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Introspective accuracy for social cognition across the psychosis spectrum: Influence of sleep disturbance

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INTROSPECTIVE ACCURACY FOR SOCIAL COGNITION ACROSS THE PSYCHOSIS SPECTRUM: INFLUENCE OF SLEEP DISTURBANCE

by

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ABSTRACT

People with schizophrenia-spectrum and bipolar disorders can have impairments in introspective accuracy (IA; ability to accurately estimate one's own abilities). Research suggests that positive, negative, and depressive symptoms may be related to IA, but findings are mixed. Examining sleep disturbance as a determinant of IA may help explain these mixed findings. The current study aimed to explore the relationships between sleep disturbance, symptoms, and IA in participants across the psychosis spectrum. Participants completed diagnostic, symptom, and sleep disturbance assessments. Participants also completed social cognitive tasks, estimated their performance on the tasks (used to calculate IA), and indicated their confidence in their answers. Across the sample, IA and sleep disturbance were not significantly related, and sleep disturbance did not moderate the relationships between symptoms and IA. However, significant relationships were revealed when examining diagnostic groups separately. For those with bipolar disorders and schizophrenia, *lower* confidence and *underestimation* of abilities were associated with greater sleep disturbance, while for those with schizoaffective disorder, greater sleep disturbances were associated with *higher* confidence and *overestimation* of performance. Additionally, sleep disturbance significantly moderated the relationships between positive symptoms, negative symptoms, and confidence. Findings from the current study suggest that sleep disturbance, and the interaction between sleep disturbance and symptoms, may be impacting IA and confidence in different ways. Results also indicate unique relationships between sleep disturbance, IA, and confidence between diagnostic groups. Future research is needed to further explore these complex relationships, including longitudinal work and studies incorporating assessments of functioning.

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CHAPTER I - INTRODUCTION

Schizophrenia-spectrum and bipolar disorders are among the most disabling conditions worldwide (Harvey et al., 2010; Insel, 2008; Vigo et al., 2016), and people with these disorders experience functional deficits across numerous domains, such as independent living, employment, social functioning, and overall quality of life (Brekke et al., 1993; Depp et al., 2012; Silberstein et al., 2018). As such, research has attempted to identify determinants of psychosocial functioning to inform intervention efforts and improve everyday functioning in these groups. Neurocognition, social cognition, and negative symptoms have been identified as global predictors of functional outcomes among people with schizophrenia-spectrum and bipolar disorders (Fett et al., 2011; Green et al., 2000; Pinkham & Penn, 2006; Tabarés-Seisdedos et al., 2008; Ventura et al., 2009; Yang et al., 2021). However, these studies do not fully account for the variance in functioning (Bowie et al., 2006, 2008, 2010; Harvey et al., 2011), and critically, current interventions do not fully alleviate functional deficits (Bellack et al., 2004; Bowie & Harvey, 2006; Harvey & Keefe, 2001). Thus, more work is needed to identify determinants of functional outcomes in these groups to improve interventions.

Recent work has introduced introspective accuracy (IA) as a promising transdiagnostic determinant of real-world functional outcomes for people with schizophrenia-spectrum and bipolar disorders. IA is defined as the ability to accurately estimate one's own abilities and skills (Harvey & Pinkham, 2015), and deficits in IA are evidenced by discrepancies between how one rates their own abilities and their actual performance in those domains. IA impairments do not appear to be global, with research suggesting that individuals can be differentially impaired in IA across domains (Gilleen

et al., 2011; Silberstein & Harvey, 2019). For example, an individual may overestimate their neurocognitive ability (i.e., impaired IA for neurocognition), while making accurate judgments regarding their social competence (i.e., intact IA for social competence). Additionally, deficits in IA are bidirectional, and people have been found to both under and over-estimate their abilities (Gould et al., 2015; Jones et al., 2019; Medalia et al., 2008; Medalia & Lim, 2004; Silberstein & Harvey, 2019). Importantly, both under and over-estimations of ability have been identified as more predictive of deficits in everyday functioning than actual performance on neurocognitive tests or measures of functional capacity (Gould et al., 2015; Silberstein et al., 2018).

When measuring IA, participants can indicate their perceived abilities using self-report measures, they can make item-by-item accuracy judgements about their responses, or they make global judgments about their performance at the end of a task (Silberstein et al., 2018; Tercero et al., 2021). Across methods, self-evaluations can be compared to objective performance or ratings of functioning made by a clinician or high-contact informant (Gould et al., 2015; Silberstein & Harvey, 2019). Related to IA, confidence regarding task performance is also commonly rated. Confidence ratings can be assessed by asking participants to indicate how confident they are in the correctness of their answers (Perez et al., 2020; Pinkham, Klein, et al., 2018). Evaluating confidence regarding task performance has yielded interesting information about IA, including that confidence ratings regarding task performance are more strongly related to IA than to actual performance on the task (Tercero et al., 2021).

People with schizophrenia-spectrum disorders demonstrate difficulty in accurately evaluating their neurocognitive, social cognitive, and functional abilities (Gould et al.,

2015; Harvey et al., 2012; Köther et al., 2012; Medalia & Lim, 2004; Moritz et al., 2012; Sabbag et al., 2011, 2012). For example, 25-50% of people with schizophrenia-spectrum disorders tend to overestimate their cognitive abilities as compared to objective performance on neuropsychological tests and clinician ratings of functioning (Medalia et al., 2008; Medalia & Lim, 2004; Medalia & Thysen, 2008; Sabbag et al., 2012). Similarly, self-evaluations of social cognitive ability are impaired in this group. People with schizophrenia-spectrum disorders tend to make high confidence errors on social cognitive tasks, and often overestimate their social cognitive ability (Jones et al., 2019; Perez et al., 2020; Pinkham, Harvey, et al., 2018). One study identified that while overconfidence about social cognitive ability occurred among both healthy control participants and people with schizophrenia, the schizophrenia group was statistically more confident than the healthy control participants, and critically, they believed they performed completely perfectly (Jones et al., 2019). Importantly, higher levels of confidence about social cognitive performance are more strongly related to social outcomes than actual performance on the tasks (Pinkham, Harvey, et al., 2018).

In addition to impairments in IA seen in people with schizophrenia-spectrum disorders, people with bipolar disorders demonstrate deficits in IA across neurocognitive and functional domains, and IA is predictive of functional outcomes in this group (Harvey et al., 2015; Strassnig et al., 2018; Tercero et al., 2021). Although there has been considerably less research on IA in people with bipolar disorders, preliminary work suggests that IA impairments mirror the continuum of worsening severity from bipolar disorder to schizophrenia that is observed across cognitive and social cognitive impairment (i.e., IA is impaired in both schizophrenia-spectrum and bipolar disorders,

but it is more severely impaired in schizophrenia-spectrum disorders) (Hill et al., 2013; Ruocco et al., 2014). Further, like the findings in schizophrenia-spectrum disorders, people with bipolar disorders have been found to overestimate, underestimate, and make accurate estimations of their abilities (Harvey et al., 2015; Tercero et al., 2021). Additionally, research suggests that IA is impaired among people high in schizotypy, the subclinical manifestation of schizophrenia-like traits found in the general population (Lenzenweger, 2006). Similar to results found among participants with schizophrenia-spectrum disorders, IA deficits have been identified across domains of neurocognition and social cognition for those high in schizotypy, and individuals both over- and underestimate their abilities (Chun et al., 2013; Li et al., 2019; Springfield & Pinkham, 2020). Further, IA is predictive of functional outcomes for this group (Springfield & Pinkham, 2020). Given the occurrence of IA impairments across multiple populations and associations with functional outcomes, better understanding of determinants of IA is imperative. IA deficits represent a novel and promising transdiagnostic treatment target, but questions remain about the variables associated with IA, including what factors influence the directions of IA deficits (i.e., overestimation or underestimation of abilities).

Potential Correlates of Introspective Accuracy

Depressive Symptoms

Depressive symptoms have been repeatedly linked to IA across populations (Harvey et al., 2017; Harvey & Pinkham, 2015). Healthy people commonly overestimate their abilities; however, those with mild depressive symptoms have been found to be more accurate in their estimations of abilities than those with no depressive symptoms,

which is a phenomenon referred to as “depressive realism” or “sadder but wiser” (Alloy & Abramson, 1979; Moore & Fresco, 2012; Soderstrom et al., 2011). The phenomenon of depressive realism in healthy populations applies specifically to mild depressive symptoms, as those with moderate depressive symptoms in this group underestimate their abilities (Soderstrom et al., 2011). Research suggests that this finding is similar in people with schizophrenia-spectrum and bipolar disorders, though the relationships between depressive symptoms and IA appear to be complex. Higher levels of depressive symptoms in schizophrenia-spectrum and bipolar disorders are associated with more accurate IA (Gould et al., 2015; Harvey et al., 2017; Sabbag et al., 2012). However, severe depressive symptoms in schizophrenia-spectrum and bipolar disorders has also been associated with an underestimation of abilities (Bowie et al., 2007; Harvey et al., 2015). Some studies indicate specific relationships between the amount of depressive symptoms (e.g., none, mild, moderate, severe) and IA, whereas other work suggests that the presence or absence of depressive symptoms, regardless of depression severity, influences IA (Sabbag et al., 2012). One study in particular found no correlations between under- or overestimations of performance, or confidence about performance, and self-reported depressive symptoms for healthy control participants and people with schizophrenia (Jones et al., 2019). Though relationships between depressive symptoms and IA have been observed across multiple populations, the mixed findings regarding the nature of these relationships require further study.

Positive and Negative Symptoms

There is less work examining the relationships between IA and positive and negative symptoms of schizophrenia-spectrum disorders, but findings also appear to be

mixed. Positive symptoms are an excess or distortion of typical experience, which can include delusions, hallucinations, and disorganized behavior (Correll & Schooler, 2020). Negative symptoms include lessening of behaviors related to motivation and interest such as avolition, anhedonia, asociality, blunted affect, and alogia (Correll & Schooler, 2020). One study in particular identified that greater positive and negative symptoms was associated with an overestimation of abilities in schizophrenia (Sabbag et al., 2012). Specifically, they found associations between overestimation and greater delusions, conceptual disorganization, suspiciousness, grandiosity, stereotyped thinking, and avolition (Sabbag et al., 2012). In an attempt to explain these findings, some work suggests that the tendency to maintain higher confidence even when incorrect, as seen in patients with schizophrenia, may be based in difficulties with self-monitoring that have been associated with greater positive symptoms (Gawęda et al., 2013; Moritz, Göritz, et al., 2015; Moritz, Thoering, et al., 2015). In healthy populations, elevated schizotypy has been associated with underestimation of abilities (Cohen et al., 2014; Springfield & Pinkham, 2020), while high levels of subclinical paranoia have been associated with overestimation of abilities (Moritz et al., 2014; Moritz, Göritz, et al., 2015). Examining the influence of positive and negative symptoms independently may elucidate some of the discrepancies in these relationships. Similar to the findings regarding depressive symptoms and IA, it appears that positive and negative symptoms may have relationships with IA, however, due to the mixed nature of the findings, more work in this area is needed.

