokama H, Martin J, Metcalf D, Coleman M, et al. Abnormalities of the left temporal lobe and thought disorder in schizophrenia. A quantitative magnetic resonance imaging study. *N Engl J Med*. 1992; 327:604–12. [PubMed: 1640954]
- Silverstein SM, Kovács I, Corry R, Valone C. Perceptual organization, the disorganization syndrome, and context processing in chronic schizophrenia. *Schizophrenia research*. 2000; 43:11–20. [PubMed: 10828411]
- Simon AE, Giacomini V, Ferrero F, Mohr S. Dysexecutive syndrome and social adjustment in schizophrenia. *Aust N Z J Psychiatry*. 2003; 37:340–6. [PubMed: 12780474]
- Smith TE, Hull JW, Huppert JD, Silverstein SM. Recovery from psychosis in schizophrenia and schizoaffective disorder: symptoms and neurocognitive rate-limitors for the development of social behavior skills. *Schizophr Res*. 2002; 55:229–37. [PubMed: 12048146]
- Stirling J, Hellewell J, Blakey A, Deakin W. Thought disorder in schizophrenia is associated with both executive dysfunction and circumscribed impairments in semantic function. *Psychological Medicine*. 2006; 36:475–484. [PubMed: 16403241]
- Stolar N, Berenbaum H, Banich MT, Barch D. Neuropsychological correlates of alogia and affective flattening in schizophrenia* 1. *Biological Psychiatry*. 1994; 35:164–172. [PubMed: 8173017]
- Stratta P, Daneluzzo E, Bustini M, Prosperini P, Rossi A. Processing of context information in schizophrenia: relation to clinical symptoms and WCST performance. *Schizophr Res*. 2000; 44:57–67. [PubMed: 10867312]
- Strauss ME, Buchanan RW, Hale J. Relations between attentional deficits and clinical symptoms in schizophrenic outpatients. *Psychiatry research*. 1993; 47:205–213. [PubMed: 8372159]
- Stuart G, Pantelis C, Klimidis S, Minas I. The three-syndrome model of schizophrenia: Meta-analysis of an artefact. *Schizophrenia Research*. 1999; 39:233–242. [PubMed: 10507515]
- Subotnik KL, Nuechterlein KH, Green MF, Horan WP, Nienow TM, Ventura J, Nguyen AT. Neurocognitive and social cognitive correlates of formal thought disorder in schizophrenia patients. *Schizophr Res*. 2006; 85:84–95. [PubMed: 16624529]
- Takahashi H, Iwase M, Nakahachi T, Sekiyama R, Tabushi K, Kajimoto O, Shimizu A, Takeda M. Spatial working memory deficit correlates with disorganization symptoms and social functioning in schizophrenia. *Psychiatry and Clinical Neurosciences*. 2005; 59:453–460. [PubMed: 16048451]
- Toomey R, Kremen WS, Simpson JC, Samson JA, Seidman LJ, Lyons MJ, Faraone SV, Tsuang MT. Revisiting the factor structure for positive and negative symptoms: evidence from a large heterogeneous group of psychiatric patients. *Am J Psychiatry*. 1997; 154:371–7. [PubMed: 9054785]
- Torres JJ, O'Leary DS, Andreasen NC. Symptoms and interference from memory in schizophrenia: evaluation of Frith's model of willed action. *Schizophrenia research*. 2004; 69:35–43. [PubMed: 15145469]
- Twamley EW, Palmer BW, Jeste DV, Taylor MJ, Heaton RK. Transient and executive function working memory in schizophrenia. *Schizophrenia research*. 2006; 87:185–190. [PubMed: 16737800]

