SCHIZOPHRENIA AND SCHIZOAFFECTIVE DISORDER: ONE CONDITION OR TWO?

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Abstract

There is long-standing debate regarding whether or not schizophrenia and schizoaffective disorder represent a single condition or two distinct disorders. Despite diagnostic criteria that differentiates these illnesses, clinical practice relies heavily upon subjective methods to separate these symptomatically overlapping conditions. Cognitive functioning has represented one of the main parameters evaluated in an attempt to discriminate between schizophrenia and schizoaffective disorder unfortunately with contradictory results. Further, these comparative studies have traditionally been limited to intellectual and cognitive functioning and have not captured other factors such as social cognition. The current research tested the hypothesis that these two conditions are cognitively distinguishable based on comprehensive and well-validated measures of neurocognition (processing speed, working memory, visual learning and memory, verbal learning and memory, reasoning and problem solving, and attention). This study is also the first to compare these diagnostic groups on multiple measures of social cognition (emotion perception, theory of mind, and attribution bias). Research participants included outpatients with a diagnosis of schizophrenia (n = 70) and schizoaffective disorder (n = 46), as well as comparison participants (n = 146). Across the various neurocognitive domains, there were no significant differences between diagnostic groups, with both uniformly performing worse than the comparison group. Discriminant function analysis revealed that performance on cognitive measures classified comparison group participants with a high degree of accuracy (93.8%) but far less so for those with schizophrenia (51.7%) and schizoaffective disorder (7.7%), suggesting substantial overlap between diagnostic groups on cognitive functioning. In terms of social cognition, the schizophrenia group was impaired on emotion perception relative to the schizoaffective disorder and comparison groups. The schizophrenia group was also impaired on theory of mind relative to the comparison group. Discriminant function analysis showed that performance on social cognitive tasks classified comparison participants accurately (83.4%) but far less so for those with schizophrenia (55.8%) or schizoaffective disorder (3.3%). These findings indicate that these two disorders are cognitively homogeneous, which is congruent with the majority of the literature, and suggests that schizoaffective disorder is not a distinct entity but is a subtype of schizophrenia. Implications for research and clinical practice are discussed.

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Schizophrenia and Schizoaffective Disorder: One Condition or Two?

Schizophrenia and schizoaffective disorder are two diagnoses within the psychotic disorder spectrum. It has been long debated whether similar or differing pathophysiological processes underlie these conditions, and more broadly, whether these diagnoses represent a single disorder or two distinct disorders. In his nosological descriptions of psychiatric illness, Emil Kraepelin (1920) created an explicit dichotomy between schizophrenia (dementia praecox) and bipolar disorder (manic-depressive insanity) (Malaspina et al., 2013). The validity of Kraepelin's taxonomy was challenged by Jacob Kasanin (1933), who introduced the term *acute schizoaffective psychosis*, when he described nine patients with good premorbid functioning who then developed a mixture of psychotic and affective symptoms with a full recovery after a few months.

While schizoaffective disorder was initially regarded as a subtype of schizophrenia in the first two editions of the *Diagnostic and Statistical Manual* (*DSM*; see Table 1), the most recent version of the *DSM* (American Psychiatric Association, APA, 2013) attempts to distinguish schizoaffective disorder from both schizophrenia and mood disorders (see Table 2). Nevertheless, there is much debate over the status of schizoaffective disorder as a specific diagnostic category, as it overlaps both schizophrenia and mood disorders. Over the years schizoaffective disorder has been conceptualized as: 1) a subtype of schizophrenia, with prominent mood symptoms; 2) a subtype of mood disorders, with prominent symptoms of psychosis; 3) an independent diagnostic entity, distinct from both schizophrenia and mood disorders; 4) a comborbid condition in which the same person simultaneously has both schizophrenia and a mood disorder; or 5) a heterogeneous or mixed group, composed of both schizophrenia and mood disorders (see Cheniaux et al., 2008). Additionally, a spectrum model

posits that psychosis severity varies on a continuum with schizophrenia and mood disorders at opposite ends and schizoaffective disorder intermediate between the two (see Cheniaux et al., 2008; Malhi, Green, Fagiolini, Peselow, & Kumari, 2008). Yet still others recommend that the concept of schizoaffective disorder be completely removed from diagnostic classification systems (e.g., Kempf, Hussain, & Potash 2005; Lake & Hurwitz, 2006; 2007; 2008) as it has poor diagnostic reliability, low temporal stability, unclear clinical utility, and weak validity (see Malaspina et al., 2013). While its removal was initially considered for *DSM-5*, schizoaffective disorder was ultimately maintained in the absence of sufficient clinical and theoretical data justifying such an omission (Malaspina et al., 2013).

Table 1

The Diagnosis of Schizoaffective Disorder in Prior DSM Editions

	Year	Schizoaffective Disorder Diagnosis
DSM I	1952	Schizophrenic reaction, Schizo-affective type
DSM II	1968	Schizophrenia, Schizo-affective type, excited Schizophrenia, Schizo-affective type, depressed
DSM III	1980	Schizo-affective Disorder No operational diagnostic criteria
DSM III-R	1987	Schizoaffective Disorder –Bipolar Type –Depressive Type Introduces four diagnostic criteria
DSM-IV	1994	Mixed subtype of Bipolar Type added No change of diagnostic criteria
DSM-IV-TR	2000	No change of diagnostic criteria
DSM-5	2013	Requires the assessment of mood symptoms for the entire course of a psychotic illness, which differs from the criterion in DSM-IV, which required only an assessment of the current period of illness

Table 2

DSM-5 Criteria: Schizoaffective Disorder

A. An uninterrupted period of illness during which there is a major mood episode (major depressive or manic) concurrent with Criterion A of schizophrenia.

B. Delusions or hallucinations for two or more weeks in the absence of a major mood episode (depressive or manic) during the lifetime duration of the illness.

C. Symptoms that meet criteria for a major mood episode are present for the majority of the total duration of the active and residual portions of the illness.

D. The disturbance is not attributable to the effects of a substance (e.g., a drug of abuse, a medication) or another medical condition

The ongoing controversy surrounding schizoaffective disorder reflects a more general and long-standing issue with mental disorder classification systems. Although the *DSM* creates the impression of relatively precise and distinct diagnostic categories, the boundaries between clinical entities are only based upon phenomenological descriptions, which are largely derived from clinical interviews, patient self-report, and subjective data. This results in substantial heterogeneity within diagnostic categories and overlapping clinical features between them. Succinctly put, "disease heterogeneity is often guaranteed, rather than simplified, through our current (DSM) diagnostic system" (Braff, Freedman, Schork, & Gottesman, 2007, p. 22). For instance, studies have found no clear symptom boundaries between schizophrenia, schizoaffective disorder, and affective disorders (for review, see Chineaux et al., 2008; Jager, Haack, Becker, & Frasch, 2011), demonstrating that clinical presentation alone does not permit a reliable differentiation between disorders. Given the confounding heterogeneity of symptom expression and the imprecision of clinical diagnostic phenotypes, an alternative or complimentary approach may be to develop a neurobiologically-based psychiatric classification system, as has been proposed by the National Institute of Mental Health (NIMH; see Cuthbert & Insel, 2010).

One way through which the neurobiological underpinnings of heterogeneous disorders can be understood is through the analysis of discrete and neurobiologically relevant endophenotypes. Endophenotypes are defined as "quantitative traits believed to be intermediate between disease phenotypes and the biological processes that underlie them" (Bearden & Freimer, 2006, p. 307). In other words, endophenotypes are seen as closer to genetic variation than are clinical symptoms of a disorder (Braff et al., 2007). Moreover, the endophenotype approach reduces the complexity of symptoms and multifaceted behaviours by using

neurobiologically informed quantitative measures (Braff et al., 2007) such as measures of cognitive functioning.

Comparing Neurocognition between Schizophrenia and Schizoaffective Disorder

The frequency, pervasiveness, and stability of cognitive impairment among persons with schizophrenia (Heinrichs, 2005) and its strong association with impaired quality of life and poor outcome (Lepage, Bodnar, & Bowie, 2014), have led investigators to posit endophenotypic models of the illness with neurobiologically based impairments in cognitive function as a core component (e.g., Gottesman & Gould, 2003; Gur et al., 2007). Indeed, there is substantial evidence that cognitive measures of sustained attention, verbal declarative memory, and working memory are valid endophenotypes in schizophrenia (Gur et al., 2007) and the Food and Drug Administration considers cognitive impairment in schizophrenia an effective treatment target (Braff, 2015). While cognitive impairment is common among other disorders, such as bipolar disorder, the magnitude of the impairment is generally greater in schizophrenia (for review, see Madre et al., 2016), suggesting that the neurobiological basis of schizophrenia and bipolar disorder may differ.

Establishing similarities and differences in the neurocognitive endophenotype of schizophrenia and schizoaffective disorder may provide important insights for future genetic studies (Braff et al., 2007), and could improve conceptualizations about the common and distinct aspects of the pathophysiology and clinical boundaries of the two disorders. Moreover, neurocognitive test performance may be useful in organizing such heterogeneous conditions into more biologically homogeneous subgroups (Heinrichs, 2005). Developing categorical diagnoses that have a neurobiological component is also important for creating targeted treatments, including pharmacological and sensory/cognitive training interventions (Braff, 2015).

If found that there are substantial differences in the cognitive performance of persons with schizophrenia and schizoaffective disorder, then this may signify that these diagnostic categories map onto different neurobiological entities and are thus distinct conditions, lending support to the current diagnostic classification system. Moreover, this could also mean that cognitive functioning be included as part of diagnostic criteria and therefore assessing cognition may become a routine part of diagnostic practices. However, if neurocognitive patterns between these diagnostic groups are not distinguishable, then it could suggest that schizoaffective disorder is not a distinct entity, which has important implications for research and clinical practices. Thus, the primary purpose of the present study was to determine whether schizophrenia and schizoaffective disorder are distinct or similar conditions by examining the extent to which they share underlying cognitive deficits. Cognitive functioning has represented one of the main parameters evaluated in an attempt to discriminate between schizophrenia and schizoaffective disorders unfortunately with contradictory results.

Studies Finding Superior Performance in Schizoaffective Disorder

Several studies have found that individuals with schizoaffective disorder perform better on some cognitive tasks than those with schizophrenia (see Table 3). In an early study by Maj and colleagues (1986), individuals with schizoaffective disorder, depressed type (n =16) showed a consistent pattern of performance on a comprehensive cognitive battery which, on average, fell midway between that of persons with schizophrenia (n = 20), who were the most impaired, and major depressive disorder (n = 16), who were the least impaired. All of the diagnostic groups were significantly more impaired than the comparison group (n = 20). The authors concluded that individuals with schizoaffective depression encompass a heterogeneous group of cognitive syndromes, some of which are related to major depression and some to schizophrenia.

Nonetheless, the differences between the schizoaffective depression group compared to those with major depression or schizophrenia were non-significant and therefore it is unclear whether schizoaffective disorder truly falls midway between schizophrenia and major depressive disorder.

These results, however, were further supported by research conducted among outpatients with schizoaffective disorder and schizophrenia subtypes. Bornstein and colleagues (1990) found that the schizoaffective disorder (n =18) and paranoid schizophrenia (n = 28) groups tended to have fewer cognitive deficits, and on most variables, the performance of these groups was intermediate between the age-matched comparison group (n = 52) and non-paranoid schizophrenia group (n = 27). When total symptom severity, education, and average daily medication dosage were covaried, the number and magnitude of cognitive differences between the diagnostic subgroups was attenuated. It was concluded that many of the cognitive differences between these groups were related to medication levels or symptom severity and the authors emphasized the need to control for the effects of these variables in comparison of diagnostic groups. Nevertheless, even with the covariates, the non-paranoid schizophrenia group remained more cognitively impaired than the other diagnostic groups on a variety of measures, suggesting that psychotic disorders are cognitively heterogeneous.

Lindenmayer, Kay, and Van Praag (1989) examined the cognitive profiles of hospitalized individuals, matched for age and length of illness, with schizophrenia (n = 21) and schizoaffective disorder (n = 21). While the schizophrenia group was significantly more impaired on verbal encoding and egocentricity of thought, their performance was comparable to the schizoaffective disorder group on verbal intelligence, memory, attention, and organic integrity. Despite this, the authors claimed that the schizophrenia group showed “consistently

greater cognitive abnormality" (p. 423). In terms of cognitive symptoms, the schizophrenia group was significantly impaired on abstract thinking, insight, stereotyped thinking, spontaneous communication, and thought disorganization. It was concluded that these results support the validity of schizoaffective disorder as separate from schizophrenia. However, this assertion is primarily based upon self-reported cognitive symptoms rather than performance on objective measures of cognitive function. This is problematic as individuals with psychotic disorders often lack awareness of their cognitive deficits, subsequently rending patient self-reports an unreliable index of neurocognitive functioning (see Burton, Harvey, Patterson, & Twamley, 2016).

Goldstein and colleagues (2005) compared Veterans Affairs male inpatients with a *DSM-III-R* diagnosis of schizoaffective disorder (n = 20) to patients with paranoid (n = 20), undifferentiated (n = 29) and residual (n = 14) subtypes of schizophrenia on a number of measures of cognitive function. While the schizoaffective disorder and paranoid schizophrenia groups were neuropsychologically indistinguishable, both groups performed significantly better than the undifferentiated and residual subtype groups. Application of cluster analysis indicated that there were relative high percentages of schizoaffective and paranoid patients in a "neuropsychologically normal" cluster. The authors concluded that schizoaffective disorder and clinical subtypes of schizophrenia are cognitively heterogeneous. However, these findings are outdated as schizophrenia subtypes no longer exist due to poor validity, low reliability, and limited diagnostic stability (see Tandon et al., 2013).

More recent studies continue to note superior neurocognitive performance in those with schizoaffective disorder compared to persons with schizophrenia. A pilot study (Stip et al., 2005) compared individuals with *DSM-IV* schizoaffective disorder (N =13) to those with schizophrenia (N = 44) on multiple computerized measures of visuomotor skills. The testing was

repeated after two years to assess for divergence in performance between the two groups (the groups were matched for symptom severity). Testing over time is important as the diagnosis of schizoaffective disorder is often temporally unstable. A significant divergence was found with schizoaffective individuals performing significantly better on tasks of basic visuo-spatial motor skills and explicit memory. The relatively low sample size in the schizoaffective disorder group, however, could have been a confounding factor in reaching these significant divergences (Stip et al., 2005). Based on these findings, the authors concluded that those with schizoaffective disorder might have more preserved cognition, which may provide them with extra ability to successfully participate in treatment and function in the community.