Sleep Disturbance

One area that has not been explored in relation to IA is sleep disturbance. People with schizophrenia-spectrum and bipolar disorders experience notable sleep disturbance (Benson, 2015; Laskemoen et al., 2019; Sylvia et al., 2012). Sleep disturbance refers to insomnia (i.e., problems falling or staying asleep), hypersomnia (i.e., prolonged sleep, excessive daytime sleepiness, and unrefreshing naps), circadian rhythm abnormalities (i.e., delayed or irregular sleep phases), poor sleep quality, or other sleep abnormalities (Laskemoen et al., 2019, 2020; Pérez-Carbonell & Leschziner, 2018). Sleep disturbance occurs in up to 80% of people with schizophrenia-spectrum and bipolar disorders, and is associated with greater symptomatology, elevated risk for suicide, reduced functional capacities, and lower quality of life (Benson, 2015; Davies et al., 2017; Gruber et al., 2009; Kaskie et al., 2017; Li et al., 2016; Sylvia et al., 2012).

Sleep disturbance has also been associated with more personal distress (Benca et al., 1992) and may impact how individuals cope with stressors (Hofstetter et al., 2005; Morin et al., 2003). For example, Hofstetter and colleagues (Hofstetter et al., 2005) found that greater sleep disturbance in people with schizophrenia-spectrum disorders resulted in difficulties appraising stressors and daily challenges in a positive light (i.e., less use of the emotion regulation strategy positive appraisal). The authors suggest that this may explain in part the relationship between sleep disturbance and poorer quality of life and impaired functioning in this group (Benca et al., 1992; Hofstetter et al., 2005; Li et al., 2016).

Sleep disturbance may be important to consider in investigations of IA for several reasons. Given the mixed findings regarding relationships between positive and negative

symptoms, depressive symptoms, and IA, it is possible that a third, previously unaccounted for variable may be impacting these relationships. Indeed, sleep disturbance has been associated with more depressive symptoms in both schizophrenia-spectrum and bipolar disorders (Gruber et al., 2009; Laskemoen et al., 2019) and with higher positive and negative symptoms in those with schizophrenia (Kasanova et al., 2020; Kaskie et al., 2017; Laskemoen et al., 2019; Reeve et al., 2019; Waters et al., 2011; Zarcone & Benson, 1997). Sleep disturbance has also been associated with elevated subclinical psychotic symptoms (Kasanova et al., 2020; Lunsford-Avery et al., 2015) in otherwise healthy populations. Further, sleep disturbance has been noted in the earliest manifestations of psychosis (Cannon et al., 2008; Kaskie et al., 2017) prior to the onset of other symptoms, with some suggesting that sleep disturbance may exacerbate the symptoms of psychosis (Naghan & Setareh, 2017). As such, it is possible that including sleep disturbance when examining relationships between symptomology and IA may help clarify the inconsistent findings in the literature.

Considering these relationships between sleep disturbance and greater symptomology and the negative impacts of sleep disturbance in this group (e.g., higher distress, impaired coping skills, poorer functioning, and overall quality of life), there may also be compounding effects of sleep disturbance and elevated symptoms on IA. Those with greater sleep disturbance may be more impacted by their symptoms than those with less sleep disturbance, due to the established negative impacts on coping skills and emotion regulatory processes associated with more disturbed sleep. As such, for those with more sleep disturbance, higher symptoms may be more impactful on IA, whereas those with less disturbed sleep may experience reduced impacts of symptoms on IA.

Thus, greater sleep disturbance may moderate the relationship between IA and symptoms such that those with more sleep disturbance may have greater symptomatic impacts on IA.

To summarize, deficits in IA have been identified across schizophrenia-spectrum and bipolar disorders, but determinants of IA impairment are currently unclear. Research suggests that positive, negative, and depressive symptoms may be related to IA and may have specific implications for the direction of IA impairment, but the findings regarding the relationships between IA and these symptoms is inconsistent. Sleep disturbance is a variable of interest as a potential determinant of IA due to the high prevalence of sleep disturbance in schizophrenia-spectrum and bipolar disorders, the impact of sleep on poorer functional outcomes, and the associations between sleep disturbance and elevated positive, negative, and depressive symptoms. Further, the relationship between IA and symptoms may vary according to one's sleep disturbance, due to the associations between sleep disturbance and impaired functioning (e.g., greater distress, impaired coping skills, poorer functioning, and overall quality of life). To date, no work has directly examined the relationships between sleep disturbance and IA. Therefore, sleep disturbance may be related to IA and may contribute to our understanding of the relationships between symptoms and IA, which could inform intervention efforts.

Current Study

To my knowledge, this study is the first to examine the relationships between sleep disturbance and IA, which could identify a novel treatment target to improve IA and functional outcomes across the psychosis spectrum. Further, previous research highlights the need to better understand determinants of IA. The current study aims to

address this gap in the literature by examining the relationships between sleep disturbance, positive, negative, and depressive symptoms, and IA for social cognition in people with disorders characterized by psychosis. The current study includes people across the psychosis spectrum (i.e., schizophrenia, schizoaffective disorder, bipolar disorders with psychotic features, and major depressive disorders with psychotic features). By including people with psychotic symptoms across clinical diagnoses, we examined differential predictors of IA between diagnostic groups, which has only been directly examined in a handful of studies. Additionally, we were able to explore the relationships between IA and sleep disturbance across the psychosis continuum, which current studies have not done.

The primary aim of the current study is to examine the relationships between sleep disturbance and IA across the psychosis spectrum. We hypothesized that IA would be associated with greater sleep disturbance across the sample. Additionally, we predicted that greater sleep disturbance would be associated with higher positive, negative, and depressive symptoms across the sample. We also expected that sleep disturbance would moderate the relationships between symptoms (positive, negative, and depressive symptoms) and IA, such that for those with greater sleep disturbance, the relationship between symptoms and IA would be stronger. Lastly, we expected that participants with schizophrenia-spectrum disorders would demonstrate greater impairments in IA compared to participants with bipolar disorders and major depressive disorders with psychotic features. We also conducted exploratory analyses to investigate patterns of IA overestimation and underestimation across the sample, as well as their relationships with sleep and confidence ratings about task performance.

CHAPTER II - METHODS

This study is a secondary data analysis and used a pre-existing dataset from a larger study (through collaboration with Dr. Pinkham's lab at the University of Texas at Dallas).

Participants

Participants included adults between the ages of 18 and 65 who met DSM-5 criteria for schizophrenia, schizoaffective disorder, bipolar I or II with psychotic features, or major depressive disorder with psychotic features. All participants were proficient in English and were clinically stable (i.e., no psychiatric hospitalizations for at least 6 weeks and no medication changes for a minimum of 6 weeks). Additionally, participants were not eligible to participate in the study if they had: (1) history of head trauma with loss of consciousness for greater than 15 minutes, (2) presence or history of medical or neurological disorders that may affect brain function (e.g., stroke, epilepsy), (3) presence or history of neurodegenerative disorder (e.g., dementia, Parkinson's Disease), (4) significant visual or auditory impairments that would interfere with assessment (e.g., blindness, glaucoma, vision uncorrectable to 20/40, hearing loss), (5) presence or history of pervasive developmental disorder (e.g., Autism) or intellectual disability (defined as WRAT-4 standard score less than 70), or (6) presence of Alcohol Use Disorder or Substance Use Disorder (excluding cannabis and tobacco) within the past 3 months. Participants were enrolled into an actively suicidal group or a non-suicidal group, with the goal of enrolling equal numbers into each group. Participants scoring a two or greater on suicidal ideation in the past month or who had suicidal behaviors in the past three months as assessed by the Columbia Suicide Severity Rating Scale (explained in detail

below) were enrolled in the actively suicidal group. Individuals not meeting these criteria were enrolled in the non-suicidal group.

Participants were recruited across three study sites: University of Texas at Dallas (UTD), University of Miami Miller School of Medicine (UM), and University of California San Diego (UCSD). UTD participants were recruited primarily from Metrocare Services, a non-profit mental health services organization in Dallas County, TX, as well as other local mental health clinics. UM participants were recruited from the Jackson Memorial Hospital-University of Miami Medical Center and the Miami VA Medical Center. UCSD participants were recruited from the UCSD outpatient Psychiatric Services Clinic, the San Diego VA Medical Center, and other local community clinics. Additionally, participants at all three sites were also recruited through internet sources (e.g., Facebook, Craigslist, lab websites, digital marketing companies). The final sample included 268 participants (bipolar disorders n = 102; schizophrenia-spectrum disorders n = 160; major depressive disorders n = 6). Of note, available sample size per task varies slightly, so sample sizes are not consistent across all analyses. 248 participants completed the BLERT task, while 257 participants completed the ER-40. PSQI sleep data was collected for 183 participants, and 1 participant is missing symptom data.

Measures

The larger study involved a variety of diagnostic assessments, self-report measures, and performance-based tasks. The measures listed here are only those that are relevant to the current study.

Diagnostic Assessments

Mini International Neuropsychiatric Interview (MINI). The MINI is a short, semi-structured diagnostic interview designed to accurately assess psychiatric disorders (Sheehan et al., 1998). The MINI has demonstrated validity and reliability with other diagnostic assessments (e.g., SCID, CIDI) (Lecrubier et al., 1997; D. Sheehan et al., 1997), and is widely used in clinical research (Abel & Minor, 2021; Eglit et al., 2018; Pettersson et al., 2018). Research assistants administered the MINI to determine if participants met diagnostic criteria for schizophrenia, schizoaffective disorder, bipolar disorder I or II with psychotic features, or major depressive disorder with psychotic features.

Structured Clinical Interview for DSM-5 – Research Version (SCID-5-RV). The SCID-5-RV is a semi-structured interview used for diagnosing psychiatric disorders, with this specific version designed to be used in clinical research (First et al., 2015). The SCID-5-RV is regularly used in research settings due to the sensitivity of the measure in making differential diagnoses (First et al., 2015). Researchers only administered the psychosis module of the SCID-5-RV to comprehensively assess psychotic symptoms. Information obtained from the MINI and SCID-5-RV was used to determine participant diagnoses.

Premorbid Intellectual Functioning

Wide Range Achievement Test-4 – Reading Subtest (WRAT-4). The WRAT-4 is a norm-referenced test that measures basic academic skills, including word reading, sentence comprehension, spelling, and math computation (Robertson, 2010). The reading subtest of the WRAT-4 is commonly used as an estimate of premorbid IQ in research involving schizophrenia-spectrum and bipolar disorders (Hanna et al., 2016; Heinrichs et al., 2015;

Tercero et al., 2021). Participants completed the reading subscale of the WRAT-4 to determine eligibility.

Symptom Assessments

Columbia Suicide Severity Rating Scale (C-SSRS). The C-SSRS assesses lifetime and current suicidal ideation and behavior (Posner et al., 2011). The C-SSRS is a widely used assessment of suicide risk and has been used across numerous populations, including people with schizophrenia-spectrum and bipolar disorders (Harvey et al., 2018; Hettige et al., 2017). Suicidality was assessed as a potential covariate.