- Uhlhaas PJ, Phillips WA, Mitchell G, Silverstein SM. Perceptual grouping in disorganized schizophrenia. *Psychiatry research*. 2006; 145:105–117. [PubMed: 17081620]
- Van der Does AJ, Dingemans PM, Linszen DH, Nugter MA. Symptom dimensions and cognitive and social functioning in recent-onset schizophrenia. *Psychological Medicine*. 1993; 23:745–753. [PubMed: 8234580]
- Van der Does AJ, Dingemans PM, Linszen DH, Nugter MA, Scholte WF. Symptoms, cognitive and social functioning in recent-onset schizophrenia: a longitudinal study. *Schizophr Res*. 1996; 19:61–71. [PubMed: 9147497]
- Ventura J, Helleman G, Thames A, Koellner V, Nuechterlein K. Symptoms as mediators of the relationship between neurocognition and functional outcome in schizophrenia: A meta-analysis. *Schizophrenia Research*. 2009; 113:189–199. [PubMed: 19628375]
- Villalta-Gil V, Vilaplana M, Ochoa S, Haro JM, Dolz M, Usall J, Cervilla J. Neurocognitive performance and negative symptoms: Are they equal in explaining disability in schizophrenia outpatients? *Schizophrenia research*. 2006; 87:246–253. [PubMed: 16859898]
- Vinogradov S, Poole JH, Willis-Shore J, Ober BA, Shenaut GK. Slower and more variable reaction times in schizophrenia: what do they signify? *Schizophrenia research*. 1998; 32:183–190. [PubMed: 9720123]
- Voruganti LN, Heslegrave RJ, Awad AG. Neurocognitive correlates of positive and negative syndromes in schizophrenia. *Can J Psychiatry*. 1997; 42:1066–71. [PubMed: 9469239]
- Woodward TS, Ruff CC, Thornton AE, Moritz S, Liddle PF. Methodological considerations regarding the association of Stroop and verbal fluency performance with the symptoms of schizophrenia. *Schizophrenia research*. 2003; 61:207–214. [PubMed: 12729872]
- Zakzanis KK. Neuropsychological correlates of positive vs. negative schizophrenic symptomatology. *Schizophr Res*. 1998; 29:227–33. [PubMed: 9516663]

Table 1
Studies included in Meta-analysis, Symptom Domain, and Patient Demographics

Author (s)	Symptom Domains	Patients	Age	Gender	Education
Guillemin et al., 2008	Disorganization	96 Outpatients	34.9 (SD = 9.8)	70M/26F	12.6 (SD = 2.8)
Leeson et al., 2008	Disorganization and reality distortion	53 Outpatients	26.8 (SD = 7.8)	34M/19F	12.8 (SD = 2.1)
Hofer et al., 2007	Disorganization and combined	106 Outpatients	37.7 (SD = 10.2)	68M/38F	NR
Maeda et al., 2007	Disorganization	79 Outpatients	32.3 (SD = 8.9)	43M/36F	13.4 (SD = 2.4)
Donohoe et al., 2006	Combined	32 Outpatients	NR	21M/11F	NR
Keefe et al., 2006	Combined	1460 Inpatients	40.6 (SD = 11.1)	1080M/380F	12.1 (SD = 2.3)
Klingberg et al., 2006	Disorganization and combined	151 Outpatients	33.6 (SD = 10.3)	73M/78F	NR
Løberg et al., 2006	Disorganization and reality distortion	129 Inpatients and Outpatients	31.6 (SD = 8.8)	89M/40F	12.5 (SD = 2.8)
Mahurin et al., 2006	Disorganization and reality distortion	84 Inpatients	NR	NR	NR
Nienow et al., 2006	Disorganization and reality distortion	56 Inpatients	41.5 (SD = 7.8)	42M/14F	NR
Rocca et al., 2006	Combined	70 Outpatients	40.8 (SD = 10.1)	46M/24F	NR
Stirling et al., 2006	Disorganization	11 Inpatients and 19 Outpatients	34.3 (SD = 10.4)	18M/12F	NR
Subotnik et al., 2006	Disorganization	47 Outpatients	28.6 (SD = 6.4)	35M/12F	NR
Twamley et al., 2006	Combined	267 Outpatients	56.4 (SD = 9.3)	182M/85F	12.6 (SD = 2.5)
Uhlhaas et al., 2006	Disorganization	35 Inpatients	37.6 (SD = NR)	29M/6F	11 (SD = NR)
Villalla-Gil et al., 2006	Combined	113 Outpatients	41.6 (SD = 12.8)	77M/36F	NR
Caligiuri et al., 2005	Combined	43 Outpatients	43.4 (SD = 8.1)	34M/9F	13.6 (SD = 2.8)
Cohen & Docherty, 2005	Reality Distortion and combined	73 Outpatients	36.0 (SD = 10.0)	45M/28F	12.4 (SD = 1.5)
Docherty, 2005	Disorganization	47 Inpatients	43.0 (SD = 4.0)	39M/8F	13.0 (SD = 1.0)
Hofer et al., 2005	Disorganization and combined	60 Outpatients	39.8 (SD = NR)	39M/21F	11.4 (SD = NR)
Rhinewhine et al., 2005	Combined	54 Inpatients	16.0 (SD = 2.2)	34M/20F	NR
Takahashi et al., 2005	Disorganization and reality distortion	50 Inpatients	36.7 (SD = 11.3)	25M/25F	12.2 (SD = 2.4)
Bowie et al., 2004	Combined	289 Inpatients and 103 Outpatients	72.3 (SD = 8.3)	176M/216F	11.0 (SD = 2.8)
Bozikas et al., 2004	Disorganization and reality distortion	58 Outpatients	37.5 (SD = 10.6)	41M/17F	10.4 (SD = 3.3)
Good et al., 2004	Disorganization and combined	167 Outpatients	26.4 (SD = 6.9)	128M/39F	NR
Gooding & Tallent, 2004	Disorganization and reality distortion	36 Outpatients	NR	21M/15F	NR
Heydebrand et al., 2004	Combined	307 Outpatients	25.0 (SD = 6.8)	233M/74F	NR
Lucas et al., 2004	Disorganization and reality distortion	53 Outpatients	19.1 (SD = 3.3)	NR	10.8 (SD = 2.0)
Rund et al., 2004	Combined	207 Outpatients	28.1 (SD = 9.6)	120M/87F	12.0 (SD = 2.4)