Another study compared the performance of inpatients with *DSM-IV* schizophrenia and schizoaffective disorder, as well as a comparison group (14 demographically matched participants in each group), on measures of verbal and visuospatial working memory (Gruber, Gruber, & Falkai, 2006). On the first verbal working memory task assessing articulatory rehearsal, the schizophrenia group was significantly more impaired than both the schizoaffective disorder group and comparison group, with large effect sizes. On the second verbal working memory task assessing non-articulatory maintenance of phonological information, the schizophrenia group performed significantly worse than the comparison group, with a medium effect size. While the authors stated that there was a "statistical trend" for reduced performance of the schizophrenia group compared to the schizoaffective group on this task, this difference was not statistically significant. The three groups did not differ significantly on the visuospatial rehearsal task or on the visuospatial pattern maintenance task. As such, Gruber and colleagues (2006) conclusion that "schizophrenic patients exhibited pronounced impairments of both verbal and visuospatial working memory" (p. 25) is misleading as the three groups did not differ

significantly on tasks of visuospatial working memory. Nevertheless, the finding of intact verbal working memory in the presence of impaired spatial working memory among individuals with schizoaffective disorder suggests that these patients may have preserved articulatory rehearsal. This may represent a neurocognitive endophenotype that differentiates schizophrenia and schizoaffective disorder; however, replication with a larger sample is required (Gruber et al., 2006). Taken together, these two studies (Gruber et al., 2006; Stip et al., 2005) only suggest that specific areas of cognition are more preserved in schizoaffective disorder compared to schizophrenia.

In contrast, a large scale study, using *DSM-IV* criteria, reported that schizophrenia outpatients (n = 103) were significantly more impaired in processing speed, executive functioning, verbal episodic memory, and working memory measures relative to a group of schizoaffective disorder outpatients (n = 48) and a comparison group (n = 72), with moderate to large effect sizes (Heinrichs, Ammari, McDermid Vaz & Miles, 2008). Despite finding a relative impairment among the schizophrenia group on all cognitive measures, group differences in cognitive performance were of insufficient magnitude to predict a diagnosis of either schizophrenia or schizoaffective disorder. In fact, approximately two-thirds of patients with schizoaffective disorder were misclassified as having a diagnosis of schizophrenia based on the full set of cognitive predictors. Overall, this study found severe average cognitive impairment among participants diagnosed with schizophrenia, but very extensive overlap with the schizoaffective group, suggesting that these disorders may exist on a continuum.

Torniainen and colleagues (2012) compared cognitive functioning between population-based familial samples of patients with *DSM-IV* schizophrenia (n = 218) and schizoaffective disorder (n = 62) derived from nationwide healthcare registers in Finland, as well as a

population-based comparison group (n = 123). While the comparison group significantly outperformed both diagnostic groups on all neuropsychological measures, the schizoaffective disorder group performed significantly better than the schizophrenia group on measures of verbal ability, processing speed, visual working memory, and verbal memory, with effect sizes ranging between small and medium. The two diagnostic groups did not differ significantly on tasks that assessed cognitive shifting, attention, and verbal working memory. Similar to previous research findings (e.g., Heinrichs et al., 2008), the effect sizes were not large enough to differentiate the diagnostic groups based on cognitive functioning because the distributions overlapped.

Importantly, after controlling for clinical characteristics (negative symptoms, positive symptoms, dose of antipsychotics, and age at onset) all significant differences in cognitive performance between the diagnostic groups disappeared (Torniainen et al., 2012). Thus, in accordance with some earlier studies (e.g., Bornstein et al., 1990), the difference in cognitive functions between these diagnostic groups was explained mostly by differences in the severity of negative symptoms, not by differences in mood symptoms or by some inherent difference between the two disorders. Overall, Torniainen and colleagues (2012) concluded that individuals with schizoaffective disorder have severe cognitive impairments, but that these tend to be milder than schizophrenia.

It is important to consider the argument that clinical characteristics should not have been covaried. For instance, if greater negative symptom severity is an intrinsic part of schizophrenia, the covarying of symptom level may artificially diminish the differences between diagnostic groups. When pre-existing groups are studied, observed differences may reflect some meaningful, substantive difference that is attributable to group membership. In this case, because symptoms are so intimately related to diagnosis, removal of variance in cognitive ability

associated with symptoms (i.e., covarying symptoms) would remove considerable variance in cognitive ability associated with diagnosis. Thus, despite this common practice of covarying, attempts to "control" for such differences by covarying have been deemed inappropriate with pre-existing groups (see Miller & Chapman, 2001). Moreover, covarying does not actually control for group differences, rather is intended to reduce variability of scores in groups that vary randomly (Miller & Chapman, 2001).

Hill and colleagues (2013) recently found that schizoaffective probands (N = 165) were significantly less neuropsychologically impaired than schizophrenia probands (N = 293) but were more impaired than psychotic bipolar probands (N = 227), suggesting that there is a continuum of cognitive deficits in psychotic disorders in which schizophrenia anchors one end (with the most severe deficits) and bipolar disorder anchors the other end (with significant but more modest deficits), with schizoaffective disorder falling intermediate between the two. In contrast, another study found that those with schizoaffective disorder (N = 129) demonstrated significantly *greater* post-onset cognitive decline compared to individuals with bipolar disorder with psychotic features (N = 269), schizophrenia with no history of major affective episodes (N = 371), and schizophrenia with a superimposed mood syndrome (N = 224), such that those with schizophrenia exhibited levels of decline intermediate to bipolar disorder with psychosis and schizoaffective disorder, even after differences in demographic characteristics and lifetime symptomatology were covaried (DeRosse et al., 2013). To date this is the only study to find that those with schizoaffective disorder had more severe cognitive impairments than schizophrenia.

Table 3

Studies Finding Significant Neurocognitive Differences between Schizoaffective Disorder and Schizophrenia

References	Population	Measures	Main Findings
Maj et al., 1986	SZ = 20, SA-D = 7, MDD = 16, CG = 20	LNNB	SZ < SA-D < MDD < CG (differences between SA-D and MDD and between SA-D and SZ not statistically significant)
Lindemayer et al., 1989	SZ =21, SA = 21	Egocentricity of Thought Test, MFD, MOT, PANSS cognitive symptoms, Quick Test of Verbal Intelligence, Span of Attention Test	SZ < SA (SZ = SA for IQ, memory, attention and organic integrity)
Bornstein et al., 1990	SZ-P = 28, SZ-U = 27, SA = 18, CG = 52	Halstead-Reitan Battery, VCAT, WAIS-R, WCST, WMS-R	SZ-UD < SA = SZ-P < CG (when medication level, total symptoms, and education were covaried, the magnitude and number of differences declined)
Goldstein et al., 2005	SZ-P = 20, SZ-U = 29, SZ-R = 14, SA = 20	HCT, HTPT, TMT-B, WAIS-R, WCST	SZ-U = SZ-R < SA = SZ-P
Stip et al., 2005	SZ = 44, SA = 13	MST, PAL, Reaction Time Test, SOC	SZ ≤ SA
Gruber et al., 2006	SZ = 14, SA = 14, CG = 14	Verbal and visuospatial Sternberg item-recognition tasks	SZ < SA = CG
Heinrichs et al., 2008	SZ = 103, SA = 48, CG = 72	CVLT, WAIS-III	SZ < SA < CG (differences insufficient to separate diagnostic groups)
Torniainen et al., 2012	SZ = 218, SA = 62, CG = 123	CVLT, TMT-A&B, WAIS-R, WMS-R	SZ < SA < CG (SZ = SA on TMT-A, digit span and visual span forward. After adjusting for

			clinical features, all significant differences in cognitive performance between the diagnostic groups disappeared).
Hill et al., 2013	SZ = 293, P-BD = 227, SA = 165, CG = 295	BACS	SZ < SA < P-BD < CG
DeRosse et al., 2013	SZ(-) = 371, SZ(+) = 224, SA = 129, P-BD = 269	Animal Naming, CVLT, COWAT, TMT-A&B, WAIS-R Digit Span, WRAT	SA < SZ(-) = SZ(+) < P-BD

Note. SA, schizoaffective disorder; SA-D, schizoaffective disorder, depressive episode; SZ, schizophrenia; SZ-P, schizophrenia paranoid; SZ-U, schizophrenia undifferentiated; SZ-R, schizophrenia residual; SZ(-), schizophrenia with no history of mood syndrome; SZ(+), schizophrenia with a superimposed mood syndrome; MDD, major depressive disorder; P-BD, psychotic bipolar disorder; CG, comparison group. BACS, Brief Assessment of Cognition in Schizophrenia; COWAT, Controlled Oral Word Association Test; CVLT, California Verbal Learning Test; HCT, Halstead Category Test; HTPT, Halstead Tactual Performance Test; LNNB, Luria-Nebraska Neuropsychological Battery; MFD; Memory for Designs Test of organic impairment; MOT, Memory Organization Test of verbal encoding; MST, Motor Screening Task; PAL, Paired Associates Learning task; SOC, Stockings of Cambridge items; TMT, Trail Making Test; VCAT, Verbal Concept Attainment Test; WAIS-III, Wechsler Adult Intelligence Scale, Third Edition; WAIS-R, Wechsler Adult Intelligence Scale Revised; WCST, Wisconsin Card Sorting Test; WMS-R, Wechsler Memory Scale Revised; WRAT, Wide Range Achievement Test. (=) no significant differences; (<) greater cognitive functioning.

Studies Finding Equivalent Performance in Schizoaffective Disorder

In contrast to the findings reported by Maj and colleagues (1986), Moses (1984) found that the LNNB failed to distinguish individuals with a *DSM-III* diagnosis of schizophrenia from those with schizoaffective disorder. Since that time, several other studies have found that individuals with schizoaffective disorder do not differ significantly from individuals with schizophrenia across several cognitive domains (e.g., Beatty, Jocic, Monson, & Staton, 1993; Manschreck, Maher, Beaudette, & Redmond, 1997; Miller, Swanson-Green, Moses, & Faustman, 1996; see Table 4).

In a study of 107 stabilized adult outpatients with their first-episode of schizophrenia, schizoaffective or schizophreniform psychosis, no significant differences were found between

diagnostic groups on standardized measures of intellect, memory, attention, and executive functioning (Townsend, Malla, & Norman, 2001). There are a number of limitations to this study acknowledged by the authors, including the absence of a comparison group, the lack of control over potential demographic differences between their sample and normative samples, as well as differences between normative samples themselves, and the fact that this was a primarily male sample (Townsend et al., 2001). Moreover, the non-significant differences found between groups may be due to the small sample sizes in subgroups.

In a naturalistic study comparing measures of executive functioning among community-dwelling individuals with RDC diagnosed schizophrenia (N = 34) and schizoaffective disorder (N = 23), as well as a comparison group (N = 30), Gooding and Tallent (2002) found that while both diagnostic groups exhibited executive dysfunction and performed significantly worse than the comparison group, the two diagnostic groups did not differ significantly from one another, suggesting that the two disorders share similar cognitive impairments. The authors noted that these findings are consistent with several alternative conceptualizations of schizoaffective disorder and that it remains unclear whether schizoaffective disorder is a variant of schizophrenia, a hybrid disorder or a heterogenous condition.

Savage and colleagues (Savage, Jackson, & Sourathathone, 2003) found mild to moderate impairments on brief measures of memory, construction, concept formation, response set maintenance, psychomotor speed, and visual speed of information processing for outpatients with *DSM-IV* diagnosis of paranoid schizophrenia (n = 20), undifferentiated schizophrenia (n = 21), and schizoaffective disorder (n = 20). The groups did not differ significantly from one other except on a task of abstract reasoning and psychomotor speed, in which those with schizoaffective disorder and paranoid schizophrenia performed significantly better than those

with undifferentiated schizophrenia (Savage et al., 2003). This study is limited by the lack of a comparison group, the small sample size in subgroups, and the use of a primarily male sample.

In a large scale study, 199 adults with *DSM-IV* diagnosed schizophrenia were compared to 73 individuals with schizoaffective disorder on measures of executive function, verbal and nonverbal memory, and processing speed with gender used as a covariate (Fiszdon, Richardson, Greig, & Bell, 2007). Consistent with the majority of previous findings, the two diagnostic groups did not differ significantly in their performance on the neurocognitive measures and results do not support a taxanomic distinction between the two disorders. The generalizability of these findings, however, may be limited by the fact that the majority of participants were veterans.

In a study of youth with *DSM-IV* diagnosis of schizophrenia (n = 79) and schizoaffective disorder (n = 40), Hooper and colleagues (2010) found that the groups did not differ significantly on intellect or any neuropsychological domains, such as fine-motor skills, attention, working memory, problem-solving efficiency, and inhibitory control. The results were relatively unchanged even after age and socioeconomic status were covaried. An earlier study with children and adolescents also found no significant differences between those with schizophrenia and schizoaffective disorder on tasks of verbal memory but that both diagnostic groups performed worse than the comparison group after adjusting for differences in estimated premorbid intelligence (Roofeh et al., 2006).

Most recently, a large scale study of outpatients with schizophrenia (n = 188), schizoaffective disorder (n = 63), and a comparison group (n = 268) were assessed for goal maintenance in working memory, relational encoding and retrieval in episodic memory, and visual integration using the Cognitive Neuroscience Test Reliability and Clinical Applications

for Schizophrenia (Owoso et al., 2013). Across these three cognitive domains, no significant differences between diagnostic groups were found, with both groups uniformly performing worse than the comparison group (Owoso et al., 2013).

Other studies continue to find no significant neurocognitive differences between individuals diagnosed with schizophrenia and schizoaffective disorder (e.g., Pinna et el., 2014). Additionally, several of these studies have included a mood disorders group in an attempt to determine whether schizoaffective disorder exists on a continuum between schizophrenia and mood disorders. Based on a continuum model, it is anticipated that cognitive impairment will increase in severity from mood disorders to schizoaffective disorder to schizophrenia.