Positive and Negative Syndrome Scale (PANSS). The PANSS is a semi-structured interview used to assess the severity of positive, negative, and general symptoms in schizophrenia (Kay et al., 1987). Researchers rate the severity of symptoms based on the participant's subjective report of their clinical symptoms within the past week. Additional information is based on the researcher's clinical observations made during the study visit. Severity ratings are provided for 30 symptoms on a scale from 1 (absent) to 7 (extreme), with higher scores indicating more severe symptoms. The positive and negative symptom subscales of the five-factor model of scoring was used (van der Gaag et al., 2006). Subscale scores are calculated by averaging the items for each of the subscales: positive scale (range: 1-7), negative scale (range: 1-7). The PANSS is a widely used symptom assessment in schizophrenia-spectrum and bipolar disorders (Daneluzzo et al., 2002; Engh et al., 2007; Opler et al., 2017).

Montgomery-Åsberg Depression Rating Scale (MADRS). The MADRS is a diagnostic questionnaire that measures the severity of depressive symptoms (Montgomery & Åsberg, 1979). The MADRS includes 10 items, which were administered to the

participant as an interview. The MADRS assesses depressive symptoms including apparent and reported sadness, tension, reduced sleep and appetite, concentration difficulties, difficulty in starting and carrying out everyday activities, inability to feel, pessimistic thoughts, and suicidal ideation. Each item has a severity scale from 0 to 6, with higher scores indicating more severe depressive symptoms. Item ratings can be summed into an overall MADRS score (range: 0 to 60). The MADRS is validated for use in individuals with schizophrenia-spectrum and bipolar disorders (Bowie et al., 2010; Herniman et al., 2019, 2021; Lee et al., 2003).

Young Mania Rating Scale (YMRS). The YMRS assesses the severity of manic symptoms (Young et al., 1978). The YMRS includes 11 items, and the researcher selects a severity rating based on the patient's subjective report of their clinical condition over the previous 48 hours. Additional information is based upon the researcher's clinical observations made during the clinical interview. There are four items that are graded on a 0 to 8 scale (irritability, speech, thought content, and disruptive/aggressive behavior), while the remaining seven items are graded on a 0 to 4 scale. Total scores on the YMRS range from 0 to 60, with higher scores indicating more severe manic symptoms. The YMRS is one of the most frequently utilized rating scales to assess manic symptoms (Lukasiewicz et al., 2013; Turkoz et al., 2013; Young et al., 1978). Manic symptoms were assessed as a potential covariate.

Sleep

Pittsburgh Sleep Quality Index (PSQI). The PSQI is a 19-item self-report measure of sleep over the past month (Buysse et al., 1989). The PSQI produces a global sleep quality score and seven component scores: subjective sleep quality, sleep disturbance, sleep

latency, sleep duration, sleep efficiency, use of sleep medication, and daytime dysfunction. The PSQI is a widely used measure of sleep quality, including among those with schizophrenia-spectrum and bipolar disorders (Faulkner & Sidey-Gibbons, 2019). Higher scores on the PSQI indicate worse sleep quality. The PSQI was added after the start date of the study, so PSQI data is only available for 183 participants.

Social Cognition and IA

Bell-Lysaker Emotion Recognition Task (BLERT). The BLERT is a measure of emotion recognition of seven emotional states: happiness, sadness, fear, disgust, surprise, anger, or no emotion (Bryson et al., 1997). Participants are presented with 21 10-second video clips of an actor portraying specific emotions using facial, vocal, and upper-body movement cues. Participants receive one point for each correctly answered emotion, and total score is calculated by summing scores on all items (range: 0-21). The BLERT demonstrates strong psychometric properties and has been identified as one of the best measures to identify social cognitive deficits in people with schizophrenia-spectrum and bipolar disorders (Hajdúk et al., 2018; Pinkham, Harvey, et al., 2018).

Penn Emotion Recognition Test (ER-40). The ER-40 is a standardized measure of facial affect recognition ability (Kohler et al., 2003). It includes 40 color photographs of static faces expressing happiness, sadness, anger, fear, or a neutral expression. Participants view one face at a time and are asked to choose the correct emotion for each face. The ER-40 demonstrates strong psychometric properties and is validated for use among people with schizophrenia-spectrum and bipolar disorders (Pinkham, Harvey, et al., 2018).

Introspective Accuracy (IA). Immediately after selecting an emotion choice on each item of the BLERT and ER-40, participants were asked "Do you think you answered correctly?" and answered with either yes or no. Participants were then asked to indicate how confident they were in the correctness of their choice. For the BLERT, participants indicated their confidence from 0 (not at all confident) to 100% (extremely confident). For the ER-40, participants indicated their confidence as 0% (not at all confident), 25%, 50%, 75% or 100% (very confident). Participants did not receive any feedback on if their answer was correct or incorrect. Items that participants indicated they answered correctly received 1 point each, and estimated scores on all items were summed together resulting in a total estimated score that had the same range as the actual total score on the task. This total estimated score can then be compared to actual score on the task, which is commonly done in IA research (Springfield & Pinkham, 2020; Tercero et al., 2021). An IA difference score is calculated by subtracting the actual task score from the participant's estimated total score (i.e., negative IA values indicate underestimation of abilities and positive IA values indicate overestimation of abilities) (Gould et al., 2015; Tercero et al., 2021). Confidence ratings on each item will be averaged into a single average confidence score for each task (Jones et al., 2019; Tercero et al., 2021).

Procedures

Participation in this study involved a screening and a baseline visit, which occurred in lab space at each study site or remotely. First, participants completed the informed consent procedures, which involved answering several questions to confirm their understanding of the consent form. If the participant demonstrated a lack of understanding that could not be clarified, the consent process was discontinued. After

providing informed consent, participants were asked to provide basic demographic information (e.g., race, ethnicity, years of completed education, marital status, etc.). Participants were then asked to complete the WRAT-4 reading subscale to determine eligibility. Diagnostic information was then collected with the MINI and psychosis module of the SCID-5-RV. Eligibility was determined at the conclusion of the screening visit and eligible participants were invited to participate in the baseline visit. The screening visit took approximately 1.5 hours to complete.

To encourage participant retention in the study, the baseline visit occurred within approximately one week of the screening visit. At the baseline visit, participants first completed the PANSS, MADRS, and YMRS symptom interviews. Participants then completed the C-SSRS. Next, participants completed the social cognitive tasks and made IA and confidence ratings. Lastly, participants completed self-report measures including the PSQI. The baseline visit took approximately 2 hours to complete.

Individuals were compensated via a reloadable Mastercard gift card. Individuals were compensated $25 for their time and participation after completing the screening visit, regardless of eligibility. Participants were compensated $25 for their time and participation after completing the baseline visit, allowing participants to earn up to $50 total for participating in the study. Additionally, participants who chose to withdraw from the study early received prorated compensation proportional to the time they attended the visit at the rate of $5 per 20 minutes.

Statistical Analyses

First, given the small sample size of the major depressive disorders group, analyses comparing major depressive disorder to the bipolar disorders and schizophrenia-

spectrum disorders groups were not conducted, though these participants were included in analyses across the full sample. Schizophrenia-spectrum and bipolar disorders groups were compared on demographic variables, including age, years of completed education, and IQ score using independent t-tests. Chi-square tests examined differences in racial identify and ethnicity between the diagnostic groups. Several variables were then examined as potential covariates. First, mania as assessed by the YMRS was examined as a potential covariate because a subset of the sample may experience notable mood disturbance (i.e., bipolar disorders, schizoaffective disorder). Sleep disturbance has been linked to mania in prior studies and is included in the diagnostic criterion for a manic episode (American Psychiatric Association, 2013; Kanady et al., 2015). Mania was not examined as a primary symptom of interest as previous work on IA in bipolar disorders has not identified mania as a potential determinant of IA impairment (Harvey et al., 2015), and the transient nature of mania suggests it is unlikely that many participants were experiencing hypomania or mania at the time of their participation. Pearson's R correlations were used to examine possible relationships between mania and the variables of interest, and independent t-tests were used to examine differences in mania between the diagnostic groups. Additionally, due to the 50% prevalence of active suicidality in the study sample and documented relationships between suicidality and sleep disturbance in these populations, suicidality was assessed as a potential covariate in our analyses, and a series of independent t-tests were conducted to examine group differences between those enrolled in the actively suicidal group and the non-suicidal group for our variables of interest (i.e., positive symptoms, negative symptoms, depressive symptoms, sleep disturbance, task scores, IA, confidence ratings). As we expected to identify one or more

covariates, we planned to use statistical techniques that would allow us to control for those covariates.

For the BLERT and ER-40, actual performance on the tasks was subtracted from the number of trials on which the participant reported that they were correct. These difference scores were used as an index of IA, consistent with past literature (Gould et al., 2015; Tercero et al., 2021). To examine associations between IA and sleep disturbance, subscale scores from the PSQI were correlated with IA difference scores using partial correlations to control for relevant covariate(s). To examine the relationship between sleep disturbance and symptoms, subscale scores on the PSQI were correlated with the MADRS and positive and negative symptom scores on the PANSS, using partial correlations to control for relevant covariate(s). To reduce the potential for alpha inflation due to multiple comparisons, p=.01 indicated significance.

To examine sleep disturbance as a moderator of the relationships between IA and symptoms, PROCESS macro (Hayes, 2017) in SPSS was used to conduct separate moderation analyses for each symptom scale. The relevant symptom scale, sleep disturbance (the moderator of interest), the interaction term between these variables, and relevant covariate(s) were entered into separate regression models predicting IA. Moderation was deemed present if the interaction term was statistically significant and significantly improved the regression model. Significant interactions were visualized using the pick-a-point approach (Rogosa, 1980), and the Johnson-Neyman technique (Bauer & Curran, 2005) was used to ascertain the value of the PSQI at which relationships between symptoms and IA change. These moderation analyses were then repeated using the PANSS anxiety item as the predictor in the model. This was included

as an alternative model to highlight any unique relationships regarding our symptoms of interest.

To examine whether participants' self-reported task scores differed significantly from their actual task scores (representing IA deficits) as a function of diagnosis, separate 2 (Task type: self-reported vs. objective score) x 2 (Diagnosis: schizophrenia-spectrum vs. bipolar disorders) repeated measures ANCOVAs for ER-40 and BLERT were used. Significant main effects of diagnosis and task type were followed up with Bonferroni post hoc tests. Significant interaction effects were followed up with paired comparisons. Significant effects of task type indicated impairments in IA, and significant interaction effects indicated differences in IA impairment between diagnostic groups.

Additional exploratory analyses investigated patterns of IA overestimation and underestimation across the sample as well as their relationships with sleep and confidence ratings about task performance. These relationships were also examined in the diagnostic groups independently. One-sample t-tests for each diagnostic group were used to determine if IA significantly differed from zero and in which direction (i.e., overestimation or underestimation of abilities). Differences between the diagnostic groups on the variables of interest were examined using ANCOVAs. Relationships between IA and confidence ratings were investigated using partial correlations controlling for relevant covariate(s). Additionally, correlations between confidence ratings, IA difference scores, subscale scores on the PSQI, and symptoms in the diagnostic groups separately were examined using partial correlations controlling for relevant covariates (p = .01). Lastly, moderation analyses were repeated to examine sleep disturbance as a moderator of the relationships between confidence ratings and

symptoms. PROCESS macro (Hayes, 2017) in SPSS was used to conduct separate moderation analyses for each symptom scale. The relevant symptom scale, sleep disturbance (the moderator of interest), the interaction term between these variables, and relevant covariate(s) were entered into separate regression models predicting confidence ratings.