Author (s)	Symptom Domains	Patients	Age	Gender	Education
Torres et al., 2004	Disorganization and reality distortion	107 Inpatients	30.9 (SD = 9.4)	73M/34F	13.2 (SD = 2.1)
Minzenberg et al., 2003	Disorganization and reality distortion	57 Outpatients	40.2 (SD = 10.7)	42M/15F	13.2 (SD = 2.3)
Pukrop et al., 2003	Combined	66 Inpatients	30.1 (SD = 9.3)	46M/20F	NR
Simon et al., 2003	Combined	38 Inpatients	24.0 (SD = 7.0)	23M/15F	NR
Stirling et al., 2003	Combined	49 Outpatients	26.3 (SD = NR)	28M/21F	NR
Woodward et al., 2003	Disorganization and reality distortion	36 Inpatients	35.6 (SD = 9.4)	27M/9F	12.8 (SD = 2.7)
Cameron et al., 2002	Disorganization and reality distortion	52 Outpatients	37.5 (SD = 9.5)	40M/12F	NR
Daban et al., 2002	Disorganization and reality distortion	15 Inpatients and 9 Outpatients	25.5 (SD = 4.2)	17M/7F	NR
Izawa & Yamamoto, 2002	Disorganization, reality distortion, and combined	24 Inpatients	46.8 (SD = 9.8)	12M/12F	11.4 (SD = 1.6)
Langdon et al., 2002	Disorganization and reality distortion	7 Inpatients and 18 Outpatients	NR	NR	NR
Park et al., 2002	Combined	28 Inpatients	34.8 (SD = 9.0)	18M/10F	12.2 (SD = NR)
Roncone et al., 2002	Disorganization and reality distortion	44 Outpatients	33.4 (SD = 6.1)	34M/10F	11.6 (SD = 2.9)
Shean et al., 2002	Disorganization and reality distortion	92 Inpatients	40.7 (SD = 9.5)	55M/37F	11.2 (SD = 1.8)
Guillem et al., 2001	Disorganization and reality distortion	27 Outpatients	38.1 (SD = NR)	16M/11F	NR
Moritz et al., 2001	Disorganization and reality distortion	25 Inpatients	30.8 (SD = 10.0)	16M/9F	11.1 (SD = 1.8)
Moritz et al., 2001	Disorganization and reality distortion	47 Inpatients	31.8 (SD = 10.7)	31M/16F	11.0 (SD = 1.7)
Allen et al., 2000	Disorganization	21 Inpatients	41.0 (SD = 8.6)	21M/0F	12.1 (SD = 2.0)
Bilder et al., 2000	Disorganization and reality distortion	94 Inpatients	25.7 (SD = 6.3)	55M/39F	13.1 (SD = 2.3)
Eckman & Shean, 2000	Disorganization and reality distortion	51 Inpatients	40.9 (SD = 9.5)	32M/19F	11.1 (SD = 2.4)
Glahn et al., 2000	Disorganization and reality distortion	62 Outpatients	29.6 (SD = 9.8)	32M/30F	13.0 (SD = 2.3)
Howanitz et al., 2000	Disorganization	35 Inpatients	67.4 (SD = NR)	34M/1F	NR
Ngan & Liddle, 2000	Disorganization and reality distortion	41 Inpatients	35.5 (SD = NR)	23M/18F	11.5 (SD = NR)
O'Leary et al., 2000	Disorganization and reality distortion	134 Inpatients	31.2 (SD = 9.6)	90M/44F	13.1 (SD = 2.0)
Parellada et al., 2000	Reality distortion and combined	25 Inpatients	24.9 (SD = 6.1)	0M/25F	NR
Silverstein et al., 2000	Disorganization	23 Inpatients	44.0 (SD = 8.0)	17M/6F	10.8 (SD = 2.8)
Stratta et al., 2000	Disorganization and reality distortion	20 Inpatients	31.1 (SD = 8.1)	14M/6F	11.1 (SD = 2.9)
Addington & Addington, 1999	Combined	80 Outpatients	36.0 (SD = 9.5)	54M/26F	12.0 (SD = 1.7)
Barch et al., 1999	Disorganization	56 Inpatients	38.3 (SD = 8.8)	32M/24F	11.9 (SD = 1.6)
Bryson et al., 1999	Disorganization and combined	120 Outpatients	43.5 (SD = 8.5)	115M/5F	12.6 (SD = 1.8)
Docherty & Gordinier, 1999	Disorganization	55 Outpatients	33.0 (SD = 7.0)	47M/8F	12.0 (SD = 2.0)
Kerns et al., 1999	Disorganization and reality distortion	26 Inpatients	36.0 (SD = NR)	20M/6F	NR