Silverstein, McDonald, and Meltzer (1988) found that inpatients with RDC schizoaffective disorder (n = 26), schizophrenia (n = 44), and major depression (n = 34) showed comparable impairments on the majority of neuropsychological variables. Overall, the results question the role of neuropsychological processes in discriminating psychiatric conditions and suggest that schizoaffective disorder may be no more distinct neuropsychologically than other psychiatric disorders. In contrast, Evans and colleagues (1999) found that the overall performance on a neuropsychological test battery was significantly more impaired among those with schizophrenia (n = 154) and schizoaffective disorder (n = 29) compared to patients with a non-psychotic mood disorder (n = 27), but that the two psychotic disorder groups did not differ significantly. These findings remained unchanged even when reanalyzed among age, gender, and education matched subsamples of the three diagnostic groups. Moreover, on the basis of discriminant function analysis, individuals in the schizoaffective disorder group were more likely to be classified as having schizophrenia than a mood disorder (Evans et al., 1999). These findings suggest that schizoaffective disorder is a variant of schizophrenia.

A study of individuals with schizoaffective disorder (*n* = 345), schizophrenia (*n* = 270), affective disorder (*n* = 50), and unspecified functional psychosis (*n* = 42) found that after adjustment for ethnic group and social class, the four groups did not differ on a proxy measure of premorbid intelligence or on measures of visual conceptual and visuomotor tracking, suggesting a degree of cognitive homogeneity among these disorders (Gilvarry, Barber, Van Os, & Murray, 2001). Similarly, Glahn and colleagues (2006) found that on backward digit span, a putative measure of verbal working memory, those in the schizophrenia (*n* = 15), schizoaffective disorder, depressive type (*n* = 15), bipolar disorder with psychotic features (*n* = 11) and non-psychotic bipolar patients (*n* = 15) groups all performed significantly worse than the comparison group; however, the diagnostic groups' performance were comparable to each other. As such, the authors concluded that it may be an appropriate endophenotypic marker that cuts across diagnostic categories. In contrast, only patients with a lifetime history of psychotic features, regardless of diagnosis, were impaired on spatial delayed response task.

Another study (Szoke et al., 2008) compared performances on two tasks of executive functioning (Wisconsin Card Sorting Task, WCST and Trail Making Task, TMT) among *DSM-IV* individuals with schizoaffective disorder (*n* = 26), schizophrenia (*n* = 48), bipolar disorder with psychosis (*n* = 52), bipolar disorder without psychosis (*n* = 40), as well as a comparison group (*n* = 48). While the four diagnostic groups performed significantly worse than the comparison group on these two measures, the number of perseverative errors on the WCST was highest in the schizophrenia group and gradually decreased in the schizoaffective, bipolar with psychosis, and bipolar without psychosis groups. However, it is important to note that the only significant differences between the four diagnostic groups occurred between the schizophrenia group and the two bipolar disorder groups. In other words, the schizoaffective disorder group

did not differ significantly from the other three diagnostic groups. On the TMT, the schizophrenia and schizoaffective disorder groups obtained relatively similar scores, as did the two bipolar disorder groups; however, the differences between the four diagnostic groups were not significant. The authors concluded that the pattern of results suggest that individuals with schizoaffective disorder resemble those with schizophrenia for certain cognitive deficits, whereas for other cognitive deficits there is a continuum of severity. Thus, different conceptual views about schizoaffective disorder should be seen as complementary, rather than mutually exclusive.

In a longitudinal, epidemiological study comparing neurocognitive performance profiles of first-admission psychotic patients with schizophrenia (n = 94), schizoaffective disorder (n = 15), psychotic bipolar I disorder (n = 78), and psychotic major depression (n = 48), the schizophrenia group was more impaired than the other groups on all cognitive domains (Reichenberg et al., 2009). Nevertheless, the four diagnostic group's cognitive profiles varied only minimally and were characterized by common relative deficits in memory, attention and processing speed, and executive functions (Reichenberg et al., 2009). Similarly, another study comparing acutely ill patients with schizoaffective disorder (n = 26), schizophrenia (n = 45), and bipolar disorder (n = 51), as well as a comparison group (n = 65), found that all three diagnostic groups performed significantly more poorly than the comparison group on global measures of memory and executive functioning, but that there were no significant differences between the diagnostic groups (Amann et al., 2012).

While all of these studies found that individuals with a diagnosis of schizophrenia or schizoaffective disorder share similar neuropsychological deficits, these studies failed to find support for the idea that cognitive impairment increases in severity from mood disorder to schizoaffective disorder to schizophrenia (with the exception of the aforementioned study by Hill

et al., 2013). Thus, most studies have found no clear evidence for a continuum model of cognitive impairment.

Table 4

Studies Finding No Significant Neurocognitive Differences between Schizoaffective Disorder and Schizophrenia

References	Population	Measures	Main Findings
Moses et al., 1984	SZ = 85, SA = 21	LNNB	SA =SZ
Silverstein et al., 1988	SZ = 44, SA = 26, MDD = 34	LNNB	SA = SZ = MDD (SA < SZ = MDD for sensorimotor and SA = MDD < SZ for tactile function)
Beatty et al., 1993	SZ = 13, SA = 13, CG = 20	Category fluency, Design fluency, FAS, SECISM, WAIS-R(digit span), WCST	SA = SZ < CG (SZ more rapid forgetting)
Miller et al., 1996	SZ = 26, SA-M = 9, SA-D = 17	RAVLT, BVRT, LNNB, WAIS-R	SA = SZ
Manschreck et al., 1997	SZ = 19, SA = 19, UD = 19, CG = 19	Miller–Selfridge Task	SA = SZ < UD = CG
Evans et al., 1999	SZ = 154, SA = 29, NP-MD = 27	ASTVS, BCT, CVLT, DVT, FMT, FTT, SMT, TMT, TPT, TWV, WAIS, WCST	SA = SZ < NP-MD
Townsend et al., 2001	SZ = 83, SA = 19	CPT, PASAT, SCWT, TMT-A&B, WAIS-III, WCST, WMS-III	SA = SZ
Gilvarry et al., 2001	SZ = 270, SA = 345, MD = 50, UFP = 42	TMT-A&B	SA = SZ = MD = UFP

Gooding & Tallent, 2002	SZ = 34, SA = 23, CG = 30	SWM, WCST	SA = SZ < CG
Savage et al., 2003	SZ-P = 20, SZ-U = 21, SA = 20	ASRT, Cognistat, COWAT, SDMT, TMT-A&B, WAIS-R	SZ-P = SZ-U = SA (SZ-U < SA = SZ-P for similarities and TMT-A)
Glahn et al., 2006	SZ = 5, SA = 15, P-BD = 11, NP-BD = 15, CG = 32	SDRT, WAIS	Backward digit span: BD = SZ = SA < CG Hx. of psychosis in spatial delayed response task: SA = SZ = P-BD = NP-BD
Roofeh et al., 2006	SZ = 37, SA = 20, CG = 60	CVLT	SA = SZ < CG
Fiszdon et al., 2007	SA = 73, SZ = 199	HVLT-R, TMT, WAIS-III, WCST	SA = SZ
Szoke et al., 2008	SZ = 48, SA = 26, P-BD = 52, NP-BD = 40, CG = 48	WCST, WMS-R	WCST: SZ < SA <P-BD < NP-BD < CG TMT: SA = SZ
Reichenberg et al., 2009	SZ = 94, SA = 15, BD = 78, UD = 48	FRT, FTT, LFSRT, SCWT, TMT-A&B, WAIS-R, WMS-R	SZ < SA = BD = UD (SZ performed the worst but difference not significant compared to SA)
Hooper et al., 2010	SZ = 79, SA = 40	COWAT, CPT, FTT, HVLT, RFFT, VSWM, WRAML, WAIS, WCST, WRAT, WJ-III	SA = SZ (SZ < SA in spelling)
Amann et al., 2012	SZ = 45, SA-M = 26, BD-M = 51, CG = 65	BADS, WMS	SZ = SA-M = BD-M < CG
Owoso et al., 2013	SZ = 188, SA = 63,	CNTRACS (DPX, JOVI, RISE)	SA = SZ < CG

	CG = 268		
Pinna et al., 2014	SZ = 44, SA = 66	BACS, MMSE	SA = SZ

Note. SA, schizoaffective disorder; SA-M, schizoaffective disorder, manic episode; SA-D, schizoaffective disorder, depressive episode; SZ, schizophrenia; SZ-P, schizophrenia paranoid; SZ-U, schizophrenia undifferentiated; MDD, major depressive disorder; MD, mood disorder; NP-MD, non-psychotic mood disorder; BD, bipolar disorder; NP-BD, non-psychotic bipolar disorder; P-BD, psychotic bipolar disorder; BD-M, bipolar disorder, manic episode; UD, unipolar depression; UFP = unspecified functional psychosis; CG, comparison group. ASRT, Anomalous Sentences Repetition Test; ASTVS, Aphasia Screening Test Verbal Score; BACS, Brief Assessment of Cognition in Schizophrenia; BADS, Behavioural Assessment of the Dysexecutive Syndrome; BCT, Booklet Category Test; BVRT, Benton Visual Retention Test; CNTRACS, Cognitive Neuroscience Test Reliability and Clinical Applications for Schizophrenia; COWAT, Controlled Oral Word Association Test; CPT, Continuous Performance Test; CVLT, California Verbal Learning Test; DPX, Dot Probe Expectancy; DVT, Digit Vigilance Test; FRT, Facial Recognition Test; FMT, Figure Memory Test; FTT, Finger Tapping Test; HVLT, Hopkins Verbal Learning Test; HVLT-R, Hopkins Verbal Learning Test, Revised; JOVI, Jittered Orientation Visual Integration; LNNB, Luria-Nebraska Neuropsychological Battery; LFSRT, Letter Fluency and Sentence Repetition Test; MMSE, Mini Mental State Examination; PASAT, Paced Auditory Serial Addition Test; RAVLT, Rey Auditory Verbal Learning Test; RISE, Relational and Item-Specific Encoding; RFFT, Ruff Figural Fluency Test; SCWT, Stroop Colour-Word Interference Test; SDRT, Spatial Delayed Response Task; SDMT, Symbol Digit Modalities Test; SECIMS, Screening Examination for Cognitive Impairments in Multiple Sclerosis; SMT, Story Memory Test; SWM, Spatial Working Memory; TMT, Trail Making Test; TPT, Tactual Performance Test; TWV, Thurstone Written Fluency; VSWM, Visuospatial Working Memory; WAIS, Wechsler Adult Intelligence Scale; WAIS-R, Wechsler Adult Intelligence Scale, Revised; WAIS-III, Wechsler Adult Intelligence Scale, Third Edition; WCST, Wisconsin Card Sorting Test; WMS, Wechsler Memory Scale; WMS-R, Wechsler Memory Scale, Revised; WMS-III, Wechsler Memory Scale, Third Edition; WJ-III, Woodcock-Johnson Test of Cognitive Abilities, Third Edition; WRAML, Wide Range Assessment of Memory and Learning; WRAT, Wide Range Achievement Test. (=) no significant differences; (<) greater cognitive functioning.

Summarizing the Literature

To date, three reviews and one meta-analysis have tried to clarify the evidence of neuropsychological studies in schizoaffective disorder. On review concluded that “schizophrenia and schizoaffective disorder share a similar pattern of cognitive impairments, which is distinct from patterns in major depression, bipolar disorder, and Alzheimer's dementia” (Buchanan et al., 2005, p. 6). That review, however, was only based upon two studies (Evans et al., 1999; Miller et al., 1996). In a later review it was similarly concluded that individuals with schizoaffective disorder are similar to those with schizophrenia on most neuropsychological measures (Abrams Rojas, & Arciniegas, 2008). A recent systematic review determined schizoaffective disorder to be more cognitively similar to schizophrenia than bipolar disorder and concluded that schizoaffective disorder is either a subtype of schizophrenia or part of the continuum spectrum

model of psychosis, with schizoaffective disorder skewed more towards schizophrenia than bipolar disorder (Madre et al., 2016).

A meta-analysis of 31 studies that compared cognitive functioning across schizophrenia, schizoaffective disorder, and affective psychoses (Bora, Yucel, & Pantelis, 2009) reported how in 6 of 12 cognitive domains people with schizophrenia performed worse than the other two diagnostic groups. Specifically, the schizophrenia group performed significantly worse on verbal memory (immediate recall), intelligence, verbal working memory, TMT-Part B, and WCST performances. However, inter-group differences were slight and the distribution of effect sizes showed a substantial heterogeneity, leading the authors to conclude that neuropsychological data do not provide evidence for categorical differences between schizophrenia and schizoaffective disorder.

Of the 29 studies reviewed herein, only 10 concluded that there were significant cognitive differences between the diagnostic groups, with 9 of these reporting worse cognitive functioning in schizophrenia relative to schizoaffective disorder (see Table 3). Some of these studies supported the conceptualization of schizoaffective disorder as a heterogenous condition (e.g., Bornstein et al., 1990; Goldstein et al., 2005; Maj et al., 1986), separate diagnostic entity (Lindenmayer et al., 1989) or existing on a continuum (Heinrichs et al., 2008; Hill et al., 2013). In contrast, the majority of the literature reviewed (19 studies) found little or no support for categorical differences between the two groups based on neurocognitive performance (see Table 4); however, it remains unclear as to which conceptualization of schizoaffective disorder these empirical studies support.

Comparing Social Cognition between Schizophrenia and Schizoaffective Disorder

Although neurocognition has been a long-standing focus in psychosis research in general and schizophrenia research in particular (see Green & Harvey, 2014), social cognition has emerged more recently as a high-priority research topic, especially due to its critical role in real world outcomes, such as social competence, community functioning, and quality of life (see Couture, Penn, & Roberts, 2006). Social cognition, generally defined as "the mental operations that underlie social interactions," is comprised of four main overlapping domains: emotion processing, social perception, attribution bias, and theory of mind (Green & Horan, 2010, p. 243). While social cognition represents the interface between emotional and cognitive processing, social cognition is distinct from neurocognition (for review, see Mehta et al., 2013).

Although individuals with schizophrenia perform significantly worse across multiple domains of social cognition compared to non-psychiatric individuals (Savla, Vella, Armstrong, Penn, & Twamley, 2013), only a few studies have compared social cognitive performance between schizophrenia and schizoaffective disorder, with findings being mixed (see Table 5). Thus, little is known about the degree to which impairments in social cognitive functioning represent endophenotypic markers of these illnesses (Eack et al., 2010) but it is believed that social cognition represents promising new endophenotypes (Gur et al., 2007).