Post hoc power analyses were conducted using G*Power (Faul et al., 2007). Using alpha of .05 and a sample size of 183 (sample with PSQI data), power analyses indicated that for moderation analyses, power was adequate to detect a medium effect (power = .99). For correlation analyses, using alpha of .01, power was adequate to detect medium effects (power = .94). For RM ANOVAs, analyses were also powered to detect medium effects (power = .98).

CHAPTER III - RESULTS

Participant demographics can be seen in Table 1. The bipolar group was significantly younger ($t(260) = -1.96$, $p = .05$), completed more years of education ($t(259) = 5.64$, $p < .001$), and had higher IQ ($t(255) = 5.35$, $p < .001$) than the schizophrenia-spectrum disorders group. More participants with schizophrenia-spectrum disorders identified as Black or African American than in the bipolar disorder group (χ^2 (5, N = 262) =. 30.94 $p < .001$). The proportion of participants who identified as Hispanic/Latinx did not differ by diagnostic group (χ^2 (1, $N = 262$) = .31, $p = .58$). Mean symptoms and task scores across the sample can be seen in Table 2.

Examination of Potential Covariates

Pearson's R correlations were conducted to examine possible relationships between mania, as assessed by the YMRS, and the variables of interest. No significant relationships were indicated between YMRS and sleep disturbance, IA difference scores, or confidence ratings across the sample. When examining YMRS and sleep disturbance in the diagnostic groups separately, greater mania was associated with shorter sleep duration ($r = .26$, $p = .01$) in the bipolar group, but all other correlations between mania and sleep disturbance were non-significant. Further, YMRS scores were not significantly different between the schizophrenia-spectrum ($M = 4.51$, $SD = 6.49$) and bipolar disorder groups ($M = 4.36$, $SD = 6.10$); $t(456) = -.178$, $p = .859$). Notably, given YMRS scores range from 0 to 60, mania scores in both groups were very low. Given this, mania was not included as a covariate in further analyses.

Next, suicidality was examined as a possible covariate. No group differences were found for task scores, IA, or confidence variables between the actively suicidal and non-

suicidal groups. However, the actively suicidal group had significantly greater positive symptoms ($t(265) = 2.53$, $p = .01$), lower subjective sleep quality ($t(181) = 2.92$, $p = .004$), greater sleep disturbances ($t(181) = 2.06$, $p = .04$), and poorer overall sleep quality ($t(181) = 2.22$, $p = .03$) than the non-suicidal group. The actively suicidal group was also significantly more depressed than the non-suicidal group ($t(265) = 8.37$, $p < .001$). Given these group differences, participants' group status (i.e., enrolled in the actively suicidal vs. non-suicidal group) was included as a covariate in all analyses.

Negative Symptom Ratings and the Pandemic

Due to the COVID-19 pandemic, slightly more than half of the sample (55%) completed the study remotely via telephone. This impacted the collection of some of the negative symptom items on the PANSS that rely partly on visual information, specifically items assessing blunted affect (i.e., reduction in facial expression and/or communicative gestures) and motor retardation (i.e., reduction in motor activity including slowing or lessening of movements and speech, diminished responses to stimuli, reduced body tone). Thus, these items could not be reliably rated when participants completed the study remotely. This resulted in more negative symptoms being rated (and included in the negative symptom average score) for those that completed the study in person, while these two items were missing data for those in the remote group. When the items in question were kept in for the group that completed interviews in person but were missing for the remote group, independent samples t-tests suggested that negative symptoms were not significantly different between those who completed the study in person and remotely ($t(215.99) = 1.92$, $p = .06$); these differences remained non-significant when controlling for suicidality ($f(2, 264) = 3.57$, $p = .06$), though notably both were approaching

significance. Given this trending group difference, we compared remote versus in-person groups on negative symptoms after these items (i.e., blunted affect and motor retardation) were removed. After removing these items for everyone, groups were not significantly different on negative symptoms ($t(212.38) = 1.40$, $p = .16$), and these differences remained non-significant after controlling for suicidality $f(2,264) = 1.84$, $p = .18$). Taken together, this suggests that trending differences on negative symptoms between the in-person and remote groups were driven at least in part by items that were unable to be rated over the phone. Thus, we removed these items for all participants.

Relationships Between IA, Symptoms, and Sleep Disturbance

Partial correlations including suicidality as a covariate were conducted to examine relationships between IA difference scores, symptoms, and sleep disturbance (Table 3). No significant relationships were indicated between IA difference scores and sleep disturbance, contrary to hypotheses. As expected, higher depressive symptoms were associated with poorer subjective sleep quality and poorer overall sleep quality. Additionally, the relationship between higher daytime tiredness and dysfunction and higher depression was trending toward significance ($p = .02$). Regarding negative symptoms, no correlations were significant, though some were trending toward significance. Inconsistent with expectations, this relationship suggested that *fewer* negative symptoms were associated with more sleep disturbances ($p = .04$). No other significant relationships were revealed between sleep disturbance and symptoms. When examining relationships between IA difference scores and symptoms, greater positive symptoms were associated with overestimations of performance on the BLERT. A similar pattern was observed for the ER-40, though at a trend level ($p = .02$). The

relationship between higher depressive symptoms and underestimation of performance on the BLERT was also trending towards significance (p = .05). No other significant relationships between symptoms and IA were indicated.

Results of moderation analyses can be seen in Table 4. Contrary to our hypotheses, sleep disturbance did not moderate the relationships between positive symptoms and IA difference scores on the ER-40 or BLERT. Similarly, sleep disturbance did not moderate the relationships between negative symptoms, depressive symptoms, anxiety symptoms, and IA difference scores on the two tasks.

Impairments in IA Between Diagnostic Groups

To examine whether participants' self-reported task scores differed significantly from their actual task scores (representing IA deficits) as a function of diagnosis, a 2 (Task type: self-reported vs. objective score) x 2 (Diagnosis: schizophrenia-spectrum vs. bipolar disorders) repeated measures ANCOVA for the BLERT task was conducted. The repeated measures ANCOVA revealed a significant task type by diagnostic group interaction ($F(1, 240) = 18.03$, $p < .001$), indicating differences in IA impairment between diagnostic groups. Specifically, those with schizophrenia-spectrum disorders demonstrated a larger discrepancy between self-reported and actual scores (i.e., greater impairments in IA) on the BLERT than those with bipolar disorders, though both groups overestimated their abilities. The repeated measures ANCOVA also revealed a significant main effect of diagnostic group ($F(1, 240) = 21.67$, $p < .001$), indicating significant differences in task scores between the bipolar (*Estimated mean* = 18.08, *SE* = .23) and schizophrenia-spectrum disorders (*Estimated mean* = 16.73, *SE* = .18; $p < .001$) groups. Lastly, the repeated measures ANCOVA revealed a significant main effect of task type

($F(1, 240) = 144.63$, $p < .001$), indicating differences between self-reported and objective scores on the BLERT, suggesting impairments in IA. Pairwise comparisons indicated that self-reported BLERT scores (*Estimated mean* = 19.74, *SE* = .15) were significantly higher than actual BLERT scores (*Estimated mean* = 15.06, *SE* = .24; $p < .001$), suggesting overestimations of ability.

This procedure was repeated for the ER-40. Results revealed a significant main effect of task type ($F(1, 248) = 47.40$, $p < .001$) where self-reported ER-40 scores (*Estimated mean* = 34.03, *SE* = .69) were significantly higher than actual ER-40 scores (*Estimated mean* = 29.25, *SE* = .46; $p < .001$). Consistent with findings for the BLERT, this suggests an overestimation of ability. The repeated measures ANCOVA also revealed a task type by diagnostic group interaction that was approaching significance ($F(1, 248) = 3.65$, $p = .057$). Though non-significant, the directions of these relationships were consistent with BLERT findings. The main effect of diagnostic group was not significant.

Exploratory Analyses

Direction of IA Impairment in the Diagnostic Groups

One-sample t-tests indicated impairments in IA for those with bipolar disorders for the ER-40 ($t(92) = 4.49$, $p < .001$) and BLERT ($t(93) = 9.33$, $p < .001$), such that they overestimated their abilities on both tasks. Similarly, the schizophrenia group also overestimated their abilities on both tasks (ER-40: $t(67) = 6.02$, $p < .001$; BLERT: $t(62) = 9.43$, $p < .001$), as did the schizoaffective group (ER-40: $t(89) = 6.34$, $p < .001$; BLERT: $t(85) = 12.53$, $p < .001$).

Relationships between IA, Confidence, Symptoms, and Sleep Disturbance

Partial correlations including suicidality as a covariate examined relationships between IA and confidence. Across the sample, IA difference scores and confidence ratings were correlated for both the ER-40 (r = .35, p < .001) and BLERT (r = .20, p = .002), suggesting that higher confidence was associated with overestimations of performance. These relationships were also present in the bipolar group (ER-40: r = .49, p < .001; BLERT: r = .29, p = .007). The direction of these relationships was consistent in the schizophrenia and schizoaffective disorder groups (i.e., higher confidence associated with overestimation), though the relationships varied between the tasks. In the schizophrenia group, only BLERT confidence and IA were significantly correlated (r = .32, p = .013). In the schizoaffective disorder group, relationships were only significant for ER-40 confidence and IA (r = .29, p = .008).

Next, partial correlations were conducted to examine relationships between confidence ratings, IA, subscale scores on the PSQI, and symptoms in the diagnostic groups separately (Table 5). In the bipolar group, lower confidence on the ER-40 was associated with longer sleep duration, greater use of sleep medication, and fewer positive symptoms. Underestimation of ER-40 performance was also associated with greater use of sleep medication in this group. In the schizophrenia group, lower confidence on the BLERT was associated with longer sleep latency, shorter sleep duration, poorer sleep efficiency, more sleep disturbances, and poorer overall sleep quality. Similarly, lower confidence on the ER-40 was associated with longer sleep latency, and underestimation of ER-40 performance was associated with poorer sleep quality, longer sleep latency, and overall poorer sleep. In contrast, in the schizoaffective disorder group, the directions of

these relationships differed: higher confidence on both tasks was associated with more sleep disturbances, and overestimation of performance on the ER-40 was associated with longer sleep latency. No significant relationships between symptoms (i.e., positive, negative, or depressive), confidence ratings, or IA difference scores were revealed in the schizophrenia or schizoaffective groups.

Moderation Models

Additional moderation analyses were conducted to examine sleep disturbance as a moderator of the relationships between confidence ratings and symptoms (Table 6). Sleep disturbance significantly moderated the relationship between positive symptoms and confidence ratings on the ER-40 such that for those with higher PSQI scores, higher positive symptoms were associated with higher confidence, while for those with lower PSQI scores, the relationships were non-significant. See Figure 1 for a graph of these interactions. The Johnson-Neyman value was 10.18, indicating that the relationship was only significant when PSQI scores were at or above that value. Just over one third of the sample (36.26%) fell into this group, which suggests moderate sleep difficulty. In contrast, sleep disturbance did not moderate the relationship between positive symptoms and confidence ratings on the BLERT. Additionally, sleep disturbance did not moderate the relationships between negative symptoms and confidence ratings on either task.