Author (s)	Symptom Domains	Patients	Age	Gender	Education
Mohamed et al., 1999	Disorganization and reality distortion	94 Inpatients	26.1 (SD = 8.1)	53M/41F	12.8 (SD = 1.9)
Park et al., 1999	Combined	34 Inpatients	34.8 (SD = 9.9)	21M/13F	12.2 (SD = NR)
Addington & Addington, 1998	Combined	40 Outpatients	36.0 (SD = 9.5)	27M/13F	12.0 (SD = 1.6)
Basso et al., 1998	Disorganization and reality distortion	9 Inpatients and 53 Outpatients	32.3 (SD = 7.3)	45M/17F	13.7 (SD = 2.2)
Baxter & Liddle, 1998	Disorganization	56 Inpatients	37.8 (SD = NR)	40M/16F	NR
Nelson et al., 1998	Disorganization	11 Inpatients and 4 Outpatients	34.0 (SD = 10.0)	7M/8F	12.0 (SD = 1.0)
Nestor et al., 1998	Disorganization	13 Inpatients and 2 Outpatients	37.6 (SD = NR)	15M/0F	11.7 (SD = NR)
Perry & Braff, 1998	Combined	58 Inpatients and 13 Outpatients	34.2 (SD = 8.7)	43M/28F	12.3 (SD = 2.4)
Robert et al., 1998	Disorganization and reality distortion	78 Outpatients	31.8 (SD = 8.1)	58M/20F	10.6 (SD = 3.1)
Vinogradov et al., 1998	Disorganization and reality distortion	26 Outpatients	40.2 (SD = 9.6)	14M/12F	13.9 (SD = 1.7)
Zakzanis et al., 1998	Reality distortion	8 Inpatients and 2 Outpatients	38.2 (SD = 5.4)	8M/2F	NR
Addington et al., 1997	Combined	59 Inpatients	33.0 (SD = 8.6)	40M/19F	11.5 (SD = 2.2)
Berman et al., 1997	Combined	30 Inpatients	50.6 (SD = 11.1)	29M/1F	12.3 (SD = 1.7)
Brebion et al., 1997	Combined	40 Inpatients	33.7 (SD = 10.5)	27M/13F	12.5 (SD = 2.7)
Collins et al., 1997	Combined	58 Outpatients	34.1 (SD = 8.0)	45M/13F	12.5 (SD = 7.4)
Lees-Roitman et al., 1997	Combined	30 Inpatients and Outpatients	43.1 (SD = 9.5)	30M/0F	12.3 (SD = 2.1)
Liu et al., 1997	Disorganization and reality distortion	60 Inpatients	28.2 (SD = 7.7)	28M/32F	10.8 (SD = 3.2)
Norman et al., 1997	Disorganization and reality distortion	87 Inpatients and Outpatients	33.3 (SD = NR)	57M/30F	NR
Rowe & Shean, 1997	Disorganization	50 Inpatients	39.9 (SD = NR)	34M/16F	11.5 (SD = NR)
Voruganti et al., 1997	Combined	52 Outpatients	32.4 (SD = NR)	34M/18F	NR
Bressi et al., 1996	Combined	30 Outpatients	31.6 (SD = 9.7)	NR	11.6 (SD = 6.7)
Carter et al., 1996	Combined	18 Outpatients	34.1 (SD = 8.3)	15M/3F	NR
Himelhoch et al., 1996	Disorganization and reality distortion	32 Inpatients	30.4 (SD = 8.2)	23M/9F	13.3 (SD = 3.0)
Morice & Delahunty, 1996	Combined	17 Outpatients	32.4 (SD = 1.3)	10M/7F	NR
Mortimer et al., 1996	Disorganization and reality distortion	60 Inpatients and Outpatients	NR	NR	NR
Ragland et al., 1996	Disorganization and reality distortion	30 Outpatients	31.0 (SD = 6.3)	17M/13F	NR
van der Does et al., 1996	Disorganization and reality distortion	60 Inpatients	21.2 (SD = 2.4)	46M/14F	NR
Brekke et al., 1995	Disorganization and reality distortion	40 Outpatients	33.2 (SD = 7.4)	25M/15F	12.5 (SD = 2.9)
Cuesta et al., 1995	Disorganization and reality distortion	38 Inpatients	30.8 (SD = 8.0)	28M/10F	10.0 (SD = 2.4)
Cuesta & Peralta, 1995	Disorganization and reality distortion	40 Inpatients	27.7 (SD = 7.5)	31M/9F	10.3 (SD = 2.8)
Hammer et al., 1995	Combined	65 Inpatients	28.3 (SD = 4.8)	57M/8F	NR