Studies Finding Superior Performance in Schizoaffective Disorder

Several studies have found that individuals with schizoaffective disorder have more intact social cognition relative to schizophrenia. As previously mentioned, Fiszdon and colleagues (2007) reported no significant differences between the two diagnostic groups on a comprehensive battery of neurocognitive measures. Participants in this study were also administered two measures of social cognition: the Hinting Task (theory of mind) and the Bell-

Lysaker Emotion Recognition Task (emotion perception). Individuals with schizoaffective disorder performed significantly better than those with schizophrenia on theory of mind but not affect perception (Fiszdon et al., 2007). This suggests that persons with schizoaffective disorder may have more intact theory of mind performance, which refers to the ability to infer the mental states of others, but have impairments similar to schizophrenia patients with respect to emotion perception.

Chen and colleagues (2012) compared the performance of adults with schizophrenia (n = 19), schizoaffective disorder (n = 15), and a non-psychiatric comparison group (n = 30) in two face-related cognitive tasks: emotion discrimination, which tests perception of facial affect, and identity discrimination, which tests perception of non-affective facial features. The schizophrenia group, but not the schizoaffective disorder group, exhibited deficient performance in both fear and happiness discrimination, as well as identity discrimination relative to the comparison group. The schizophrenia group showed significantly impaired performance in a theory of mind task compared to schizoaffective disorder and comparison groups; however, the schizoaffective disorder and comparison groups did not differ significantly. This pattern of results suggests distinct processing of face information in schizophrenia and schizoaffective disorder and lends empirical support to the notion that differential pathophysiological processes underlie social cognition in the two disorders.

Most recently, a pilot study in Israel (Tadmor et al., 2016) compared 40 clinically stable individuals with schizophrenia, 20 first episode-persons with schizophrenia, 9 individuals with schizoaffective disorder, and 200 comparison participants on the 'Reading the Mind in the Eyes' task (Eyes task) for which emotional expressions are identified based upon the eye regions of face images (total correct as well as negative emotional valence, positive emotional valance, and

neutral emotional valance were examined). The two schizophrenia groups did not differ significantly from each other but performed significantly worse than the comparison group in all Eyes test parameters. In contrast, the schizoaffective disorder group performed significantly better than the comparison group in decoding positive and neutral valance, with large effect size, but not negative valence (Tadmor et al., 2016). Moreover, the performance of the schizoaffective disorder group was significantly better than both schizophrenia groups in all Eyes test parameters.

These results suggest that the presence of mood symptoms in schizoaffective disorder individuals is related to better processing of facial information, and might indicate that mood abnormality increases the sensitivity to social cues (Tadmor et al., 2016). This provides preliminary evidence that schizoaffective disorder might differ from schizophrenia in their ability to decode the mental state of other people, indicating that mentalizing might be an endophenotype in the diagnostic process of schizophrenia disorders. It is important to note that the small size of the study groups, especially the schizoaffective disorder group, is a major limitation of the study and that future studies with larger diagnostic groups are necessary to validate these findings. Moreover, a study that assessed the reliability and construct validity of the Eyes test rejected the three-factor structure "… on the basis of fit indexes and factor loading. This may be because the mental states in the test are sufficiently different to each other, so that they cannot easily be grouped into a small number of categories" (Vellante et al., 2013, p. 347).

Studies Finding Equivalent Performance in Schizoaffective Disorder

Some studies have reported that social cognition does not differ between diagnostic groups. One study concluded that inpatients with schizoaffective disorder (n = 29) performed significantly better on a task of social cognition (Picture Arrangement subtest of the Wechsler

Adult Intelligence Scale-Revised) relative to those with schizophrenia (n = 26). This difference, however, disappeared when a proxy measure of premorbid intelligence, a variable that significantly differed between the two groups, was covaried (Shean, Murphy, & Meyer, 2005).

In a study examining theory of mind, Greig and colleagues (Greig, Bryson, & Bell, 2004) compared Hinting Task performance among outpatients with *DSM-III-R* diagnosis of schizoaffective disorder and subtypes of schizophrenia. While the disorganized schizophrenia subtype (n = 12) performed significantly worse than the schizoaffective disorder group (n = 41), no significant performance differences were found between the schizoaffective disorder group and any of the other subtypes of schizophrenia (i.e., paranoid schizophrenia, n = 61; residual schizophrenia, n = 8; undifferentiated schizophrenia, n = 5) (Greig et al., 2004). In a study with youth, no significant differences were found among those with schizophrenia and schizoaffective disorder on theory of mind, as assessed by the Eyes task (Hooper et al., 2010).

Summarizing the Literature

Of the few studies that have compared these diagnostic groups on social cognition, the majority have failed to include a comparison group and most have assessed only a single domain of social cognition. Social cognition, like other aspects of cognition, is a multifaceted concept, comprised of several interrelated sub-domains and processes. As such, multiple measures are important in order to adequately address the range of social cognitive abilities shown to be impaired among people with psychosis (see Savla et al., 2013). More studies on this subject are needed as the current dearth of studies with mixed results means that no summary statement about social cognition can be made. Moreover, even fewer studies have compared these diagnostic groups on both social cognition and neurocognition and the findings from those that have (e.g., Fiszdon et al., 2007; Hooper et al., 2010) are limited to youth or veteran samples.

Overall the literature reviewed largely suggests that these two disorders are not distinct. It is interesting to note that the DSM-5 acknowledges "growing evidence that schizoaffective disorder is not a distinct nosological category" (APA, p. 90). Nevertheless, it was retained in the DSM as an independent entity and remains a frequent diagnosis in clinical practice. Thus, this research study will further investigate the validity of schizoaffective disorder through objective, biologically valid means and sets to test the idea that schizoaffective disorder is not a distinct diagnostic entity.

Table 5

Studies Comparing Social Cognition between Schizoaffective Disorder and Schizophrenia

References	Population	Measures	Main Findings
Greig et al., 2004	SZ-P = 62, SZ-U= 5, SZ-D = 12, SZ-R = 8, SA = 41	Hinting Task	SZ-D = SZ-U < SZ-P = SZ-R = SA
Shean et al., 2005	SZ = 26, SA = 29, BD = 18	WAIS picture arrangement	SZ = SA = BD
Fiszdon et al., 2007	SZ = 199, SA = 73	BLERT, Hinting Task	BLERT: SZ = SA Hinting task: SZ < SA
Hooper et al., 2010	SZ = 79, SA = 40	Reading the Mind in the Eyes	SZ = SA
Chen et al., 2012	SZ = 19, SA= 15, CG = 30	Reading the Mind in the Eyes	SZ < SA = CG
Tadmor et al., 2016	SZ-CS = 41, SZ-FE = 20, SA = 9, CG = 200	Reading the Mind in the Eyes	SZ-CR = SZ-FE < CG < SA

Note. SA, schizoaffective disorder; SZ, schizophrenia; SZ-P, schizophrenia paranoid; SZ-U, schizophrenia undifferentiated; SZ-R, schizophrenia residual; SZ-D, schizophrenia disorganized, SZ-CR, schizophrenia clinically stable; SZ-FE, schizophrenia first-episode; BD, bipolar disorder; CG, comparison group. BLERT, Bell Lysaker Emotion Recognition Task; WAIS, Wechsler Adult Intelligence Scale. (=) no significant differences; (<) greater cognitive functioning.

Objectives and Hypotheses

The primary purpose of the present study was to determine whether schizophrenia and schizoaffective disorder are distinct or similar conditions by examining the extent to which they share underlying cognitive deficits. This is the first study to assess whether schizophrenia and schizoaffective disorder are separable using a state-of-the-art, comprehensive cognitive battery designed specifically for the illness (Nuechterlein et al., 2008). While most studies to date have primarily attempted to distinguish these diagnostic categories by using neurocognitive measures, the current research breaks ground by comprehensively assessing and comparing *both* neurocognitive and social cognitive performances among a representative sample of community dwelling adults with schizophrenia and schizoaffective disorder, as well as a comparison group. Additionally, to provide a more detailed and comprehensive understanding of the ways in which these diagnostic categories differ and overlap demographic and clinical variables, as well as indicators of functionality, were examined.

This study, however, is not only focused upon detecting differences between these diagnostic groups, but aims to determine whether neurocognitive and social cognitive performance can accurately classify individuals into schizophrenia and schizoaffective disorder diagnostic categories, as well as predict those without psychiatric illness. Understanding the ability of standardized measures to quantify the differences and similarities between diagnostic categories has important implications for enhancing the clinical practice of differential diagnosis, which currently relies upon subjective symptom reports. Thus, the findings from this study will speak to the utility of cognitive testing as a routine part of diagnosing psychotic disorders.

It was predicted that relative to the comparison group, both diagnostic groups will be significantly more impaired across all domains of neurocognitive and social cognitive

functioning. It was also expected that the two diagnostic groups would not differ significantly across neurocognitive domains and therefore neurocognitive performance would not be able to accurately predict diagnosis. In contrast, it was hypothesized that individuals with schizoaffective disorder would perform significantly better on tasks of social cognition compared to those with schizophrenia but as little research has yet looked at this area it was unclear whether such a difference will be large enough to predict diagnosis. This will be the first study to examine this. Last, it was predicted that the two diagnostic groups would not differ substantially on demographic or clinical features but the schizoaffective disorder group was anticipated to be more intact functionally than those with schizophrenia.

Methods

Participants

The clinical sample was comprised of 116 male and female individuals who met the following criteria: 1) a diagnosis of schizophrenia (n = 70) or schizoaffective disorder (n = 46) confirmed by the Structured Clinical Interview for *DSM-IV-TR* Axis I Disorders (First, Spitzer, Gibbon, & Williams, 2002); 2) outpatient status; 3) a history free of developmental or learning disability; 4) age 18 - 65; 5) a history free of neurological or endocrine disorder; and 6) no concurrent *DSM-IV-TR* (APA, 2000) diagnosis of substance use disorder. Participants in the comparison group (n = 146) were screened for medical and psychiatric illness and history of substance abuse. Demographic and clinical characteristics of the diagnostic groups and comparison group are reported in Table 6.

The clinical samples were recruited from three outpatient clinics in Hamilton, Ontario, Canada: the Cleghorn Early Intervention in Psychosis Program, the Hamilton Program for Schizophrenia, and the Community Schizophrenia Service. Participants in the comparison group

were recruited through local newspaper and online classified advertisements for paid research participation. All participants provided written informed consent on a form approved by the institutional review board. This study was part of a larger research project which was approved by the institutional review board at each research site and by York University.

Measures

Demographic and clinical history. Patients' medical charts were reviewed to determine presence, type, and dose of anti-psychotic medications. The presence and type of other psychotropic medications along with psychiatric, medical, and demographic data were recorded using the Social and Psychiatric History Schedule, which is a comprehensive record of information such as age, education, marital status, and vocational and psychiatric history. A screening questionnaire was used to gather demographic and medical history among comparison group participants.

Psychiatric diagnosis and symptom severity. Patients were administered the Structured Clinical Interview for *DSM-IV-TR* (SCID-I/II; First et al., 2002) to confirm psychiatric diagnosis. Trained clinical research staff used standard administration instructions and guidelines to gather diagnostic and symptom data. Psychiatric symptoms were assessed with the Positive and Negative Syndrome Scale (PANSS; Kay, Opler, Fiszbein, Ramirez, & White, 2000). This semi-structured interview contains 30 items that are rated on a severity scale ranging from 1 (absence of psychopathology) to 7 (extremely severe). This measure contains subscales which provide an index of positive and negative symptoms, depressive symptoms, as well as general psychopathology. Higher scores indicate more severe symptoms.

Functionality. Two indicators of functionality were used for patients based on information obtained from the Social and Psychiatric History Schedule. These include

employment status (full-time, part-time, volunteer or unemployed) and living status (independent or assisted living).

Intelligence estimates. Participants' premorbid intelligence was estimated using the Word Reading subtest from the Wide Range Achievement Test - Fourth Edition (WRAT-4; Wilkinson & Robertson, 2006). The standardized score was used and higher scores indicate higher estimated premorbid intelligence. An estimate of general intellectual ability was obtained from the Vocabulary and Matrix Reasoning subtests of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). Higher scores represent greater estimated intelligence.

Neurocognitive measures. Neurocognitive function was assessed using the MATRICS Consensus Cognitive Battery (MCCB; Nuechterlein et al., 2008), which was developed by the National Institute of Mental Health's (NIMH) Measurement and Treatment to Improve Cognition in Schizophrenia (MATRICS) initiative. The MCCB is a reliable, consensus-based set of standards for measuring cognitive deficits that characterize schizophrenia and related disorders. Domain T scores (Processing Speed, Working Memory, Visual Learning and Memory, Verbal Learning and Memory, Reasoning and Problem Solving, and Attention/Vigilance) were calculated for each participant. These domains were assessed through the following: *Processing Speed*: Category Fluency: Animal Naming, Trail Making Test: Part A, and Brief Assessment of Cognition in Schizophrenia: Symbol Coding; *Working Memory*: Wechsler Memory Scale-III: Spatial Span and Letter-Number Span; *Verbal Learning:* Hopkins Verbal Learning Test Revised; *Visual Learning:* Brief Visuospatial Memory Test Revised; *Reasoning and Problem Solving:* Neuropsychological Assessment Battery: Mazes; and *Attention:* Continuous Performance Test – Identical Pairs (please see the Appendix for a more detailed description of each MCCB subtest).

Social cognitive measures. The Reading the Mind in the Eyes test (Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001) is a widely used task of theory of mind which measures a person's capacity to infer and discriminate the emotions of others from expressions in the eye region of the face. Participants viewed 36 photographs of the eye region from both female and male faces and had to select for each image which of four accompanying words best described the emotion that was being conveyed. Participants were awarded one point for each correct response with total scores ranging from 0-36. Higher scores indicate greater social sensitivity.

Emotion perception was assessed using the social cognition score from the MCCB. More specifically, the MCCB measures social cognition through the Managing Emotions subtest from the Mayer–Salovey–Caruso Emotional Intelligence Test, Version 2.0 (MSCEIT; Mayer, Salovey, & Caruso, 2002). The ability to manage emotions is assessed through a series of scenarios asking the test-taker to identify the most adaptive ways to regulate or manage one's own feelings (Emotion Management Task) and the feelings of others in social situations (Emotional Relationship Task). Higher scores reflect better ability to manage emotions.