Regarding depression, sleep disturbance significantly moderated the relationships between depressive symptoms and confidence ratings on both tasks. See Figure 2 for a graph of these interactions. Results revealed that for those with higher PSQI scores, elevated depression was associated with higher confidence, while for those with lower PSQI scores, elevated depression was associated with lower confidence. On the ER-40,

for participants scoring at or below a value of 2.59 on the PSQI, which indicates low amounts of sleep difficulties, (2.32%), elevated depression was associated with lower confidence (Figure 2a). For participants scoring at or above 17.80 on the PSQI (4.65%), which indicates high levels of sleep difficulty, higher depression was associated with higher confidence. Those scoring between these values reflected a non-significant relationship. Similarly, for the BLERT, for participants at or below 4.74 (11.45%), higher depression was associated with lower confidence, while for participants at or above 15.59 (10.24%), higher depression was associated with higher confidence (Figure 2b).

These patterns were consistent in our models including anxiety as the predictor. For the ER-40, for participants with PSQI scores at or below 5.12 (16.96%), elevated anxiety was associated with lower confidence. While for those scoring at or above 13.90 (19.30%), elevated anxiety was associated with higher confidence (Figure 3a). Similarly, for the BLERT, for those scoring at or below 4.86 on the PSQI (11.52%) higher anxiety was associated with lower confidence, while elevated anxiety was associated with higher confidence for those scoring at or above 12.85 on the PSQI (23.63%; Figure 3b).

CHAPTER IV – DISCUSSION

This study is the first to investigate sleep disturbance as a potential determinant of IA across the psychosis spectrum. Contrary to hypotheses, no significant relationships between sleep disturbance and IA difference scores were revealed across the sample, and sleep disturbance did not serve as a moderator in the relationships between symptoms (positive, negative, or depressive symptoms) and IA. However, exploratory analyses revealed interesting relationships between sleep disturbance, IA, and confidence ratings on the tasks, some of which varied between diagnostic groups. For those with bipolar disorder and schizophrenia, *lower* confidence on the tasks and *underestimation* of abilities were associated with greater sleep disturbance, while for those with schizoaffective disorder, greater sleep disturbances were associated with *higher* confidence and *overestimation* of performance. Across the sample, sleep disturbance significantly moderated the relationships between positive symptoms, depressive symptoms, and confidence ratings. These relationships were such that for those with greater sleep disturbances, higher positive symptoms were associated with higher confidence, while for those with fewer sleep disturbances, the relationships were non-significant. Interestingly, elevated depression was associated with higher confidence for those with greater sleep disturbances, while for those with fewer sleep disturbances, elevated depression was associated with lower confidence. Overall, despite moderate correlations between confidence ratings and IA, results suggest that sleep disturbance, and the interaction between sleep disturbance and symptoms, may be impacting these

different forms of self-evaluation in varied ways. Further, results point to differential relationships between sleep disturbance, IA, and confidence between diagnostic groups.

Broadly, results from this study are consistent with a growing body of work highlighting impairments in IA across the psychosis spectrum (Gould et al., 2015; Jones et al., 2019; Perez et al., 2020; Tercero et al., 2021). Results indicate that although both people with schizophrenia-spectrum disorders and bipolar disorders overestimated their performance on the tasks, IA was more impaired for those with schizophrenia-spectrum disorders. In other words, people with schizophrenia-spectrum disorders displayed a greater discrepancy between their self-reported and actual scores on the tasks. This is consistent with prior work documenting greater IA impairments for those with schizophrenia-spectrum disorders compared to those with bipolar disorders (Hill et al., 2013; Ruocco et al., 2014). Though there has been considerably less work examining IA in bipolar disorder (Harvey et al., 2015; Strassnig et al., 2018; Tercero et al., 2021), these findings add to a growing body of work suggesting IA impairment in this group.

Positive, Negative, and Depressive Symptoms as Determinants of IA

Study findings extend work examining determinants of IA impairment (Harvey et al., 2017; Harvey & Pinkham, 2015; Sabbag et al., 2012). There is limited research examining relationships between IA and positive and negative symptoms with mixed findings. We found that across the sample, overestimations of performance were associated with greater positive symptoms, consistent with some prior work in schizophrenia-spectrum disorders (Sabbag et al., 2012) and in healthy populations for those with elevated subclinical paranoia (Moritz et al., 2014; Moritz, Göritz, et al., 2015). However, contrary to expectations, we did not observe relationships between negative

symptoms and IA. This is inconsistent with one prior study in schizophrenia which found that negative symptoms (i.e., avolition and stereotyped thinking) were associated with overestimations of functional ability (Sabbag et al., 2012). This inconsistency may be due to measurement differences. Sabbag and colleagues (2012) found relationships between IA and single item negative symptoms assessed by the PANSS interview. In the current study, we utilized an average score of six different negative symptoms (i.e., avolition, emotional withdrawal, lack of spontaneity/conversation flow, poor rapport, disturbance of volition, and preoccupation), consistent with the five-factor scoring of the PANSS (van der Gaag et al., 2006). Thus, negative symptoms were examined in different ways which could contribute to these varying findings. Alternatively, relationships with IA might be present for positive but not negative symptoms due to difficulties in self-monitoring that are frequently associated with greater positive symptoms in schizophrenia (Gawęda et al., 2013) and have been suggested as an explanation for why some may maintain greater confidence even when incorrect (Moritz, Göritz, et al., 2015; Moritz, Thoering, et al., 2015).

Regarding depressive symptoms and IA, higher depressive symptoms were associated with underestimations of performance, consistent with some (Bowie et al., 2007; Harvey et al., 2015) but not all work on this topic (Gould et al., 2015; Harvey et al., 2017; Jones et al., 2019; Sabbag et al., 2012). Of note, research suggests that relationships between IA and depressive symptoms are complex and may vary depending on the severity of depressive symptoms. Specifically, in schizophrenia-spectrum and bipolar disorders, higher levels of depressive symptoms have been associated with more accurate IA in some studies (Gould et al., 2015; Harvey et al., 2017; Sabbag et al., 2012),

while severe depressive symptoms have been associated with an underestimation of abilities (Bowie et al., 2007; Harvey et al., 2015). Further, one study in particular found no links between under- or overestimations of performance, confidence about performance, or self-reported depressive symptoms for people with schizophrenia (Jones et al., 2019). In the current study, depressive symptoms across the sample were in the mild to moderate range (i.e., mean of 14 on a scale from 0 to 60). Given the relationship between depressive symptoms and underestimations of performance in the current study, this finding may be explained in part by the "depressive realism" and "sadder but wiser" literature (Alloy & Abramson, 1979; Moore & Fresco, 2012; Soderstrom et al., 2011), which has found links between moderate levels of depressive symptoms and underestimations of ability (Soderstrom et al., 2011).

Relationships Between Sleep Disturbance and Symptoms

When examining relationships between sleep disturbance and depressive symptoms, higher depressive symptoms were associated with greater sleep disturbance across the sample, consistent with prior work (Gruber et al., 2009; Laskemoen et al., 2019). While depressive symptom findings were as expected, the relationships between sleep disturbance and positive and negative symptoms were less consistent. In the current study, we used $p = .01$ to indicate significance to reduce the potential for alpha inflation due to multiple comparisons. While correlations examining relationships with positive and negative symptoms did not fall in this range, one relationship with negative symptoms was trending ($p < .05$) in an unexpected direction, such that more sleep disturbances were associated with *lower* negative symptoms. This finding is inconsistent with past work that has found that more sleep disturbance is associated with greater

negative symptoms (Kaskie et al., 2017; Laskemoen et al., 2019; Reeve et al., 2019; Waters et al., 2011; Zarcone & Benson, 1997). One possible explanation for this finding may be that the people in our study who were more willing to acknowledge and self-endorse sleep disturbances could also have better motivation or be more socially engaged, which would correspond with lower clinician rated negative symptoms, but future work should investigate this. The lack of observed relationships between positive symptoms and sleep disturbance is also surprising given past work across clinical and subclinical populations documenting relationships between greater sleep disturbance and more positive symptoms (Cannon et al., 2008; Kasanova et al., 2020; Kaskie et al., 2017; Laskemoen et al., 2019; Lunsford-Avery et al., 2015; Reeve et al., 2019). One possible explanation for these lacking relationships may be due to generally low symptoms in our sample. A relative restriction of range may have impacted results, and future studies in more symptomatic samples may have different findings. Across the sample, average positive symptoms were approximately 2.5 (on a scale from 1 to 7). A score in this range on the PANSS indicates minimal to mild positive symptoms. Additionally, average negative symptom scores across the sample were approximately 1.5 on the same scale. Values in this range indicate absent to minimal symptoms. These lower scores may have influenced relationships as the reduced variability offers limited opportunity for statistical relationships to emerge. Our sample may have had lower symptom scores given that we recruited a relatively stable, chronic sample from outpatient mental health clinics, as well as online sources like Craigslist and Facebook. Thus, our recruitment methods may oversample higher functioning people. These trending and/or absent statistical relationships are important to replicate in future investigations.

Sleep Disturbance as a Determinant of IA and Confidence

Contrary to expectations, we did not observe significant relationships between sleep disturbance and IA, and sleep disturbance did not serve as a moderator between IA and positive, negative, or depressive symptoms. However, we did see relationships between IA, confidence, and sleep disturbance when examining the diagnostic groups separately. For those with bipolar disorder, greater use of sleep medication was associated with both underestimation of performance and lower confidence. Lower confidence was also associated with longer sleep duration in this group. Similarly, in the schizophrenia group, underestimation of performance and lower confidence were consistently associated with greater sleep disturbance across multiple domains (i.e., longer sleep latency, shorter sleep duration, poorer sleep efficiency, more sleep disturbances, and poorer overall sleep quality). Again, opposite patterns were revealed for those with schizoaffective disorder: overestimation of performance was associated with longer sleep latency, and higher confidence was associated with more sleep disturbances. Relationships between sleep disturbance, IA, and confidence in the current study are novel, and indicate that sleep disturbance is a determinant of both IA and confidence, particularly for those diagnosed with schizophrenia.

Differential relationships between diagnostic groups are of interest and warrant further discussion, particularly the contrasting relationships between schizophrenia and schizoaffective disorder. One possible explanation for these findings is the greater symptom complexity associated with schizoaffective disorder, specifically the significant mood episodes that distinguish schizoaffective disorder from schizophrenia (American Psychiatric Association, 2013). This mood component may drive differential

relationships observed in the current study. Indeed, mood has often been considered integral to understanding how one perceives their abilities and skills (Harvey & Pinkham, 2015; Silberstein & Harvey, 2019), and the exact relationships with IA and confidence are still being investigated. Differences between these two disorders are noted in additional studies as well, which suggest that those with schizoaffective disorder demonstrate better cognitive and social cognitive abilities than people with schizophrenia and experience better long term outcomes (Chen et al., 2012; Harrow et al., 2000; Hartman et al., 2019; Hill et al., 2013). Notably, a large majority of the research in the IA literature combines people with schizophrenia and schizoaffective disorders into one group (i.e., schizophrenia-spectrum disorders) (e.g., Badal et al., 2023; Dalkner et al., 2023; Perez et al., 2020; Tercero et al., 2021). Given findings from the current study, it may be especially important to consider diagnostic differences in research examining IA and confidence. Exploring these relationships in diagnostic groups independently, specifically separating schizophrenia-spectrum disorders, may help to better elucidate specific relationships between IA, confidence, and symptoms.