Author (s)	Symptom Domains	Patients	Age	Gender	Education
Bell et al., 1994	Disorganization and reality distortion	27 Inpatients and 120 Outpatients	42.0 (SD = 9.0)	140M/7F	12.0 (SD = 2.0)
Pandurangi et al., 1994	Disorganization	41 Inpatients and Outpatients	30.0 (SD = 6.5)	30M/11F	12.3 (SD = 2.3)
Stolar et al., 1994	Reality Distortion	27 Inpatients	36.0 (SD = 10.7)	21M/6F	NR
Strauss et al., 1993	Disorganization and combined	50 Outpatients	34.0 (SD = 7.6)	38M/12F	12.5 (SD = 2.0)
van der Does et al., 1993	Disorganization	60 Inpatients	21.2 (SD = 2.4)	46M/14F	NR
Franke et al., 1992	Disorganization and reality distortion	73 Inpatients	32.5 (SD = NR)	46M/27F	9.9 (SD = NR)
Morrison-Stewart et al., 1992	Combined	4 Inpatients and 26 Outpatients	32.1 (SD = 8.5)	25M/5F	NR
Addington et al., 1991	Disorganization and reality distortion	38 Inpatients	30.9 (SD = 8.7)	25M/13F	11.5 (SD = NR)
Braff et al., 1991	Combined	40 Outpatients	29.7 (SD = 7.9)	30M/10F	13.3 (SD = 1.7)
Breier et al., 1991	Combined	58 Outpatients	32.0 (SD = 7.0)	30M/28F	NR
Liddle & Morris, 1991	Disorganization and reality distortion	43 Inpatients	51.9 (SD = NR)	28M/15F	NR
Liddle, 1987	Disorganization and reality distortion	12 Inpatients and 28 Outpatients	35.0 (SD = NR)	31M/9F	NR
Bilder et al., 1985	Disorganization and reality distortion	32 Inpatients	32.5 (SD = 7.6)	16M/16F	NR