The Internal, Personal, and Situational Attributions Questionnaire (IPSAQ; Kinderman & Bentall, 1996) measures the degree to which individuals generate internal, personal, or situational causal attributions for both positive and negative events. Externalizing Bias (EB) score was calculated by subtracting the number of internal attributions for negative events from the number of internal attributions for positive events. A positive score indicates a strong self-serving bias or tendency to blame oneself less for negative events than for positive events (i.e., over attribute positive rather than negative events to oneself). Scores range from 16, indicating a strong self-serving bias, to -16, indicating a weak self-serving bias. Personalizing Bias (PB)

score was calculated by dividing the number of personal attributions by the sum of both personal and situational attributions for negative events. A score of greater than 0.5 represents a tendency to use personal, rather than situational, external attributions for negative events (i.e., blame others rather than situations for negative outcomes).

Procedure

Participants in the present study were part of a larger research project preserved cognitive ability as well as impairments in individuals with a diagnosis of schizophrenia/schizoaffective disorder. This project, which occurred between 2010 and 2014 and was funded by Canadian Institute of Health Research (CIHR), aimed to provide the first detailed assessment of the psychopathology, cognition and structural brain biology of individuals with schizophrenia whose verbal abilities are cognitively exceptional compared to more typical patients with cognitive impairments and both exceptional and cognitively intact persons without psychiatric illness. This research was driven by the theory that the co-occurrence of schizophrenia and superior verbal ability represents a variant of schizophrenia whereby neural mechanisms generate severe psychopathology, but leave cognitive performance relatively unaffected. Thus, participants were recruited to cover a broad spectrum of cognitive abilities, such that those with a mental illness diagnosis not only had cognitive impairments but several were also cognitively "normal" (defined as an overall MCCB composite T score from 40 to 60). Similarly, those in the comparison group were recruited to include individuals functioning in the cognitively "normal" range as well as those in the "impaired" range (defined as an MCCB composite T score from 20 to 39).

In the present study, after those with a psychiatric diagnosis provided signed informed consent, they underwent a structured diagnostic interview to confirm diagnosis. Following

confirmation of diagnosis, patients were administered the PANSS to assess symptom severity. Patients' psychiatric, medical, and demographic data were recorded with the Social and Psychiatric History Schedule. Patients then completed the neurocognitive and social cognitive measures. Once participants in the comparison group provided written informed consent, they were screened and excluded for medical and psychiatric illness. Those in the comparison group subsequently provided demographic information and completed neurocognitive and social cognitive measures.

Trained graduate-level psychology students and a research assistant administered all tests and interviews. The test battery and the clinical interviews took approximately 6 hours and were usually completed in two separate sessions, scheduled several days apart. All participants received monetary compensation for their time.

Statistical Analyses

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS), Version 23, as well as R Studio when certain tests were not available in SPSS. To overcome lack of normal distribution of demographic and clinical scores among groups, as well as violations of homogeneity of variance for several variables, robust methods were used (see Cribbie, Fiksenbaum, Wilcox, & Keselman, 2012) in R Studio. A series of heteroscedastic one-way ANOVAs (Wilcox, 2012) for trimmed means (20%) were conducted to determine whether groups differed significantly on age, education, estimated premorbid intelligence, and estimated current intelligence. Significant findings were followed up with Yuen's test for trimmed means (20%), which is a robust independent sample *t*-test (Yuen, 1974). The effect size of group differences was measured using Cohen's *d*, which in this case was calculated by dividing the trimmed mean difference by pooled standard deviation (Cohen, 1988). Effect sizes of $\geq$0.20,

≥0.50 and ≥.80 were considered small, medium, and large, respectively. Statistical comparisons on discrete variables, such as sex, first language, and handedness, were conducted using Pearson's chi-square test (or in cases where the assumption of this test was violated, i.e., expected frequencies of less than 5, the likelihood ratio statistic was used). The effect size of group differences was measured using Crammer's V, which varies based on degrees of freedom.

The two diagnostic groups were compared on lifetime hospitalization, duration of illness, and severity of positive, negative, general, and depressive symptoms using Yuen's test for trimmed means (Yuen, 1974). Discrete variables, such as medication status, employment status and living status, were compared using Pearson's chi-square test or likelihood ratio statistic.

Analysis of the mean neuropsychological T-scores was conducted using a profile multivariate analysis of variance (MANOVA) to determine if there were significant differences among the three groups across cognitive domains. If a significant interaction of group by neurocognitive domain was noted, it was followed up with univariate ANOVAs to determine which neurocognitive domains differ between groups. Post-hoc statistical power was calculated for each ANOVA using GPower (Version 3.1) and was based upon the total sample size, adjusted alpha level, and effect size (which was determined from partial eta squared). Power equal to or greater than 0.80 was set as the standard for adequacy. If individual cognitive domain ANOVAs were significant, they were followed up with Games Howell post-hoc tests. The effect size of group differences was measured using Cohen's *d*, which was calculated by dividing the mean difference by pooled standard deviation (Cohen, 1988). A discriminate function analysis was also performed to determine which linear combination of individual neurocognitive variables leads to maximum group distinction and to examine the degree to which neurocognitive performance could correctly predict group membership.

Analysis of social cognitive measures was conducted using MANOVA to determine if there were significant differences among the three groups across social cognitive domains. If a significant interaction of group by social cognitive domain was noted, it was followed up with univariate ANOVAs and post-hoc statistical power was calculated for each ANOVA. If individual social cognitive domain ANOVAs were significant, they were followed up with Games-Howell post-hoc tests and the effect size of group differences was measured using Cohen's *d*. A discriminate function analysis was performed to determine how the social cognitive domains discriminate the three groups, as well as to examine the degree to which social cognitive performance could effectively predict group membership.

Results

Demographic and Clinical Characteristics

As displayed in Table 6, group status was not significantly associated with sex, first language, or handedness, with all effect sizes being small (V = 0.12, V = 0.06, V = 0.11, respectively). Further, the three groups did not differ significantly in terms of age or years of education; however, they differed significantly on estimated premorbid intelligence and estimated current intelligence. In terms of estimated premorbid intelligence, there was a medium and significant difference between the diagnostic groups, $t(52.70) = 2.66$, $p = .010$, $d = 0.61$, such that those with schizophrenia (trimmed $M = 89.29$, $SD = 10.82$) scored significantly below those with schizoaffective disorder (trimmed $M = 95.83$, $SD = 10.70$). There was also a medium and significant difference between the schizophrenia and comparison groups, $t(50.03) = 3.34$, $p = .002$, $d = 0.60$, such that the schizophrenia group performed significantly worse than the comparison group (trimmed $M = 95.54$, $SD = 10.16$); however, the schizoaffective disorder and comparison groups did not differ significantly, $t(33.50) = 0.145$, $p = .885$, $d = 0.03$.

In terms of estimated current intelligence, while the schizophrenia group (trimmed M = 93.30, SD = 17.80) scored below the schizoaffective disorder group (trimmed M = 99.57, SD = 17.80), this difference was small and not statistically significant, $t(53.95) = 1.44$, $p = .155$, d = 0.35. The performance of the schizophrenia group fell significantly below the comparison group (trimmed M = 102.20, SD = 15.23), $t(86.24) = 3.03$, $p = .003$, d = 0.54, whereas the schizoaffective disorder and comparison groups did not differ significantly, $t(36.26) = .698$, $p = .490$, d = 0.16.

Table 6

Demographic Comparison of Three Groups

Demographic Variables	Groups			Group Comparisons	
	SZ (n = 70)	SA (n = 46)	CG (N = 146)	F, $\chi 2$ or $L\chi 2$	p
Age in years, $M(SD)$	41.39(11.36)	44.54(9.24)	40.34(11.18)	$F(2, 72.03) = 2.87$	0.064
Sex, n(%), male	52(74.3)	29(63.0)	88(60.3)	$\chi^2(2) = 4.11$	0.128
Education in years, $M(SD)$	12.46(2.15)	12.84(2.47)	11.95(2.28)	$F(2, 69.32) = 2.28$	0.110
First language, n(%), English	62(88.6)	43(93.5)	134(91.8)	$\chi^2(2) = .96$	0.618
Handedness, n(%), right	65(92.9)	36(81.8)	125(86.2)	$\chi^2(2) = 3.29$	0.193
Premorbid IQ, $M(SD)$	88.98(10.82)	94.61(10.70)	95.50(10.16)	$F(2, 49.6) = 5.78$	0.006
Current IQ $M(SD)$	93.29(17.80)	98.83(17.80)	101.56(15.23)	$F(2, 58.75) = 4.56$	0.014

Note. For purposes of clarity, untrimmed means and standard deviations are presented but all *F* values were based on trimmed means. Education was missing for one SZ participant; handedness was missing for one CG participant and two SA group participants; estimated premorbid IQ was missing for 14 SZ, 8 SA and 2 CG participants; and current IQ was missing for 1 SZ group participant. SZ = schizophrenia; SA = schizoaffective disorder; CG = comparison group.

Table 7 summarizes clinical variables among the two diagnostic groups. The two diagnostic groups did not differ significantly in terms of the number of lifetime hospitalizations or the number of years since the onset of first characteristic signs and symptoms. The two diagnostic groups also did not differ significantly in terms of general psychiatric, positive or negative symptom severity. There was a medium and significant difference between diagnostic groups on depressive symptom severity, such that the schizoaffective group had significantly more severe depressive symptoms than the schizophrenia group.

In terms of functionality, employment status and living status were assessed. There was a medium but non-significant association between diagnostic category and employment status. With respect to living status, there was a medium and significant association between diagnostic category and living status, such that those with schizophrenia were significantly less likely to live independently than those with schizoaffective disorder.

The majority of patients (N = 83) were medicated with only one patient being un-medicated (data for 33 patients was missing). The proportion of patients medicated or not medicated did not differ significantly between the diagnostic groups. There was no significant difference in the class of anti-psychotic medication (i.e., typical, atypical or combination) between diagnostic groups. The diagnostic groups also did not differ significantly in terms of the proportion taking or not taking anti-depressants, mood stabilizers, benzodiazepines, and anti-Parkinson agents. All effect sizes were small. Overall, the demographic and clinical features of the current sample of participants with schizophrenia and schizoaffective disorder is

representative of community dwelling research participants with psychotic disorder (see Cheniaux et al., 2008; Heinrichs & Zakzanis, 1998).

Table 7

Clinical Comparison of Schizophrenia and Schizoaffective Disorder Groups

Clinical Variables	Diagnostic Groups		Group Comparisons		
	SZ (n = 70)	SA (n = 46)	*t, χ2 or Lχ2*	*p*	*Effect size*
Symptom severity, *M*(*SD*)					
Positive	43.81(9.18)	42.52(8.77)	*t*(45.93) = 0.589	0.559	*d* = 0.13
Negative	40.80(8.14)	37.87(5.96)	t(66.990) = 1.660	0.102	*d* = 0.40
Depression	47.67(11.70)	54.87(12.71)	*t*(52.17) = 2.699	0.009	*d* = 0.60
General	41.30(7.14)	42.72(8.10)	*t*(44.14) = 1.075	0.288	*d* = 0.26
Years of Illness, *M*(*SD*)	17.45(12.15)	17.34(8.75)	*t*(47.51) = 0.211	0.834	*d* = 0.06
Hospitalizations (lifetime), *M*(*SD*)	4.61(6.38)	5.46(7.29)	*t*(35.35) = 0.511	0.613	*d* = 0.06
Employment status, *n*(%)			$L\chi^2(3) = 5.80$	0.122	V = .26
Full-time	4(7.7)	3(8.3)			
Part-time	2(3.8)	7(19.4)			
Volunteer	20(38.5)	11(30.6)			
Unemployed	25(50.0)	15(41.7)			
Living status, *n*(%)			χ2(1) = 5.032	0.025	V = .290
Independent	15(44.1)	19(73.1)			

Assisted	19(55.9)	7(26.9)			
Medicated, *n*(%)	47(57.3)	35(42.7)	$L\chi 2(1) = 1.104$	0.293	V=.094
Anti-Psychotic Type, *n*(%)			$L\chi 2(2) = 1.104$	0.576	V = .118
…..Typical only	8(17.8)	4(12.5)			
…..Atypical only	32(71.1)	26(81.3)			
…..Both types	5(11.1)	2(6.3)			
Anti-Depressant,	21(43.8)	18(51.4)	$\chi 2(1) = .479$	0.489	V = .076
Mood Stabilizers	5(10.4)	6(17.1)	$L\chi 2(1) = .786$	0.375	V = .098
Benzodiazepines	17(35.4)	15(42.9)	$\chi 2(1) = .473$	0.492	V = .075
Anti-Parkinsonian	5(10.6)	8(22.9)	$\chi 2(1) = 2.245$	0.134	V = .165

Note. For purposes of clarity, untrimmed means and standard deviations are presented but all *t* values are based on trimmed means. Sample sizes varied and are as follows: years of illness (SZ = 47, SA = 33); lifetime number of hospitalizations (SZ = 51, SA = 35); employment status (SZ = 52, SA = 36); living status (SZ = 34, SA = 26); Anti-psychotic (SZ = 45, SA = 32); Anti-depressants (SZ = 48, SA = 35); Mood stabilizers (SZ = 48, SA = 35); Benzodiazepines (SZ = 48, SA = 35); Anti-Parkinsonian (SZ = 47, SA= 35). M = mean; SD = standard deviation. SZ = schizophrenia; SA = schizoaffective disorder.

Comparing Neurocognitive Domains

The sample of participants with neurocognitive data was smaller than the overall sample with a total of 242 participants (58 schizophrenia, 39 schizoaffective disorder, and 145 comparison) having complete neuropsychological data. The respective groups with complete data were compared on demographic and clinical variables. The findings were consistent with what was reported above in Tables 6 and 7, except that years of education differed significantly between groups, $F(2, 56.65) = 3.19$, $p = .048$. The schizophrenia (trimmed $M = 12.69$, $SD = 1.99$) and schizoaffective disorder (trimmed $M = 12.82$, $SD = 2.50$) groups did not differ significantly, $t(46.09) = .290$, $p = .773$, $d = 0.06$. The comparison group (trimmed $M = 11.99$, SD

= 2.27) had significantly fewer years of education than schizophrenia group, $t(71.69) = 2.10$, $p = .040$, $d = 0.34$, and schizoaffective disorder group, $t(37.85) = 1.95$, $p = .058$, $d = 0.35$.