Sleep Disturbance as a Moderator of Relationships Between Symptoms and Confidence

While expected moderation of relationships with IA was lacking, we found that sleep disturbance significantly moderated relationships between positive symptoms, depressive symptoms, and confidence ratings. Sleep disturbance significantly moderated the relationship between positive symptoms and confidence ratings such that for those with greater sleep disturbance, higher positive symptoms were associated with higher confidence, while for those with less sleep disturbance, these relationships were non-significant. This is consistent with our hypothesized relationship in IA and suggests a

compounding effect of sleep disturbance and higher positive symptoms on confidence ratings. Those with increased sleep disturbance may be more impacted by their symptoms than those with less sleep disturbance, which may be explained by negative impacts of sleep disturbance on factors such as coping skills, emotion regulation, and the elevated distress associated with disturbed sleep (Benca et al., 1992; Hofstetter et al., 2005; Li et al., 2016; Morin et al., 2003). Ultimately, these findings suggest that those with more sleep disturbance may experience greater symptomatic impacts on their evaluations of their abilities (i.e., higher confidence ratings). Of note, Johnson-Neyman values indicated that these transitions in significance occurred at approximately 10 on the PSQI (on a scale from 0 to 21), indicating moderate sleep difficulty. Thus, future work incorporating participants with more severe sleep disturbance is warranted and may provide additional information about the compounding effects of sleep disturbance and positive symptoms on self-evaluations.

Regarding depression, moderation analyses indicated that for those with greater sleep disturbance, elevated depression was associated with higher confidence, while for those with less sleep disturbance, elevated depression was associated with lower confidence. This interaction between elevated depression and less sleep disturbance is consistent with the aforementioned literature on "depressive realism" (Alloy & Abramson, 1979; Moore & Fresco, 2012; Soderstrom et al., 2011). However, the interaction between greater sleep disturbance and elevated depression being associated with higher confidence is more difficult to interpret and requires further research. Similar to the compounding effect of greater sleep disturbance and higher symptoms that was observed for positive symptoms, perhaps there are limited capacities available when sleep

is highly disturbed and depression is high (e.g., higher distress, impaired coping skills, poor emotion regulation) (Benca et al., 1992; Hofstetter et al., 2005; Li et al., 2016; Morin et al., 2003). These diminished capacities may lead to an inability to accurately monitor performance resulting in overconfidence while completing tasks. Johnson-Neyman values indicated that these transitions in significance occurred when participants had scores of 2 to 5. Relationships then changed directions at scores of 15 to 18. At scores of 2 to 5 on the PSQI (scale from 0 to 21), participants are experiencing minimal sleep difficulties, while those scoring between 15 and 18 on the PSQI are experiencing high amounts of sleep difficulty. Notably, the number of participants that fell into these groups were very low (i.e., 2-11% of the sample). Many participants across the sample, given mean scores, demonstrated moderate sleep difficulties (M = 9.46). The small number of participants in these extremes limits our ability to generalize from these results. Future work in larger samples, with a wider range of sleep disturbances, is necessary to replicate these findings.

In order to emphasize unique relationships regarding positive, negative, and depressive symptoms, the moderating role of sleep disturbance on the relationships between anxiety and confidence ratings was examined as an alternative model. Interestingly, this model demonstrated the exact same patterns of relationships as the depressive symptom findings, suggesting that these relationships may not be unique to depressive symptoms. These similar relationships may be due in part to the high comorbidity between depressive and anxiety symptoms (Belzer & Schneier, 2004; Pollack, 2005), which extends to schizophrenia-spectrum and bipolar disorders (Buckley et al., 2009; Ott, 2018). While we included the anxiety model as an alternative to our

symptoms of interest, this is a possible avenue for future work to explore. Only one study to date has examined anxiety as a possible determinant of IA, specifically examining anxiety as a negative mood state (Dalkner et al., 2023). The authors examined relationships between IA and negative affect, which combined momentary ratings of sad and anxious moods (Dalkner et al., 2023). They found that higher negative affect was associated with greater overestimation of cognitive performance for those with bipolar disorders, but not in schizophrenia (Dalkner et al., 2023). On the other hand, it is also plausible that someone with higher anxiety may underestimate their abilities because they may incorrectly believe that they do not have skills in a certain domain, or are not performing well on a task, essentially mistaking their anxiety for incompetence (Silberstein & Harvey, 2019). Of note, one limitation of this model is that our anxiety measure came from a single item on the PANSS semi-structured interview. More commonly used and comprehensive anxiety assessments should be used to explore these relationships in the future.

Assessing IA and Confidence

Across symptom results in the full sample, confidence emerged as significant in numerous relationships, while IA did not. This is deserving of discussion, as these constructs are highly related yet demonstrated differential relationships. In the current study, IA difference scores and confidence ratings were moderately correlated and in expected directions (i.e., higher confidence associated with overestimation of performance). However, sleep disturbance was differentially impacting these different forms of self-evaluation. Our results indicate that sleep disturbance, and the interactions between sleep disturbance and symptoms, may be more strongly tied to confidence

ratings than to IA difference scores. There are a few possible explanations for this discrepancy. First, the nature of the confidence questions allows for a wider range of responses than the IA questions. When assessing IA, participants were asked “Do you think you answered correctly?” immediately after selecting an emotion choice for each item. Conversely, when assessing confidence, participants were asked to indicate their confidence from 0 to 100% on the BLERT, and 0%, 25%, 75%, or 100% on the ER-40. Thus, inquiring about confidence ratings offers greater variability and nuance in participant responses. Additionally, this approach provides more opportunities for statistical relationships to be observed as a greater number of response options can improve explanatory and discriminating power (Kazis et al., 2004; Preston & Colman, 2000). Anecdotally, during administration of these tasks, many participants frequently report the same answer to “Do you think you answered correctly?” throughout the tasks, but their confidence ratings often vary between the items. This may be related to the dichotomous nature of the yes/no question as well as participant willingness to endorse fluctuating confidence rather than indicate they believe they answered something incorrectly. It may be worthwhile to gather qualitative information from participants inquiring what information they are using to make these estimations, and why their confidence ratings may vary between items more so than other types of IA ratings. This is an avenue for future work. Additionally, it is possible that confidence ratings may be a more accurate way to measure fluctuations in assessments of own's own abilities and skills between items on a task. The field of IA research is relatively new, and there is not one agreed upon method to capture evaluations of own’s own abilities and skills. For example, existing studies of IA have asked participants to indicate their perceived

abilities using self-report measures, make item-by-item accuracy judgements about their responses, select global judgments about their performance at the end of a task, as well as report their confidence regarding their task performance (Badal et al., 2023; Perez et al., 2020; Pinkham, Klein, et al., 2018; Silberstein et al., 2018; Tercero et al., 2021). Alternatively, given the moderate correlations between IA difference scores and confidence here and in other studies (Tercero et al., 2021), it is plausible that they are not fully separable constructs. Indeed, a recently posited definition of IA conceptualizes both IA difference scores and confidence (as measured here) as part of a broader IA construct. Specifically, authors suggest that IA involves multiple components including momentary judgments (e.g., "Do you think you answered correctly"), confidence in those judgments, and the ability to combine judgments and feedback into global assessments of functioning or performance (Morgan et al., 2022). Further, the authors suggest that while IA seems to be broadly impaired in both schizophrenia-spectrum and bipolar disorders, impairments may occur at different stages of this self-evaluation process (Morgan et al., 2022). Thus, within this framework, results of the current study may be more consistent with hypotheses regarding IA than they seem. However, this conceptualization of IA is new, and consensus regarding definitions in the field is needed. Ultimately, as the research examining IA continues to grow, investigators should continue to explore different ways to assess IA and how they are interrelated.

Explaining Differences in Findings Between Emotion Recognition Tasks

Of note, we did observe some differences in our findings between the two social cognitive tasks used to generate IA and confidence scores. While both of these tasks assess emotion recognition broadly, the different skills required of these tasks may

explain some of these differences. For example, the BLERT tasks involves more complex skills, as participants watch videos using different facial, vocal, and upper-body movement cues to determine the expressed emotion (Bryson et al., 1997). In contrast, the ER-40 is facial affect recognition from static images (Kohler et al., 2003). In the current study, links between IA and sleep were present only for the ER-40, while relationships between confidence and sleep were documented for both tasks. This suggests that sleep disturbance may be important for understanding IA when completing a facial emotion recognition task but may not be as important for multi-modal emotion recognition. Thus, there may be something about the difficulty of the task, or the incorporation of various sources of information, that have different relationships with symptoms and sleep disturbance. For example, in the more complex BLERT task, participants have access to many different sources of information including facial cues, vocal sounds, and upper-body movements. Perhaps sleep disturbance is less impactful on this task because participants have more sources of information available to use when monitoring their performance. Conversely, for the simplified ER-40 task, maybe the limited stimuli allows sleep disturbance to have a stronger impact on their judgments about their performance because there is little information available for participants to utilize when making these determinations. Future research should further investigate these questions.

Limitations

While this study has several strengths, including identifying a novel determinant of IA and confidence and examining relationships both across and between diagnostic groups, there are several important limitations to consider. First, because of the small sample size of the major depressive disorders sample, we were not able to conduct any

diagnostic comparisons for this group. Additionally, our sample consisted of mostly women. This is less common in studies of people with schizophrenia-spectrum disorders (e.g., Longenecker et al., 2010; Sommer et al., 2020). While our bipolar sample was largely driving this gender difference, there were also more women in our schizoaffective disorder group. Given work suggesting that women with schizophrenia-spectrum disorders may have better functional outcomes compared to men (Ochoa et al., 2012), perhaps they were better equipped to participate in our research study. This may have resulted in our sample including higher functioning individuals broadly, which could impact the nature of our results. In addition, some participants completed the study prior to the start of the pandemic, while over half of participants completed the study remotely after the pandemic began. The change in administration style/method, testing environment, as well as the mental health consequences of the pandemic broadly are important to consider when interpreting the findings from the current study. Lastly, we also had a large proportion of our sample missing data on sleep disturbance, as this measure was added several months after study initiation. Future work should attempt to replicate these findings in person, with larger samples, and with a wider range of symptom presentations.

Conclusion

Despite these limitations, results from the current study suggest that sleep disturbance, and the interaction between sleep disturbance and symptoms, may be impacting IA and confidence in different ways. Results also indicate unique relationships between sleep disturbance and over- and underestimations of performance between diagnostic groups. Future work is needed to further explore these complex relationships.

Utilizing longitudinal methods to explore how day-to-day changes in sleep, symptoms, and mood may impact IA and confidence is warranted and could help to further elucidate these relationships. Additional investigations should also incorporate assessments of functioning and outcomes. Understanding how the relationships between IA, confidence, symptoms, and sleep disturbance impact functioning is crucial and should be examined in future work. This could inform potential interventions to improve functional outcomes for people across the psychosis spectrum.