NR = not reported

Table 2

Neurocognitive Domains and Symptom Assessment Measures

Neuro-cognitive Domain	Neurocognitive Tests	Brief Description of Tests
Verbal Memory	Logical Memory Subtest – WMS-R	Subjects are asked to recall the contents of two short stories immediately after presentation and again after a 30 minute delay.
	Paired Associates Subtest – WMS-R	Five trials of paired word presentations are given and subjects are asked to recall the list immediately after presentation and again after a 30 minute delay.
	California Verbal Learning Test (CVLT)	Test consists of an oral presentation of a 16-word list for five immediate recall trials, followed by a single presentation and recall of a second 16-word ‘interference’ list. Free-and category-cued recall is elicited immediately, again 20 minutes later, and a recognition trial is administered.
	Hopkins Verbal Learning Test (HVLT)	A list of words belonging to a semantic category is presented verbally for three trials. Subject are asked to recall as many words as possible immediately and again after a delay.
	Rey Auditory Verbal Learning Test (RAVLT)	Subjects are given a list of 15 items and asked to recall them immediately over five trials. Subsequently, an interference list is administered and then recall of 15 words from initial list.
	Buschke-List Learning Test	Multiple-trial list-learning task.
	Test de Aprendizaje Verbal España-Complutense (TAVEC)	Spanish verbal learning and memory test similar to the California Verbal Learning Test.
	Münchener Gedächtnistest	German version of the California Verbal Learning Test.
	Word List Learning Test (WLLT)	Subjects are read a list of words and tested on immediate free recall, immediate cued recall, delayed free recall, delayed cued recall, and recognition
	Free Recall Word List Task	Subjects have 30 seconds to learn 16 words and are asked to write down as many words as can be remembered either immediately or after a delay. This procedure is repeated for four word lists.
	Warrington Recognition Memory Test for Words	Subjects are asked to read a list of 50 words and are then presented with 50 pairs of words. Each pair contains a target word from the list and a foil word. Subjects are asked to identify which word they had read on the list.
Visual Memory	Rey-Osterreith Complex Figures Test (Rey-O)	Subjects are asked to copy the stimulus figure and asked after a 3-minute and a 30-minute delay to draw the figure from memory.
	Visual Reproduction Subtest – WMS-R	Subjects are asked to look at five figures for 10 seconds each and to “draw the design” from memory and after a 25 minute delay.
	Benton Visual Retention Test (BVRT)	Subjects are shown 10 designs, one at a time, and asked to reproduce each one as precisely as possible from memory.
	Recognition Memory Test, Faces Subtest	A set of 50 black and white photographs of unfamiliar male faces are shown. Immediately after the presentation the subject is tested using a forced-choice recognition paradigm.
	Searchlight Test	A geometric figure is displayed but covered by a black mask with a hole through which part of the figure can be seen. Subjects are asked to draw that figure from memory and to select the correct figure from six similar geometric figures.
Working Memory	Digit Span Forward – WAIS	Subjects are instructed to repeat a string of numbers that increase in length over the task.
	Digit Span Backward – WAIS	Subjects are instructed to repeat a string of numbers that increase in length over in the task in the reverse order presented.
	Spatial Span – WMS-R	Subjects are instructed to point to a series of blocks in the same or reverse order that is presented by the Examiner.
	Letter-Number Sequencing -WAIS-III/Letter-Number Memory - WMS-III	Subjects are asked to listen to strings of alternating numbers and letters of increasing length and then repeat them with the numbers first in ascending order and then the letters in alphabetical order.

Neuro-cognitive Domain	Neurocognitive Tests	Brief Description of Tests
	Arithmetic Subtest - WAIS	Subjects are read arithmetic problems and must perform the calculations mentally without the use of pencil and paper.
	Keyptrack Task	Subjects are presented with 3-5 categories, followed by 15 exemplars from each category and asked to remember the last word presented from each category.
	Corsi Test	The Examiner touches many wood cubes according to a standard sequence and asks the subject to do the same.
	Spatial Delayed Matched-to-Sample Task	A neutral face (target stimulus) is randomly displayed in one of five squares representing different spatial locations on a computer screen. After a delay (which includes a distractor), the subject is asked to identify the prior spatial location of the target.
	Spatial Working Memory Task – CANTAB	Subjects are asked to search an increasing number of boxes on the screen to locate hidden tokens and instructed that once a token is located, that box will not hide another token.
	Delayed Response Task	Subjects are asked to remember the position of a target on a screen after a 4-second delay.
	Excluded Letter Fluency	Subjects are asked to name real words that do not contain the letter E, A, and I.
	Hebb's Recurring Digits	Subjects are asked to repeat sets of aurally presented digits without being told every third set of digits repeats after the first set.
	Alternating Semantic Categories	Subjects are given one minute to name as many word pairs as possible of alternating exemplars from two distinct categories.
	Wicken's Test	Subjects are read five lists of eight words (one-or two-syllables each). After each list, the subject is asked to count backward by three for 15 seconds before trying to recall the words.
	Tracking Task with Tones	Subjects are presented with a series of tones from a loudspeaker and instructed to press a foot switch as quickly as possible.
Reasoning and Problem Solving	Wisconsin Card Sorting Test (WCST)	Subjects are asked to sort a series of cards according to different principles (e.g., by shape). Feedback is provided. After 10 consecutive correct sorts, the test rules shift without warning to a new sorting rule. Note: Modified versions were also used.
	Block Design – WAIS	Subjects are given a set of blocks and asked to arrange the blocks according to the stimulus picture.
	Gorham's Proverbs – Interpretation	Subjects are given 12 proverbs for which they must provide an interpretation.
	Raven's Progressive Matrices	For each test item, the subject is asked to identify the missing segment required to complete a larger pattern.
	Category Test – Halstead-Reitan Battery	Subjects are presented with groups of pictures consisting of geometric figures and must note similarities and differences. Through positive and negative reinforcement they must deduce the underlying organizing principle which differentiates the figures.
	Tower of London Task	Subjects are shown colored beads arranged on pegs of different heights and a "goal" arrangement. Subjects are instructed to move the beads around until they achieve the goal arrangement quickly and in as few moves as possible.
	Visual Elevator Task	Subjects are shown pictures of elevator doors (representing hotel floors) and asked to follow a series of elevator door pictures coupled with directional arrows to establish the floor number of the last floor in the series.
	Behavioral Assessment of Dysexecutive Syndrome (BADS)	Six scenarios are presented that assess the ability to formulate strategies, change a pattern of responding, engage in forward planning, organize a set of rules and restrictions, and estimate the time requirements of a task.
	Contour Integration Task	Subjects are shown 15 cards containing varying numbers of Gabor elements and asked to correctly locate the position of the contour.