Assumptions for MANOVA were assessed. All observations were independently distributed, all neurocognitive outcome variables were continuous, and the sample sizes in each group were adequate. Based on Mahalanobis distance ($df = 6$, cut off = 22.46) one multivariate outlier was identified amongst the residuals (22.67). Outliers were examined and overall no values had extreme leverage (all hat values were less than 1, with a maximum value of .094) or influence (all Cook's distance values were less than 1, with a maximum value of .060). As SPSS does not have a test of multivariate normality, this was conducted in R Studio using Mardia's multivariate test of normality. Based on the residuals of all of the neurocognitive variables, the skewness (Mardia's = 2.96, $\chi^2 = 119.33$, $p < .001$) and kurtosis (Mardia's = 48.66, $\chi^2 = -.53$, $p = .598$) estimates indicate that the distribution of the residuals is not multivariate normal. Visual inspection of a chi-square Q-Q plot indicates that this deviation from multivariate normality is mild. Box's test of equality of covariance matrices was violated, $M = 65.74$, $F(42, 44137.30) = 1.49$, $p = .022$; however, this is likely because this test is susceptible to deviations from multivariate normality. There is no multicollinearity (correlations between outcome variables were less than 0.9) and neurocognitive outcome variables were moderately correlated with each other, with values ranging from .430 to .686.

The omnibus MANOVA showed a significant difference between groups in terms of neurocognitive performance, $\Lambda = 0.70$, $F(12, 468) = 7.53$, $p < .001$. To check for the impact of potential outliers, a simple robust method that iteratively down weights the observations with large multivariate residuals was performed in R Studio with essentially the same results, $\Lambda = 0.67$, $F(12, 468) = 8.515$, $p < .001$. The omnibus MANOVA was followed up with separate

univariate ANOVAs and multiple comparisons were adjusted using a Bonferonni correction, α(.05/6) = .008. Levene's assumption of equality of homogeneity variance was upheld for all ANOVAs. The ANOVAs showed that the groups differed significantly on all neurocognitive domains (all *p*-values < .001) and that power was adequate. See Table 8 and Figure 1.

Table 8

Neurocognitive Domain Mean (SD) T-Scores and Between Groups Mean Comparison

Neuro-cognitive Domains	Groups			One-way ANOVAs			
	SZ (n = 58)	SA (n =39)	CG (n = 145)	F(2, 239)	p	Partial η^2	Power
Processing Speed	33.10(11.84)	33.15(9.23)	45.12(10.45)	37.069	< .001	.237	1.00
Attention	33.45(13.25)	34.56(13.18)	43.67(12.28)	17.399	< .001	.127	.998
Working Memory	37.33(11.92)	38.08(12.81)	45.66(11.18)	13.908	< .001	.104	.988
Verbal Learning	35.66(9.07)	36.54(8.73)	44.96(9.44)	27.346	< .001	.186	.999
Visual Learning	32.31(11.98)	32.39(9.96)	40.31(10.12)	16.607	< .001	.122	.997
Reasoning/ Problem Solving	41.36(8.80)	39.92(8.61)	49.20(9.37)	25.062	< .001	.173	.999

Note. SD = standard deviation; SZ = schizophrenia; SA = schizoaffective disorder; CG = comparison group.

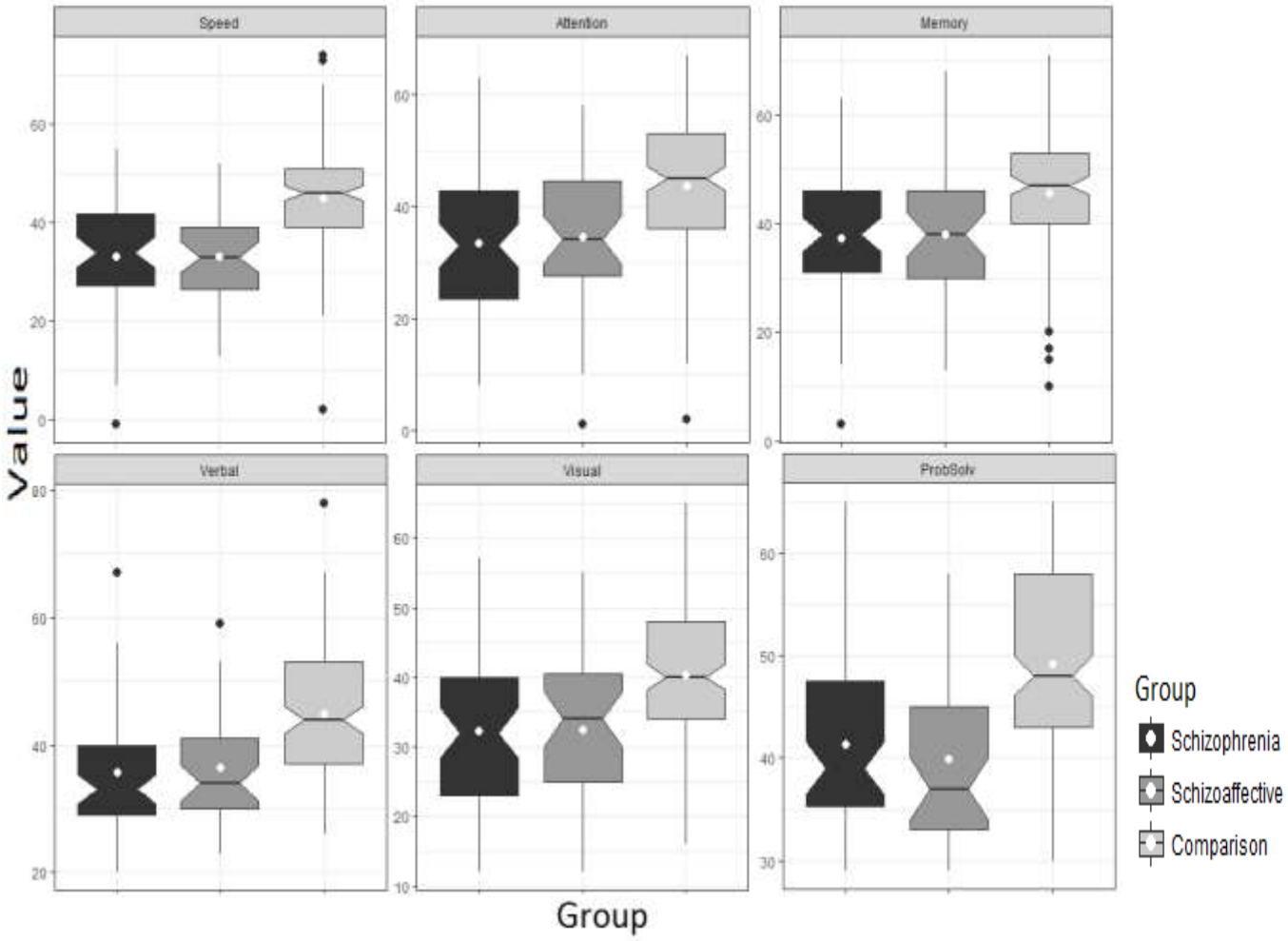

Figure 1. Boxplots comparing the performance between groups on neurocognitive domains. White dots represent group means (as reported in Table 3). Speed = processing speed; Memory = working memory; Verbal = verbal learning; Visual = visual learning; ProbSolv = problem solving.

Games-Howell post-hoc comparisons demonstrated that on all neurocognitive domains, the schizophrenia group performed significantly worse than the comparison group (all $p < .001$). This produced the following rank order: processing speed ($d = 1.08$), verbal learning ($d = 1.00$), reasoning/problem solving ($d = 0.86$), attention ($d = 0.80$), working memory ($d = 0.72$) and visual learning ($d = 0.72$). The schizoaffective disorder group also performed significantly worse

than the comparison group on all neurocognitive domains (all $p < .001$, except attention, $p = .001$, and working memory, $p = .004$). This produced the following rank order: processing speed ($d = 1.21$), reasoning/problem solving ($d = 1.03$), verbal learning ($d = 0.93$), visual learning ($d = 0.79$), attention ($d = 0.72$), and working memory ($d = 0.63$). While the schizophrenia group performed slightly worse than the schizoaffective disorder group on all neurocognitive domains, except for reasoning/problem solving (see Table 8), the differences between the two diagnostic groups was not statistically significant (all p values > .70) and effect sizes were small (Cohen's d ranged from 0.005 to 0.17).

The MANOVA was followed up with discriminant analysis, which revealed two discriminant functions. The first function explained 98.5% of the variance in the group means, while the second only explained 1.5% of variance in group means. In combination these discriminant functions significantly differentiated the groups, $\Lambda = .70$, $\chi 2(12) = 83.47$, $p < .001$, but removing the first function indicated that the second function did not significantly differentiate the groups, $\Lambda = .99$, $\chi 2(5) = 1.48$, $p = .915$. Thus, the significant difference from the MANOVA between the comparison group and two diagnostic groups can best be explained in terms of one underlying dimension. Moreover, what most strongly differentiated the comparison group from the two diagnostic groups was performance on tasks of processing speed ($r = .625$), verbal learning ($r = .446$) and reasoning/problem solving ($r = .396$). See Figure 2.

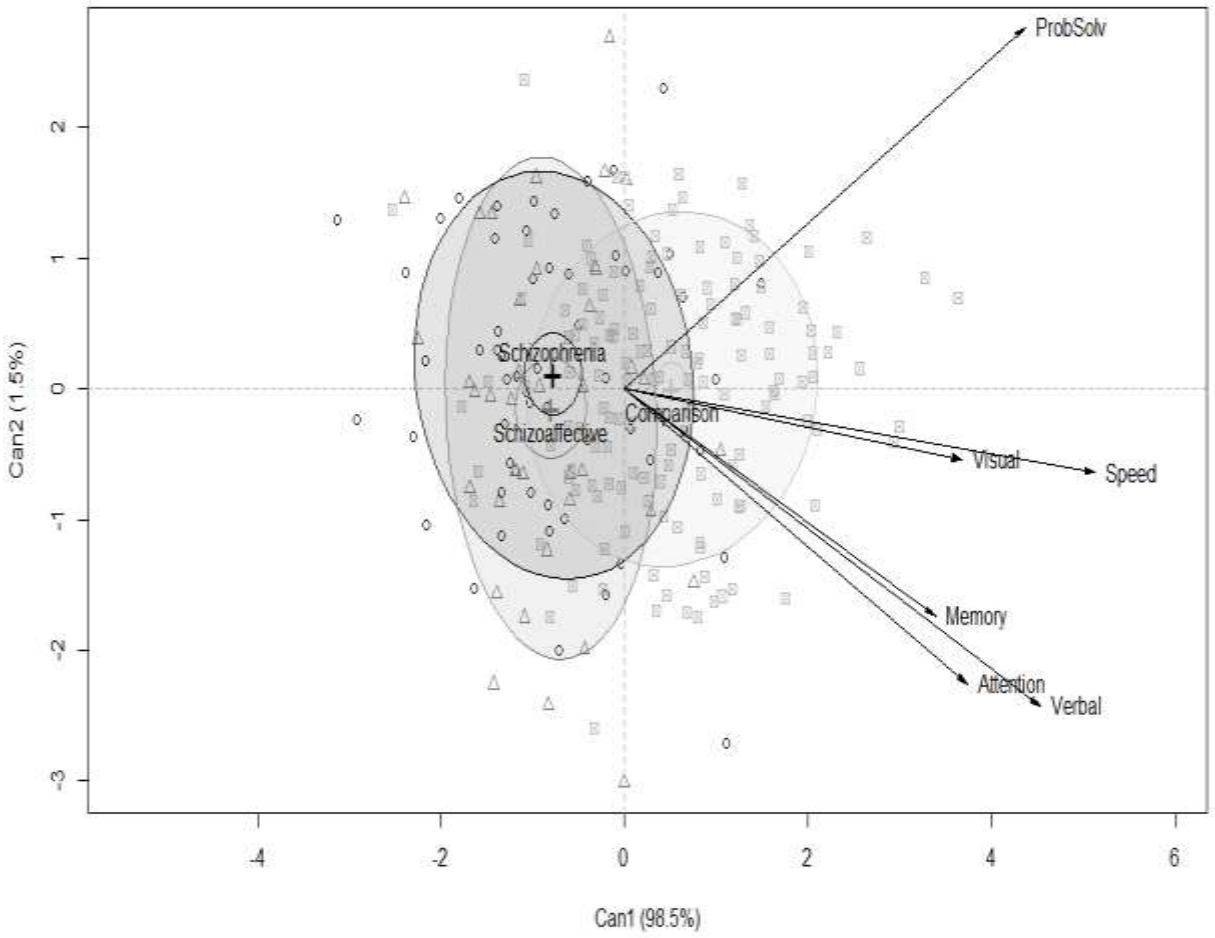

Figure 2. Canonical discriminant function plot of neurocognitive domains by group. This figure indicates that problem solving, processing speed and verbal leaning are the neurocognitive domains that most discriminate the three groups. The group centroids are denoted with a cross, with the schizophrenia, schizoaffective disorder and comparison group centroids represented by a black, dark grey, and light grey cross, respectively. Black circles represent participants in the schizophrenia group, dark grey triangles represent individuals in the schizoaffective disorder group, and light grey squares represent individuals in the comparison group. ProbSolv = problem solving; Speed = processing speed; Visual = visual learning; Verbal = verbal learning; Memory = working memory.

The discriminant function analysis was also performed to examine the degree to which cognitive performance could correctly classify individuals as having schizophrenia, schizoaffective disorder or no psychiatric condition (comparison). See Table 9. Of the 58 individuals in the schizophrenia group, the cognitive measures only correctly identified 51.7% (*n* = 30) of people with schizophrenia as such. Of the 39 individuals with schizoaffective disorder, the cognitive measures were only able to correctly identify 7.7% (*n* = 3). The majority of individuals with schizoaffective disorder were incorrectly classified as belonging to the comparison group, 48.7% (*n* = 19), or schizophrenia group, 43.6% (*n* = 17).

Of the 145 participants in the comparison group, the cognitive measures were able to correctively identify the vast majority of participants, 93.8% (*n* = 136). No participants in the comparison group were misclassified as belonging to the schizoaffective disorder group and only 6.2% (*n* = 9) were incorrectly classified as belonging to the schizophrenia group. Overall, 69.8% of the original grouped cases were correctly classified.

Table 9

Predicted Group Membership Based on Neurocognitive Performance

Actual Group membership	Predicted Group Membership			
	Schizophrenia	Schizoaffective Disorder	Comparison	Total
Schizophrenia, *n*(%)	30(51.7)	1(1.7)	27(46.6)	58
Schizoaffective, *n*(%)	17(43.6)	3(7.7)	19(48.7)	39
Comparison, *n*(%)	9(6.2)	0(0)	136(93.8)	145

Comparing Social Cognitive Domains

The sample of participants with social cognitive data was smaller than the overall sample with a total of 139 participants (43 schizophrenia, 30 schizoaffective disorder, and 66 comparison) having complete social cognition data. The respective groups with completed data were compared on demographic and clinical variables. The findings were consistent with what was reported above in Tables 5 and 6, except that the three groups no longer differ significantly with respect to estimated current intelligence, $F(2, 41.55) = 2.835$, $p = .070$.