APPENDIX – Tables and Figures

Table 1 *Demographic and Descriptive Characteristics Across the Sample*

	n (%) / *M (SD)*
Major Depressive Disorder with psychotic features	6 (2.2%)
Bipolar Disorder with psychotic features	102 (38.1%)
Schizophrenia	70 (26.1%)
Schizoaffective Disorder	90 (33.6%)
Age	41.56 (11.91)
Years of Education	13.68 (2.75)
WRAT-4	98.99 (12.96)
Race	
American Indian or Alaskan Native	1 (.4)
Asian	9 (3.4)
Black or African American	98 (36.6)
White	113 (42.2)
Native Hawaiian or Other Pacific Islander	3 (1.1)
More than one race or other	44 (16.4)
Ethnicity	
Hispanic/Latinx	63 (23.5)
Non-Hispanic/Latinx	205 (76.5)
Gender identity	
Male	98 (36.6)
Female	168 (62.7)
Prefer not to disclose	2 (.7)
Suicidality Group	
Actively Suicidal	128 (47.8)
Non-suicidal	140 (52.2)
Type of Visit	
In-person	122 (45.5)
Remote	146 (54.5)

Table 2 *Average Symptom Ratings and Task Scores Across the Sample*

	M (SD)
Symptoms	
YMRS	4.35 (6.29)
MADRS	14.39 (11.20)
PANSS Positive	2.51 (.93)
PANSS Negative	1.55 (.55)
PSQI Total	9.46 (4.18)
PSQI Component 1	1.30 (.95)
PSQI Component 2	1.70 (1.05)
PSQI Component 3	.93 (1.10)
PSQI Component 4	.98 (1.10)
PSQI Component 5	1.53 (.72)
PSQI Component 6	1.33 (1.36)
PSQI Component 7	1.32 (.95)
ER-40 Objective Score	29.13 (7.02)
ER-40 Self-reported Score	34.24 (10.51)
ER-40 IA Difference Score	5.11 (8.22)
ER-40 Confidence Ratings	79.42 (15.57)
BLERT Objective Score	14.81 (3.81)
BLERT Self-reported Score	19.71 (2.32)
BLERT IA Difference Score	4.91 (4.38)
BLERT Confidence Ratings	81.30 (14.77)

Note. YMRS = Mania symptoms; MADRS = Depressive symptoms; PANSS Positive = Positive symptoms; PANSS Negative = Negative symptoms; PSQI Component 1 = Subjective sleep quality; PSQI Component 2 = Sleep latency; PSQI Component 3 = Sleep duration; PSQI Component 4 = Sleep efficiency; PSQI Component 5 = Sleep disturbances; PSQI Component 6 = Use of sleeping medication; PSQI Component 7 = Daytime dysfunction; PSQI Total = Global PSQI Score; ER-40 IA Difference Score = Self-reported score – objective score on the ER-40; BLERT IA Difference Score = Self-reported score – objective score on the BLERT

Table 3 *Partial Correlations Between IA Difference Scores, Symptoms, and Sleep Disturbance*

	PSQI 1	PSQI 2	PSQI 3	PSQI 4	PSQI 5	PSQI 6	PSQI 7	PSQI Total	PANSS Positive	PANSS Negative	MADRS
BLERT IA	-.10	-.05	-.05	-.11	.05	.09	.02	-.04	.18*	.11	-.13†
ER-40 IA	-.13	-.02	.04	-.01	-.05	-.14	-.03	-.09	.15†	.16	-.07
PANSS Positive	-.003	-.10	.13	.08	.04	.01	.08	.12	---	---	---
PANSS Negative	-.14	-.12	-.02	-.05	-.17†	-.07	-.05	-.15	---	---	---
MADRS	.27*	.10	.15	.01	.11	.04	.18†	.25*	---	---	---

**p<.01; †p<.05*

Note. PSQI 1 = Subjective sleep quality; PSQI 2 = Sleep latency; PSQI 3 = Sleep duration; PSQI 4 = Sleep efficiency; PSQI 5 = Sleep disturbances; PSQI 6 = Use of sleeping medication; PSQI 7 = Daytime dysfunction; PSQI Total = Global PSQI Score; BLERT IA = Self-reported score – actual score on the BLERT; ER-40 IA = Self-reported score – actual score on the ER-40; PANSS Positive = Positive symptoms; PANSS Negative = Negative symptoms; MADRS = Depressive symptoms

Table 4 *Results of Moderation Analyses Examining Sleep Disturbance, Symptoms (Positive, Negative, Depressive, Anxiety Symptoms), and IA Difference Scores*

Variable	Coefficient	SE	*t*	*p*
Positive Symptom Models				
ER-40 IA: R^2 = .05, F = 2.12, p = .08				
Constant	-3.33	5.01	-0.66	0.51
PANSS Positive	4.71	2.17	2.17	0.03
PSQI Total	0.52	0.53	0.98	0.33
Interaction Term	-0.34	0.22	-1.52	0.13
Suicidality Group (Covariate)	-0.46	1.35	-.34	0.73
BLERT IA R^2 = .04, F = 1.78, p = .13				
Constant	2.63	2.39	1.10	0.27
PANSS Positive	0.99	1.06	0.94	0.35
PSQI Total	-0.04	0.25	-0.17	0.86
Interaction Term	.004	0.11	0.04	0.97
Suicidality Group (Covariate)	0.06	0.65	0.09	0.93
Negative Symptom Models				
ER-40 IA: R^2 = .05, F = 1.98, p = .10				
Constant	4.27	4.71	0.91	0.37
PANSS Negative	1.37	2.70	0.51	0.61
PSQI Total	-0.48	0.50	-0.96	0.34
Interaction Term	0.21	0.30	0.70	0.49
Suicidality Group (Covariate)	-0.19	1.35	-0.14	0.89
BLERT IA R^2 = .03, F = 1.12, p =.35				
Constant	3.28	2.16	1.52	0.13
PANSS Negative	0.82	1.25	0.66	0.51
PSQI Total	-0.08	0.23	-0.35	0.73
Interaction Term	0.05	0.14	0.39	0.70
Suicidality Group (Covariate)	0.12	0.65	0.18	0.86
Depression Models				
ER-40 IA R^2 = -14, F = .57, p = .68				
Constant	8.07	2.48	3.26	0.001
MADRS	-0.11	0.16	-0.67	0.51
PSQI Total	-0.35	0.26	-1.37	0.17
Interaction Term	0.001	0.02	0.73	0.47
Suicidality Group (Covariate)	-0.03	1.46	-0.02	0.98
BLERT IA R^2 = .02, F = .83, p = .51				
Constant	4.49	1.20	3.76	< 0.001
MADRS	-0.03	0.08	-0.34	0.74
PSQI Total	0.07	0.13	0.58	0.56
Interaction Term	-0.003	0.01	-0.45	0.65

Table 4 Continued

Variable	Coefficient	SE	*t*	*p*
Suicidality Group (Covariate)	0.54	0.70	0.78	0.44
Anxiety Models				
ER-40 IA: R^2 = .02, F = .76, p =.55				
Constant	9.90	3.34	2.96	0.004
PANSS Anxiety	-1.13	1.01	-1.11	0.27
PSQI Total	-0.46	0.34	-1.34	0.18
Interaction Term	0.09	0.10	0.92	0.36
Suicidality Group (Covariate)	0.14	1.38	0.10	0.92
BLERT IA: R^2 = .007, F = .28, p = .89				
Constant	3.95	1.60	2.46	0.01
PANSS Anxiety	0.20	0.48	0.41	0.68
PSQI Total	0.11	0.17	0.68	0.50
Interaction Term	-0.03	0.05	-0.76	0.45
Suicidality Group (Covariate)	0.21	0.67	0.32	0.75

Table 5 *Partial Correlations Between Confidence Ratings, IA, Symptoms, and Sleep Disturbance by Diagnostic Group*

	PSQI 1	PSQI 2	PSQI 3	PSQI 4	PSQI 5	PSQI 6	PSQI 7	PSQI Total	PANSS Positive	PANSS Negative	MADRS
Bipolar Disorders											
BLERT Confidence	.06	-.22	.18	-.07	-.03	-.09	-.07	-.07	.23	.21	.07
ER-40 Confidence	.06	-.14	.27*	-.06	.02	-.27*	-.13	-.09	.35**	.17	.16
BLERT IA	-.03	.02	-.003	-.12	.18	-.04	.15	-.003	.12	.15	-.04
ER-40 IA	-.02	-.05	.21	.03	.07	-.25*	-.05	-.04	.18	.13	-.01
Schizophrenia											
BLERT Confidence	-.15	-.41*	-.45*	-.47**	-.47**	-.29	-.26	-.52**	-.15	.01	-.16
ER-40 Confidence	-.09	-.43*	-.24	-.18	-.31	-.19	-.29	-.36	-.29	.32	-.23
BLERT IA	-.15	-.24	-.13	-.34	-.09	.19	.03	-.06	.04	-.09	-.14
ER-40 IA	-.39*	-.41*	-.31	-.30	-.34	-.18	-.02	-.38*	-.13	.22	-.03
Schizoaffective Disorder											
BLERT Confidence	.09	-.15	-.05	-.01	.30*	-.11	-.002	-.09	.16	.13	-.10
ER-40 Confidence	.10	-.14	.06	.04	.33*	-.24	.01	-.03	.19	.16	-.07
BLERT IA	.08	.12	.12	.12	.15	.22	.07	.07	.15	.17	-.10
ER-40 IA	.05	.34*	.18	.11	.14	.03	.09	.08	.08	.07	-.03

****p<.001; **p<.01; *p<.05*

PSQI 1 = Subjective sleep quality; PSQI 2 = Sleep latency; PSQI 3 = Sleep duration; PSQI 4 = Sleep efficiency; PSQI 5 = Sleep disturbances; PSQI 6 = Use of sleeping medication; PSQI 7 = Daytime dysfunction; PSQI Total = Global PSQI Score; BLERT Confidence = Average confidence ratings on the BLERT; ER-40 Confidence = Average confidence ratings on the ER-40; BLERT IA = Self-reported score – actual score on the BLERT; ER-40 IA = Self-reported score – actual score on the ER-40; PANSS Positive = Positive symptoms; PANSS Negative = Negative symptoms; MADRS = Depressive symptoms

Table 6 *Results of Moderation Analyses Examining Sleep Disturbance, Symptoms (Positive, Negative, Depressive, Anxiety Symptoms), and Confidence Ratings*