Neuro-cognitive Domain	Neurocognitive Tests	Brief Description of Tests
	Shipley Institute of Living Scale, Abstraction Subtest	Subjects are presented with the beginnings of 20 different sequences of numbers or letters and asked to complete the sequences.
	Behavioural Assessment of Dysexecutive Syndrome (BADS)	Consists of six subtests which assess a variety of executive dimensions such as planning and strategic abilities, conceptual flexibility, divided attention, and inhibition control.
	Booklet Category Test	Subjects must attempt to identify the organizing principle or concept involved in seven groups of stimuli.
	Verbal Concept Attainment Test (VCAT)	Subject are shown four lines of words containing four words each and asked to select one word from each line such that the words are similar in some way.
	Luria's Frontal Signs	Subjects are verbally given a series of tasks with sequenced instructions that must be carried out in correct order.
	Picture Arrangement Task – WAIS	Subjects are shown sets of small pictures and must arrange them into a logical sequence.
Speed of Processing	Trail Making Test A & B	Part A requires the subject to connect a series of numbered circles arrayed randomly on a sheet of paper using a pencil. In part B the array consists of both numbers and letters, and the subject must connect them in alternating order.
	Stroop Test (Color-Word)	Subjects are given words representing colors that are printed in different color ink and instructed to read the ink color as quickly as possible and later while ignoring the printed word.
	Finger Tapping Test	Test that requires that the subject tap as rapidly as possible with the index finger on a small lever, which is attached to a counter.
	Cancelling Test of Zazzo (and related cancelling tasks)	Subjects are required to cross out or circle target letters or numbers among an array of distractors.
	Controlled Oral Word Association Test (COWAT)	Subjects are asked to name as many different words as possible beginning with a specific letter within a specified amount of time or to name animals
	Chicago Word Fluency Test (CWF)	Subject writes down as many words as possible that start with a particular letter, e.g., "S" in 5 minutes and as many words that start with another letter having only 4 letters in 4 minutes
	Newcombe Word Fluency tasks	Subjects are asked to name as many different items as possible from given categories in one minute.
	Jones-Gotman Design Fluency Test	Requires production of novel (original) abstract designs under a time constraint.
	Ruff Figural Fluency Test	Subjects are asked to draw as many unique patterns as possible in one minute using straight lines to connect two or more dots.
	Digit Symbol – WAIS	Subjects are provided with numbers along with corresponding symbols and required to reproduce symbols that correspond with a number on a grid as quickly as possible.
	Lexical Decision Task	Subjects are presented, either visually or auditorily, with a mixture of words and pseudo words and asked to indicate whether the presented stimulus is a word or not.
	Hayling Sentence Completion Test	Two sets of 15 sentences are read aloud, each having the last word missing, and the subject must complete the sentences.
	Grooved Pegboard	Subjects are asked to place as many pegs as possible in a certain order into a pegboard in two 45-second trials.
	Speed of Comprehension Task – SCOLP	Subjects are asked to judge whether a list of declarative sentences are true or false and have two minutes to complete the task.
	Simple Reaction Time Test	Subjects are instructed to respond quickly by pressing a keyboard key whenever they see a downward arrow presented on the screen.
	Forced Choice Reaction Time Test	Subjects are told that they will see a series of left-and right-pointing arrows on a screen and asked to press the appropriate key on the keyboard.