Assumptions for MANOVA were assessed. All observations were independently distributed, all social cognitive outcome variables were continuous, and the sample sizes in each group were adequate. Based on Mahalanobis distance ($df = 4$, cut off = 18.47) there were no multivariate outliers identified and all Cook's distance and hat values fell well below one. Based on the residuals of all of the social cognitive variables, the skewness (Mardia's = 1.23, $\chi^2 = 28.54$, $p = .097$) and kurtosis (Mardia's = 22.86, $\chi^2 = -.97$, $p = .330$) estimates, along with visual inspection of a chi-square Q-Q plot, indicate that the distribution of the residuals is multivariate normal. Box's test of equality of covariance matrices was not violated, Box's M = 16.83, $F(20, 33921.57) = .801$, $p = .715$. There was no multicollinearity (correlations between outcome variables were less than 0.9) and social cognitive outcome variables were weakly correlated with each other, with values ranging from -.066. to .437.

The omnibus MANOVA showed a significant difference between groups in terms of performance on tasks assessing social cognition, $\Lambda = 0.80$, $F(8, 266) = 3.930$, $p < .001$. This was followed up with separate univariate ANOVAs that were adjusted for multiple comparisons using a Bonferroni correction at $\alpha(.05/4) = .013$. Levene's assumption of equality of homogeneity variance was upheld for all ANOVAs. The ANOVAs indicated that the groups

differed significantly on managing emotions and theory of mind but not on externalizing or personalizing attribution bias; however, this could be due to inadequate statistical power. See Table 10 and Figure 3.

Table 10

Social Cognitive Domain Mean (SD) T-Scores and Between Group Mean Comparison

Social Cognitive Abilities	Groups			One-way ANOVAS			
	SZ (n = 43)	SA (n =30)	CG (n = 66)	F(2, 136)	p	partial η^2	Power
Managing Emotions	35.83(11.32)	44.53(12.80)	45.05(13.29)	7.666	.001	.101	.86
Theory of Mind	20.81(5.58)	22.87(4.50)	24.98(5.57)	7.967	.001	.105	.88
Externalizing Attribution Bias	1.16(3.61)	2.10(4.29)	2.77(3.57)	2.409	.094	.034	.28
Personalizing Attribution Bias	.68(.29)	.71(.24)	.58(.27)	2.855	.061	.040	.35

Note. SD = standard deviation; SZ = schizophrenia; SA = schizoaffective disorder; CG = comparison group.

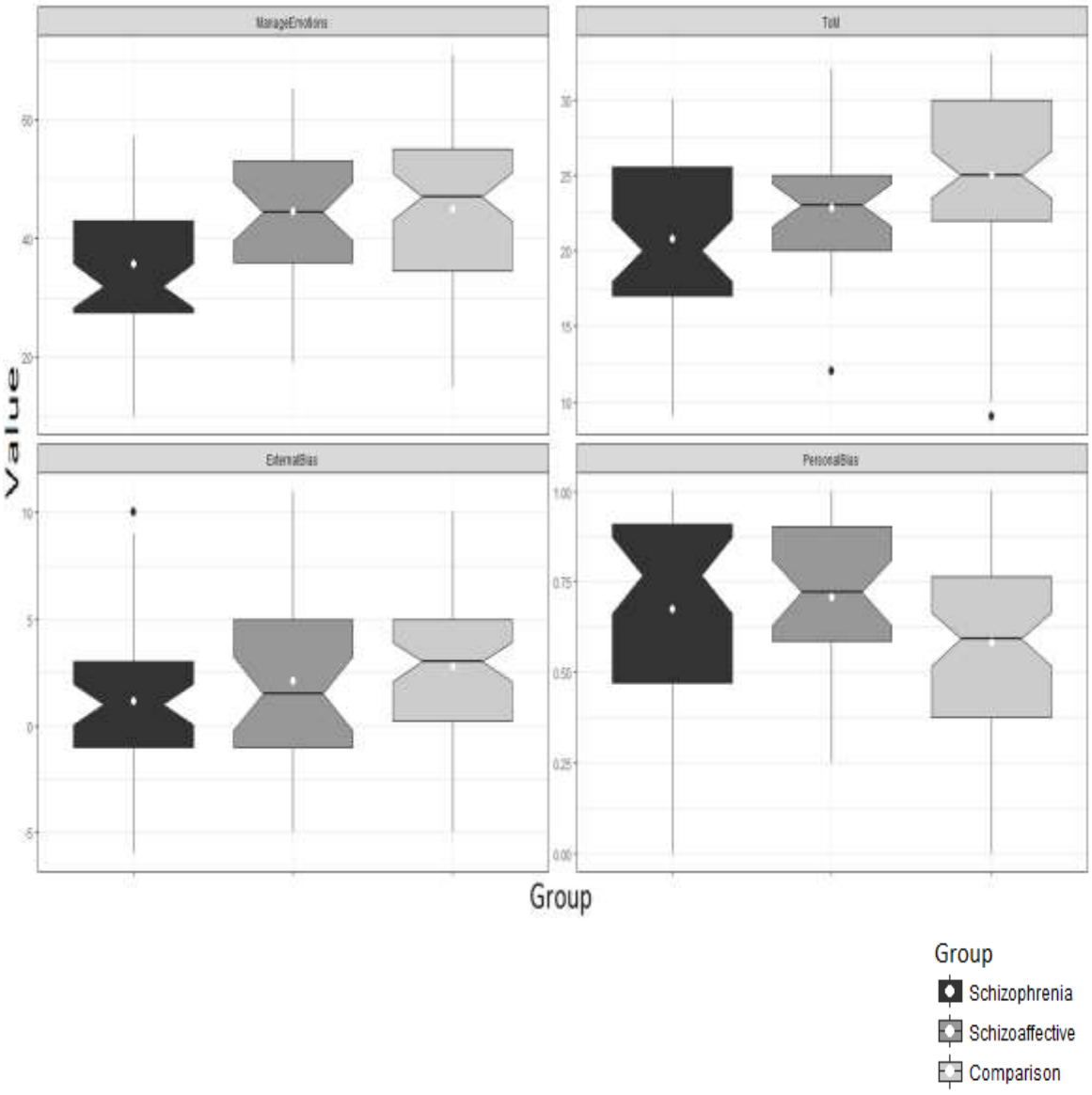

Figure 3. Boxplots comparing the performance between groups on social cognitive domains. The three groups were compared in terms of their performance on social cognitive tasks assessing managing emotions, theory of mind, externalizing bias and internalizing bias. White dots represent group means (as reported in Table 6).

The two significant ANOVAs were followed up with Game-Howell post-hoc comparisons. In terms of managing emotions, the schizophrenia group performed significantly worse than both the comparison group (p = .001), with a medium effect (d = 0.74), and the schizoaffective disorder group (p = .011), with a medium effect (d = 0.75). While the schizoaffective disorder group performed slightly worse than the comparison group, this difference was non-significant (p = .982, d = 0.02).

With respect to theory of mind, the schizophrenia group performed significantly worse than the comparison group (p = .001), with a medium effect (d = 0.77). Although the schizophrenia group performed worse, on average, than the schizoaffective disorder group, this difference was not statistically significant (p = .199, d = -0.48). The schizoaffective disorder and comparison groups did not differ significantly (p = .125, d = -0.38).

The omnibus MANOVA was followed up with discriminant analysis, which revealed two discriminant functions. The first function explained 84.9% of the variance in the group means, while the second explained 15.1% of variance in group means. In combination these discriminant functions significantly differentiated the groups, $\Lambda = .800$, $\chi 2(8) = 30.054$, $p < .001$, but removing the first function indicated that the second function did not significantly differentiate the groups, $\Lambda = .965$, $\chi 2(3) = 4.839$, $p = .184$. Thus, the significant MANOVA can best be explained in terms of one underlying dimension. Moreover, what most strongly differentiated the groups was theory of mind (r =.583) and managing emotions (r =. 413). See Figure 4.

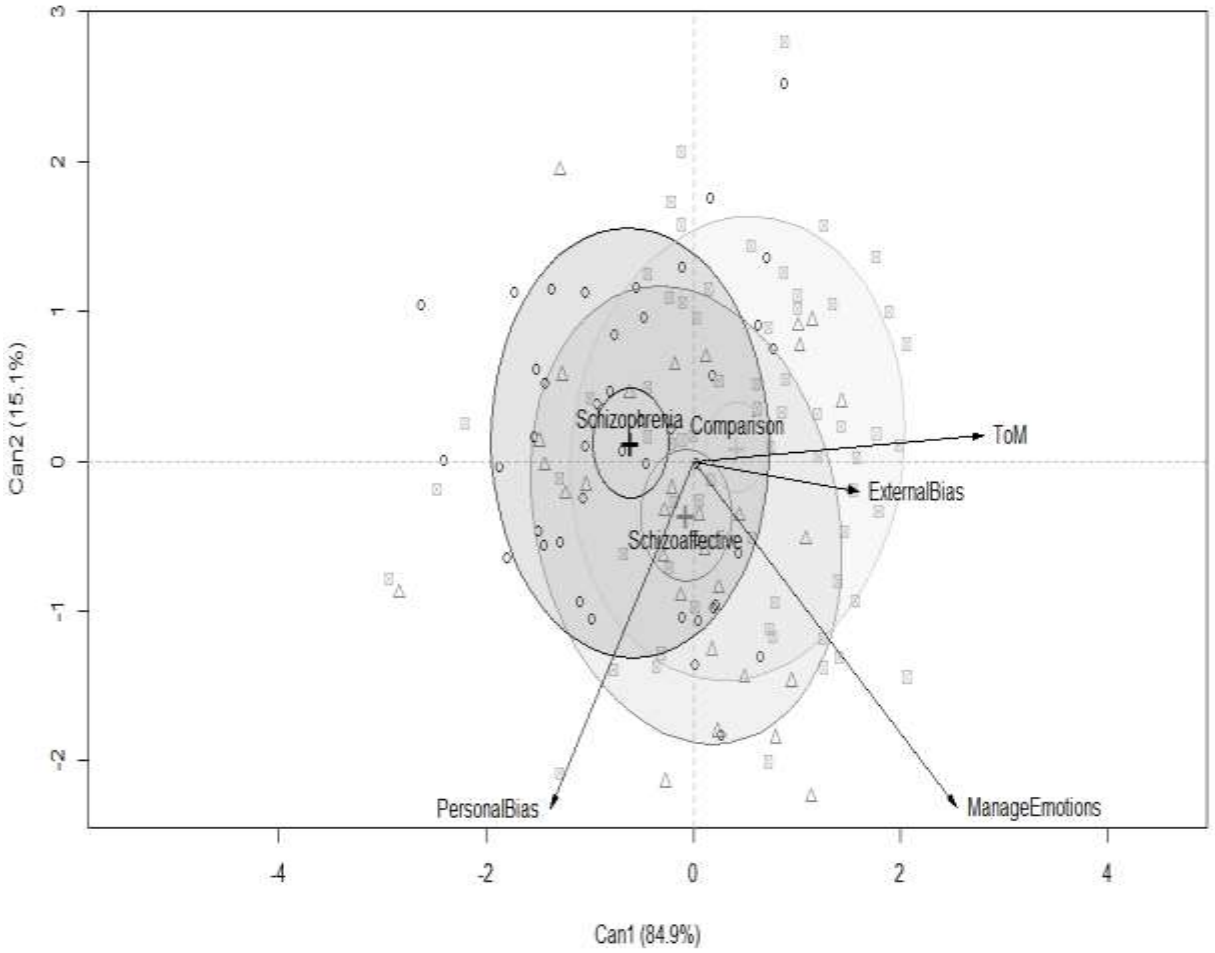

Figure 4. Canonical discriminant function plot of social cognitive domains by group. Theory of mind and managing emotions are the social cognitive variables that most discriminate the schizophrenia group from the other two groups. The group centroids are denoted with a cross, with the schizophrenia, schizoaffective disorder, and comparison group centroids represented by a black, dark grey, and light grey cross, respectively. Black circles represent participants in the schizophrenia group, dark grey triangles represent individuals in the schizoaffective disorder group, and light gray squares represent individuals in the comparison group. ExternalBias = externalizing bias; ToM = theory of mind; ManageEmotions = managing emotions; PersonalBias = personalizing bias.

The discriminant function analysis was also performed to examine the degree to which social cognitive performance could correctly classify individuals as belonging to the schizophrenia, schizoaffective disorder or comparison group. See Table 11. Of the 43 individuals in the schizophrenia group, the social cognitive measures only correctly identified 55.8% (*n* = 24) as such, whereas 44.2% (*n* =11) were incorrectly classified as belonging to the comparison group. Nobody with schizophrenia was misclassified as belonging to the schizoaffective disorder group. Of the 30 individuals in the schizoaffective disorder group, only 3.3% (*n* = 1) were correctly classified as such based on the social cognitive measures. The majority of individuals with schizoaffective disorder, 70% (*n* = 20), were incorrectly classified as belonging to the comparison group and the remaining 26.7% (*n* = 8) were incorrectly classified as belonging to the schizophrenia group.

Of the 66 participants in the comparison group, the vast majority, 86.4% (*n* = 57), were correctly classified as such, with only 9.1% (*n* = 6) and 4.5% (*n* = 3) incorrectly classified as belonging to the schizophrenia and schizoaffective disorder groups, respectively. Overall, 59.0% of the original grouped cases were correctly classified.