Variable	Coefficient	SE	*t*	*p*
Positive Symptom Models				
ER-40 Confidence Ratings: R^2 = .06, F = 2.60, p =.04				
Constant	97.56	8.66	11.26	< 0.001
PANSS Positive	-6.55	3.76	-1.74	0.08
PSQI Total	-2.45	0.91	-2.70	0.01
Interaction Term	**0.91**	**0.38**	**2.39**	**0.02**
Suicidality Group (Covariate)	-1.75	2.33	-0.75	0.45
BLERT Confidence Ratings: R^2 = .05, F = 2.01, p = .10				
Constant	88.84	8.53	10.42	< 0.001
PANSS Positive	-0.47	3.79	-0.12	0.90
PSQI Total	-1.23	0.89	-1.38	0.17
Interaction Term	0.28	0.38	0.72	0.47
Suicidality Group (Covariate)	-1.34	2.34	-0.57	0.57
Negative Symptom Models				
ER-40 Confidence Ratings: R^2 = .04, F = 1.85, p = .12				
Constant	78.87	8.20	9.61	< 0.001
PANSS Negative	2.28	4.70	0.49	0.63
PSQI Total	-0.72	0.87	-0.83	0.41
Interaction Term	0.30	0.52	0.57	0.57
Suicidality Group (Covariate)	-2.18	2.34	-0.93	0.35
BLERT Confidence Ratings: R^2 = .04, F = 1.62, p = .17				
Constant	85.42	7.68	11.13	< 0.001
PANSS Negative	1.31	4.43	0.30	0.77
PSQI Total	-0.75	0.81	-0.92	0.36
Interaction Term	0.13	0.48	0.27	0.79
Suicidality Group (Covariate)	-1.38	2.33	-0.59	0.56
Depression Models				
ER-40 Confidence Ratings: R^2 = .05, F = 2.02, p = .09				
Constant	90.02	4.24	21.26	< 0.001
MADRS	0-.59	0.28	-2.11	0.04
PSQI Total	-1.13	0.44	-2.55	0.01
Interaction Term	**0.06**	**0.03**	**2.30**	**0.02**
Suicidality Group (Covariate)	-1.82	2.49	-0.73	0.47
BLERT Confidence Ratings: R^2 = .07, F = 2.97, p < .02				
Constant	95.20	4.19	22.75	< 0.001
MADRS	-0.68	0.29	-2.38	0.02
PSQI Total	-1.42	0.44	-3.25	0.001
Interaction Term	**0.07**	**0.03**	**2.61**	**0.01**

Table 6 Continued

Variable	Coefficient	SE	*t*	*p*
Suicidality Group (Covariate)	-1.19	2.44	-0.49	0.63
Anxiety Models				
ER-40 Confidence Ratings: R^2 = .06 F = 2.62, p =.04				
Constant	95.84	5.69	16.85	< 0.001
PANSS Anxiety	-4.33	1.73	-2.51	0.01
PSQI Total	-1.77	0.59	-3.02	0.003
Interaction Term	**0.45**	**0.16**	**2.77**	**0.006**
Suicidality Group (Covariate)	-1.86	2.35	-0.79	0.43
BLERT Confidence Ratings: R^2 = .08, F = 3.56, p = .008				
Constant	100.34	5.52	18.16	< 0.001
PANSS Anxiety	-4.27	1.67	-2.56	0.01
PSQI Total	-2.06	0.57	-3.62	< 0.001
Interaction Term	**0.46**	**0.16**	**2.95**	**0.004**
Suicidality Group (Covariate)	-0.99	2.30	-0.43	0.67

Figure 1. Visualization of the Moderation by Sleep Disturbance in the Relationship Between Positive Symptoms and Confidence Ratings on the ER-40

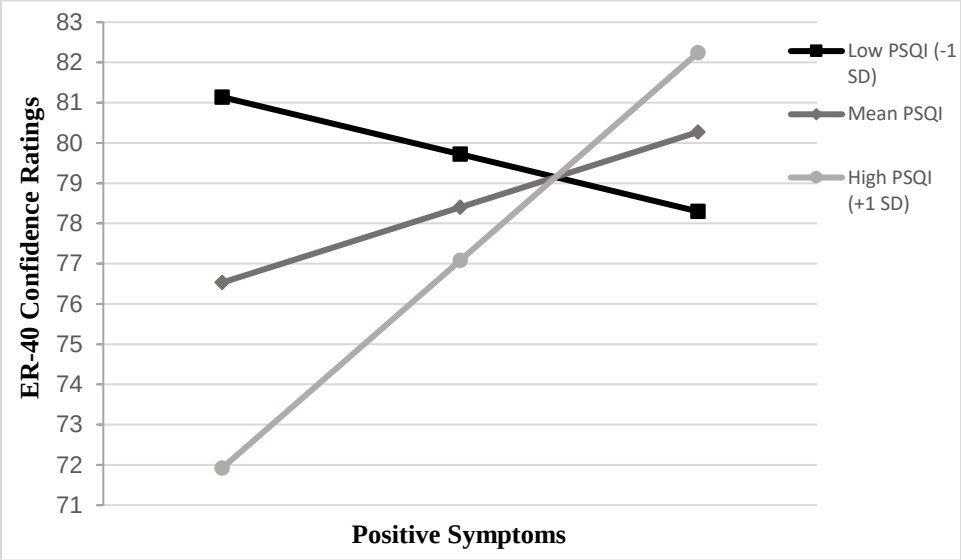


Figure 2. Visualization of the Moderations by Sleep Disturbance in the Relationships Between Depressive Symptoms and Confidence Ratings

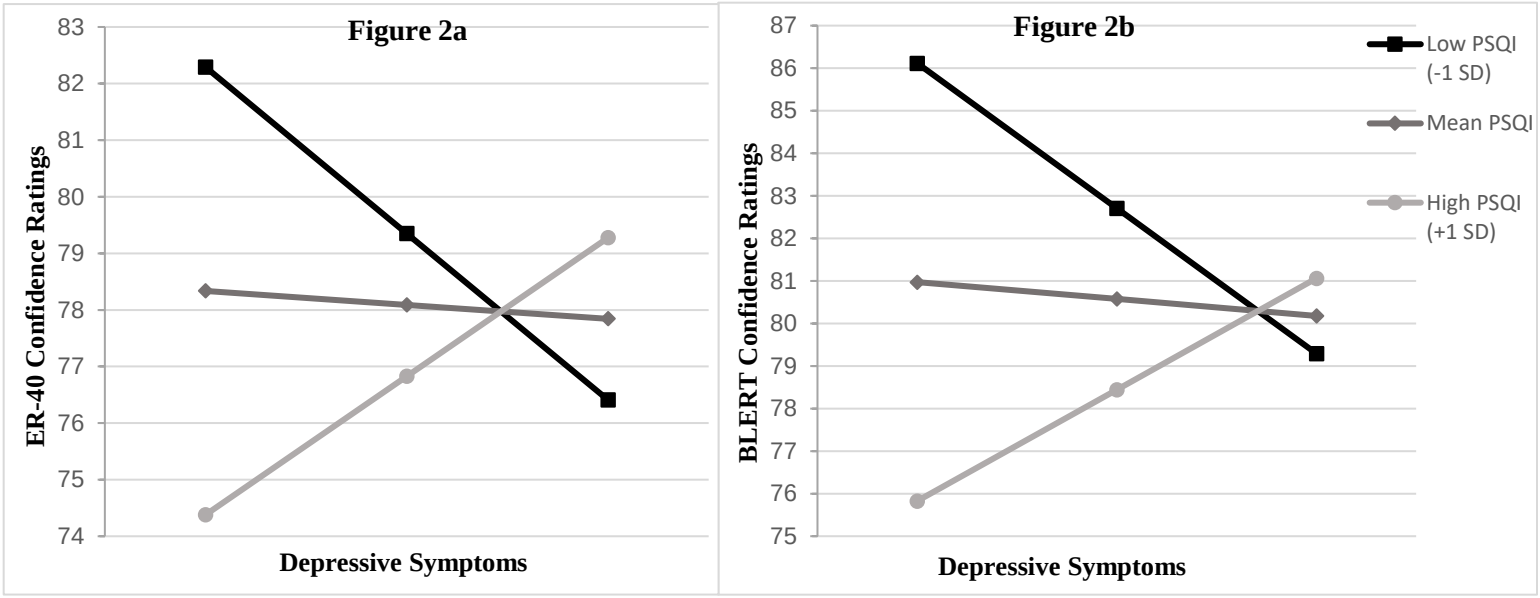
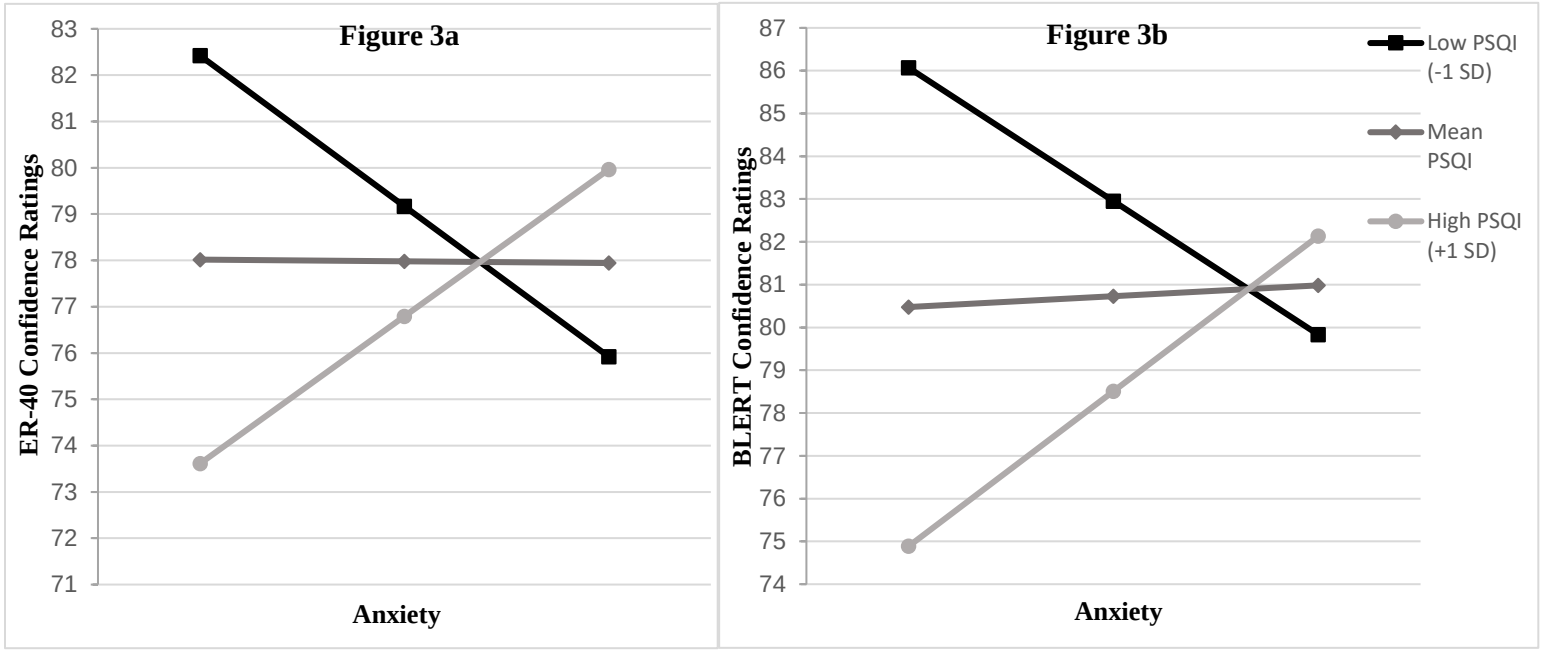


Figure 3. Visualization of the Moderations by Sleep Disturbance in the Relationships Between Anxiety Symptoms and Confidence Ratings



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