Neuro-cognitive Domain	Neurocognitive Tests	Brief Description of Tests
Attention/Vigilance	Continuous Performance Test (CPT)	Subjects are presented with a series of numbers on a screen and instructed to indicate when the current number is identical to the previous number.
	Degraded Stimulus Continuous Performance Test (DSCPT)	Similar to the CPT in all respects, except that the stimulus presentation is degraded (blurred) and therefore the digits are more difficult to discern.
	Span of Apprehension Test (SOA or SPAN)	Arrays of letters that contain either the letter T or F, along with non-target letters, are flashed on a screen. The subject is instructed to press the appropriate button (T or F) depending on which letter appeared in the array.
	Digit Span Distractibility Test – Interference	Subjects hear short strings of digits with and without distractors and are asked to recall the digits in correct order.
	Dichotic Listening Test	Subjects listen to a series of pairs of consonant-vowel sounds and are either instructed to attend to stimuli presented in their right ear or left ear, or are given no specific instructions. Subjects are asked to report the syllable they heard best.
	Test for Attention Performance (TAP) – Subtest 2	Subjects are presented with 100 mixed single digits on a computer screen, and are instructed to press a button as quickly as possible whenever they identify a digit as identical to the penultimate one.
	Orientation Questionnaire	Subjects are given a questionnaire regarding orientation in time, place, and age.

Symptom Assessment Measures	Brief Description of Measures
Brief Psychiatric Rating Scale (BPRS)	An 18-item rating scale designed to assess psychiatric symptoms, including positive and negative symptoms, based on a semi-structured interview
Scale for the Assessment of Positive Symptoms (SAPS)	A 35-item semi-structured scale that assesses observed and self-reported positive symptoms including formal thought disorder
Positive and Negative Syndrome Scale (PANSS)	A 30-item semi-structured measure that assesses psychiatric symptoms in domains such as positive, negative, and general symptoms
Holzman-Johnston Thought Disorder Index (TDI)	TDI evaluates the disordered thinking that occurs during verbal discourse. Any verbal sample can be used, but it is most commonly applied to responses to Rorschach Ink Blot cards.
Thought, Language, and Communication Scale (TLC)	A rating scale that includes 18 subtypes of thought disorder commonly encountered in psychiatric populations, as well as a global rating.
Psychiatric Assessment Scale (PAS)	An 8-item rating scale designed for chronic psychiatric patients that provides a composite measure of the severity of current psychiatric symptoms rated on a four-point scale.
MRC Social Behavior Scale (SBS)	Used to assess 21 problem behaviors. The score for each item on the SBS (mostly a five-point scale) reflects the severity of the behavioral disturbance.
Comprehensive Assessment of Symptom History (CASH)	Developed for research studies of schizophrenia and mood disorders and allows for assigning a diagnosis, rating of current and past signs and symptoms, premorbid functioning, types of treatment, and course of illness.
Signs and Symptoms of Psychotic Illness rating scale (SSPI)	A 20 item scale of which 19 items assess psychotic disorder symptoms and one item measures insight.
Positive and Negative and Disorganized Symptoms Scale (PANADSS)	Assesses psychopathology specific to schizophrenia including positive and negative symptoms, and disorganization rated on a 7 point likert scale.
Schedule for Affective Disorders and Schizophrenia (SADS)	Contains a set of psychiatric diagnostic criteria and symptom rating scales which allows for diagnoses based on Research Diagnostic Criteria (RDC) and level of functioning.
Present State Examination (PSE)	The PSE was designed to assess the individual's present mental state to identify mood and psychotic symptoms to make major diagnoses.

Correlations Showing the Magnitude of Relationships between Neurocognition with Reality Distortion and Disorganization Symptoms

Table 3

	Reality Distortion				Disorganization				Differences			
	Studies	n	r	95% CI	p	Studies	n	r	95% CI	p	delta	p
Neurocognitive Domains												
Attention/Vigilance	10	743	-.12	(-.19, .05)	<.01	19	1404	-.25	(-.31, -.20)	<.01	.13	<.01
Reasoning and Problem Solving	27	1427	-.06	(-.11, -.01)	=.03	38	2300	-.24	(-.28, -.19)	<.01	.17	<.01
Speed of Processing	33	1870	-.03	(-.07, .02)	NS	42	2473	-.26	(-.30, -.22)	<.01	.23	<.01
Verbal Memory	16	927	-.01	(-.07, .06)	NS	22	1532	-.20	(-.24, -.15)	<.01	.19	<.01
Working Memory	18	855	.00	(-.07, .07)	NS	20	945	-.20	(-.26, -.13)	<.01	.20	<.01
Visual Memory	10	630	.01	(-.07, .09)	NS	14	978	-.20	(-.27, -.14)	<.01	.21	<.01
Composite Score	50	2722	-.04	(-.08, -.01)	=.03	69	4002	-.23	(-.26, -.20)	<.01	.19	<.01