Table 11

Predicted Group Membership Based on Social Cognitive Performance

Actual group membership	Predicted Group Membership			
	Schizophrenia	Schizoaffective disorder	Comparison	Total
Schizophrenia, *n*(%)	24(55.8)	0(0)	19(44.2)	43
Schizoaffective disorder, *n*(%)	8(26.7)	1(3.3)	21(70.0)	30
Comparison, *n*(%)	6(9.1)	3(4.5)	57(86.4)	66

Discussion

Schizoaffective disorder represents an ongoing challenge for psychiatric nosology, given the uncertainty of its boundaries in relation to schizophrenia. Using the MCCB, the current study found that the cognitive profile of individuals with a diagnosis of schizoaffective disorder and schizophrenia did not differ significantly. This is consistent with several previous findings (Amann et al., 2012; Beatty et al., 1993; Evans et al., 1999; Fiszdon et al., 2007; Gilvarry et al., 2001; Glahn et al., 2006; Gooding & Tallent, 2002; Hooper et al., 2010; Manschreck et al., 1997; Miller et al. 1996; Moses, 1984; Owoso et al., 2013; Pinna et al., 2014; Reichenberg et al., 2009; Roofeh et al., 2006; Savage et al., 2003; Silverstein et al., 1988; Szoke et al., 2008; Townsend et al., 2001) including a recent systematic review of the literature (Madre et al., 2016). While the performance of the schizophrenia group on each cognitive domain was, on average, slightly below that of the schizoaffective disorder group (except on tasks of reasoning and problem solving), these differences were of small effect and non-significant. As such, these results are inconsistent with studies reporting cognitive heterogeneity across these diagnostic groups (e.g., Bornstein et al., 1990; Goldstein et al., 2005; Maj et al., 1986) and do not support the conceptualization of schizoaffective disorder as cognitively distinct from schizophrenia (Lindemayer et al., 1989) or as existing on a continuum of cognitive impairment (Heinrichs et al., 2008; Hill et al., 2013). Rather, these data suggest that global cognitive impairment is a shared feature of both disorders.

In light of the small and non-significant neurocognitive differences between the diagnostic groups, it is not surprising that cognitive performance was poor at classifying patients as having a diagnosis of schizophrenia or schizoaffective disorder. In the current study, only 51.7% of patients with schizophrenia and 7.7% of those with schizoaffective disorder were

correctly classified as such, suggesting substantial overlap between these diagnostic groups on cognitive functioning. Even among previous studies that found *significant* cognitive differences between patients with schizophrenia and schizoaffective disorder (e.g., Heinrichs et al., 2008; Torniainen et al., 2012), those differences were insufficient in magnitude to differentiate the diagnostic groups because the distributions overlapped, lending further to support to the finding that these disorders are more neurocognitively similar than they are distinct. Thus, the present findings suggest that including cognitive variables in the next version of the *DSM* will not help to increase the distinction between schizophrenia and schizoaffective disorder. Nevertheless, some scholars in the area have argued that including cognitive impairment in the diagnostic criteria and/or as a specifier may help clinicians target and potentially improve cognition in those living with psychotic disorders (see Bora, Yucel, & Pantelis, 2010; Keefe & Fenton, 2007).

As predicted, both diagnostic groups performed significantly worse then the comparison group on all neurocognitive domains, with such differences being of a large magnitude. This is consistent with numerous other studies (e.g., Amann et al., 2012; Gooding & Tallent, 2002; Manschreck et al., 1997; Owoso et al., 2013; Roofeh et al., 2006). Moreover, cognitive performance was able to accurately predict not having a psychiatric illness as the vast majority of participants in the comparison group (93.8%) were correctly classified as such, lending further support to the notion that the neurocognitive performance of the comparison group is generally distinct from both diagnostic groups. Additionally, what most strongly differentiated the diagnostic groups from the comparison group was significantly poorer performance among the diagnostic groups on tasks of processing speed, verbal learning, and reasoning/problem solving. Another study also using the MATRICS similarly found that performance on speed of processing

best distinguished individuals with schizophrenia from community residents (see Kern et al., 2011).

With respect to social cognition, it was predicted that the schizophrenia group would be more impaired on all tasks compared to the schizoaffective disorder group; however, the two diagnostic groups only differed significantly from each other on a task of managing emotions. Specifically, participants in the schizophrenia group were significantly impaired on managing emotions relative to participants in both the schizoaffective disorder and comparison groups (medium effect sizes), while the schizoaffective disorder group was intact relative to the comparison group (small but non-significant difference). This suggests that the presence of mood symptoms in the schizoaffective disorder group may be related to having more adaptive methods for regulating and managing their own emotions and the feelings of others in social situations than those with schizophrenia. This provides limited support for a distinction between the two diagnostic categories.

In terms of theory of mind, there was a medium but non-significant difference in performance between the schizophrenia and schizoaffective disorder groups. This lack of statistical difference was not due to inadequate power and is consistent with some previous findings (see Greig et al., 2004; Hooper et al., 2010). However, findings remained mixed as other studies have found schizophrenia patients to perform significantly worse on theory of mind tasks than schizoaffective disorder patients (see Chen et al., 2012; Fiszdon et al., 2007; Tadmor et al., 2016). The present research also found that those in the schizophrenia group were significantly more impaired in theory of mind than the comparison group (medium effect), which is consistent with former studies (Chen et al., 2012; Tadmor et al., 2016). Findings are more mixed when it comes to comparing individuals in the schizoaffective disorder group to those in

the comparison group. While Tadmor and colleagues (2016) found that those with schizoaffective disorder scored significantly higher than the comparison group on theory of mind, the current study, as well as a previous study by Chen and colleagues (2012), found a non-significant difference between the schizoaffective disorder and comparison groups.

Last, the three groups did not differ significantly from each other on attribution bias. This could be due to a lack of statistical power; however, the lack of significant difference between the schizophrenia and comparison group is consistent with previous findings. For instance, a meta-analysis found no significant differences in attribution style (as assessed by the IPSAQ) between a schizophrenia group and a comparison group (see Savla et al., 2013). The current study is the first to compare persons with schizophrenia and schizoaffective disorder on attribution bias and thus no comparison to previous findings can be made at this time. As such, further studies, with larger sample sizes, are needed and other measures of attribution style should also be considered (see Savla et al., 2013).

Despite the schizophrenia group exhibiting significantly impaired theory of mind relative to the comparison group, and despite significant deficits in the schizophrenia group on managing emotions compared to the comparison and schizoaffective disorder groups, these differences did not translate into high rates of classification accuracy. Among those with schizophrenia only 55.8% were correctly classified and only 3.3% of those with schizoaffective disorder were accurately identified. Thus, performance on social cognitive tasks was poor at accurately predicted and distinguishing diagnostic category. In contrast, the majority of individuals in the comparison group (86.4%) were correctly classified.

In addition to the lack of neurocognitive and social cognition differentiation between the diagnostic groups, the present study also found few significant differences between these groups

on most of the demographic and clinical variables, which is consistent with previous research (see Cheniaux et al., 2008). The two major clinical differences were that those with schizoaffective disorder had more severe depressive symptoms and less functional impairment as assessed by independent living status. While these differences could be factors that truly distinguish these two groups, these could also reflect differences in underlying diagnostic criteria. The present data found a strong resemblance of participants diagnosed with schizoaffective disorder to those with schizophrenia in terms of demographic characteristics, symptomatology, and neurocognitive and social cognitive profiles and do not support the validity of schizoaffective disorder as separate from schizophrenia.

Limitations, Strengths, and Future Directions

Several different conceptualizations of schizoaffective disorder have been proposed. Based on the current findings, it is unclear which conceptualization of schizoaffective disorder the data support as these findings are consistent with various alternative conceptualizations (Gooding & Tallent, 2002). Further, it may be the case that these different conceptual views are complementary (Szoke et al., 2003). In order to fully understand the co-occurrence of psychosis and cognitive impairment and whether it holds true across the schizophrenia-bipolar disorder continuum, a bipolar disorder group needs to be included. A recent systematic review of the literature addressed this issue and concluded that neurocognitively, individuals with schizoaffective disorder are more similar to those with schizophrenia than those with a diagnosis of bipolar disorder (Madre et al., 2016); however, these three diagnostic groups have not yet been compared in terms of social cognition.

Importantly, continuing to compare diagnostic groups based on phenomenological manifestations, as done in the present study, only serves to recapitulate current DSM

nomenclature, which at present lacks biological validity. Thus, future research is encouraged to look across diagnostic categories to determine whether cognitive impairment is a transdiagnostic feature and whether or not there are particular patterns of cognitive impairment that can be used as an organizing principle instead of symptoms. Since 2009 the NIMH Research Domain Criteria (RDoC) initiative has been attempting to develop new ways of classifying mental illnesses based on dimensions of observable behaviour and neurobiological measures (including cognition), as opposed to descriptive phenomenology (see Cuthbert & Insel, 2010). Consistent with the RDoC initiative is the Bipolar Schizophrenia Network on Intermediate Phenotypes (BSNIP) in which individuals were pooled across multiple diagnostic groups in the psychosis spectrum without regard to traditional diagnostic categories. The investigators studied a range of variables across levels of analysis and used statistical techniques to identify clusters of individuals based on patterns in the data that were independent of traditional diagnostic categories (see Clementz et al., 2016).

There are other limitations that should be noted with regard to the present study. Due to unequal sample sizes, the neurocognitive and social cognitive MANOVAs did not take advantage of all data points. However, this analysis was preferred over conducting multiple ANOVAs since MANOVA reduces the likelihood of Type I errors. Additionally, most studies, including the current study, are cross-sectional in nature, which can be a limitation as the diagnosis of schizoaffective disorder has been shown to be unstable over time (see Malaspina et al., 2013). However, a longitudinal study by Stip and colleagues (2005) found that cognitive differences between schizophrenia and schizoaffective disorder remained stable over a two-year period.

The current research project also used a basic estimate of functioning (i.e., employment status and living status); however, functional outcome is a multifaceted construct and more comprehensive measures that assess different domains of functioning have been developed and validated for use among persons with psychosis (for a brief discussion see Lepage et al., 2014). Finally, there is no consensus about which measures of social cognition best index a given social cognitive domain. The majority of social cognition measures have poor psychometric properties (see Pinkham et al., 2013). As such, the Social Cognition Psychometric Evaluation (SCOPE) study is attempting to identify and improve the best existing measures of social cognition (Pinkham et al., 2013). Future research may want to include different measures of social cognition, as well as have a larger sample size to increase statistical power.

The present work also had several strengths. This study replicated previous findings that schizophrenia and schizoaffective disorder are not neurocognitively distinct. While other studies may not have found neurocognitive differences between groups due to small sample size (e.g., Savage et al., 2003; Townsend et al., 2001), this study had adequate sample size and statistical power to detect group differences. Moreover, by recruiting patients at the upper end of cognitive functioning and comparisons participants at the lower end of cognitive abilities, it ensured that our sample covered the full spectrum of cognitive abilities found among these diagnostic groups, as well as among the comparison group. This research has also enhanced the field by being the first study to compare these two diagnostic groups using a state-of-the-art, comprehensive cognitive battery designed specifically for the illness (Kern et al., 2008; Nuechterlein et al., 2008). Additionally, this study is one of the few to compare schizophrenia and schizoaffective disorder patients on both neurocognitive and social cognitive measures. To date only two other studies have done so but the generalizability of those studies findings are limited to veterans

(Fiszdon et al., 2007) and youth (Hooper et al., 2010). Moreover, this is the first study to compare these diagnostic groups on multiple domains of social cognition. Although social cognitive measures in general are not standardized and have poor psychometric properties, this study used the MSCEIT and Eyes test, both of which are well-validated (e.g., Eack et al., 2010; Vellante et al., 2013).

Conclusions

The primary purpose of this study was to examine the similarities and differences in neurocognitive and social cognitive performance in a group of outpatients with schizophrenia and schizoaffective disorder in order to determine if they are more similar than they are distinct. Taken together, these results suggest no statistically significant differences on comprehensive neurocognitive measures between schizophrenia and schizoaffective disorder samples, and a difference favouring the schizoaffective disorder group on only one of the social cognition tasks. This difference, however, is insufficient in magnitude to provide objective validation for two distinct and separable psychotic syndromes. The findings of this study suggest that, with regard to deficits in cognition, considered a major aspect of psychotic spectrum disorders, schizophrenia and schizoaffective disorder demonstrate major overlap and are more similar than they are distinct. In terms of neurocognition, the current data and previous studies suggest that global cognitive impairment is a shared feature of schizophrenia and schizoaffective disorder. Findings are less clear when it comes to social cognition but in general suggest more similarities than differences. These results provide evidence consistent with the hypothesis that there is no natural distinction between cognitive functioning in schizophrenia and schizoaffective disorder.

As cognitive impairment is increasingly being understood as a core feature of psychotic disorders and an important factor that affects overall symptom course and functional outcome,

non-significant differences in cognition between schizophrenia and schizoaffective disorder furthers the idea that the two diagnostic categories are more similar than distinct. This cognitive homogeneity may reflect similar underpinnings for cognitive deficits in schizoaffective disorder and schizophrenia. Thus, these results support the research practice of pooling together schizophrenia and schizoaffective disorder groups of patients among shared genetics and neurobiological researchers. These findings, along with the majority of the literature reviewed, also question the validity and clinical utility of having a separate diagnostic category of schizoaffective disorder as distinct from schizophrenia. Nevertheless, schizoaffective disorder is clinically a frequent diagnosis. Until further studies are conducted to clarify its nosology, the clinical concept of a subgroup of psychotic patients with prominent affective symptoms remains important (e.g., Schumann et al., 2014). Thus, it is suggested that in the next version of the *DSM* the diagnostic category of schizoaffective disorder be removed and replaced with a more valid diagnosis of schizophrenia, mood specific.

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Appendix

Cognitive Domain	MCCB Test	Dependent Variables
Processing Speed	Category Fluency: Animal Naming	Total number of animals named within 60-seconds
	TMT: Part A	Time to correctly connect 25 numbered circles in ascending order
	BACS: Symbol Coding	Total number of correct symbol-number pairings completed within a 90-second time limit
Working Memory	WMS-III Spatial Span	Sum of total number of correct trials demonstrated by tapping the correct sequence for the location of irregularly spaced blocks under forward and backward conditions from a 12-item list over three learning trials
	Letter-Number Span	Total number of Letter-Number strings of increasing length correctly reordered
		\
Verbal Learning	HVLT-R	Total number of words recalled correctly from a 12-item list over three learning trials
Visual Learning	BVMT-R	Total recall score for reproduction of six abstract figures over three learning trials
Reasoning and problem solving	NAB Mazes	Total raw score based on time to complete seven mazes
Attention/vigilance	CPT-IP	Mean d-prime value across 2-, 3-, and 4-digit conditions

Note. TMT, Trail Making Test; BACS, Brief Assessment of Cognition in Schizophrenia; WMS-III, Wechsler Memory Scale-III; HVLT-R, Hopkins Verbal Learning Test Revised; BVMT-R, Brief Visuospatial Memory Test Revised; NAB, Neuropsychological Assessment Battery; CPT-IP, Continuous Performance Test - Identical Pairs.