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General Versus Person-specific Models of Psychotic-like Symptoms

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GENERAL VERSUS PERSON-SPECIFIC MODELS OF PSYCHOTIC-LIKE SYMPTOMS

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Abstract

Schizophrenia is a chronic brain disease and carries a profound burden of illness and disability. Schizotypy, reflecting personality traits associated with a vulnerability for schizophrenia-spectrum pathology, is characterized, in part, by a tendency to experience psychotic-like symptoms (PLS). Perceived social support, or lack thereof, plays a role in the intensity of PLS. Etiological mechanisms underlying PLS, such as monolithic social support, are putatively expected to be common across individuals sharing elevated schizotypal traits. This "nomothetic" model fails to appreciate that social support is multidimensional and likely idiographic in its effects on PLS. Another salient issue that arises when attempting to understand PLS concerns their historical assessment (e.g., laboratory-based questionnaires or clinical interviews). Ambulatory assessment, which involves naturalistic data collection, uniquely facilitates studying the temporal complexity of PLS while also providing large streams of longitudinal and "idiographic" data streams that enable modeling person-specific psychological processes. The present study evaluated how social support across multiple domains (e.g., family, friends, significant other, academic) was related with PLS and assessed how common this network was across individuals by modeling general- and person-specific associations between social support and PLS using ambulatory assessment methods over 15 days. Contrary to expectations, there was little support for a general-level connection between poor social support and PLS in schizotypy. Person-specific models of PLS revealed dramatic heterogeneity across participants in terms of the magnitude of effects, direction, and lagged associations among the social support-PLS linkage. Findings provide further support for creating idiographic profiles of clinical data to improve etiologic theories and long-term outcomes via tailored interventions.

Introduction

Schizophrenia-Spectrum Pathology

Schizophrenia is a chronic brain disease that affects virtually every aspect of the central nervous system. Schizophrenia carries a profound burden of illness and disability with the World Health Organization (WHO) declaring it as one of the costliest sources of chronic dysfunction known to mankind (World Health Organization, 2001). Despite palliative pharmacological treatments for psychotic symptoms (e.g., delusions, hallucinations), critical treatment needs are largely unmet. For example, individuals with schizophrenia frequently experience poor outcomes in domains such as interpersonal activities, educational, vocational, and recreational activities, among many others. More specifically, fewer than 20% of patients achieve functional recovery, fewer than 15% are employed, and over 50% receive disability compensation within 6 months of receiving a diagnosis (Harvey et al., 2012; Kiviniemi et al., 2011). These functional impairments span a patient's lifespan as these deficits can be observed in the prodromal and first episode (Ventura et al., 2011) and continue well after psychotic symptoms have remitted (Folsom et al., 2006; Jääskeläinen et al., 2013). On average, patients endure approximately 10-15 years of direct illness (Parks, Svendsen, Singer, Foti, & Mauer, 2006) and schizophrenia is one of the leading causes of healthy years lost to disease (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006). Accordingly, the annual cost of schizophrenia in the United States is estimated to exceed $65 billion when factors such as family caregiving, lost wages, and treatments are considered (World Health Organization et al., 2001). Moreover, a paucity of social connections such as social support is associated with a 26% increased likelihood of mortality (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015). As such, schizophrenia confers vast economic and social toll for patients, their families, and society more broadly.

The core symptoms of schizophrenia can be defined in the present-day diagnosis of 'Schizophrenia' within the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5; American Psychiatric Association, 2013). Per the DSM-5, an individual must have two of the following symptoms to meet the criteria for a schizophrenia diagnosis: delusions, hallucinations, negative symptoms, disorganized speech, or disorganized or catatonic behavior. Additionally, an individual must experience these symptoms for a significant portion of time within the preceding month along with pronounced social or occupational dysfunction due to these disturbances for at least six months to warrant a diagnosis of schizophrenia. While schizophrenia is the most empirically researched psychotic disorder, it is just one of many disorders positioned under the umbrella of 'Schizophrenia-Spectrum and Other Psychotic Disorders' in the DSM-5. The other psychotic disorders embedded within this category are as follows: Schizotypal Personality Disorder, Delusional Disorder, Brief Psychotic Disorder, Schizophreniform Disorder, Schizophrenia, Schizoaffective Disorder, Catatonia, and Psychosis Related to Substance Use or Medical Condition. While there are subtle differences in the various diagnostic criteria concerning symptoms duration, many of these schizophrenia-spectrum disorders share common underlying symptoms such as positive symptoms (e.g. delusions and hallucinations), negative symptoms (e.g. decreased hedonic and motivational capacities), and disorganized thought processes (e.g. speech or behavior). As such, there are no diagnostic criteria unique to the disorders listed under 'Schizophrenia-Spectrum and Other Psychotic Disorders' that aren't typical to other disorders (Strauss & Cohen, 2017). Furthermore, it is not clear that these disorders are categorically distinct from one another from a neurodevelopmental viewpoint (Raine, 2006). While the APA has reported lifetime prevalence rates for schizophrenia at 1%, the collective schizophrenia-spectrum disorders along with subclinical traits likely affect a

much broader segment of the population (Debbané et al., 2015). Given the prohibitive public health costs of these disorders, it is highly important to identify individuals at risk for schizophrenia-spectrum disorders to understand the risk and resiliency factors associated with this schizophrenia-spectrum trajectory (Kwapil & Barrantes-Vidal, 2014).

Schizotypy

Schizotypy is defined as a range of personality traits that reflect a vulnerability to developing schizophrenia-spectrum pathology (Lenzenweger, 2006). Decades of schizotypy research have been based on Paul Meehl's landmark neurodevelopmental model of schizotypy and schizophrenia (Meehl, 1962). Meehl postulated that there are latent genetic and neurological factors, or "schizotaxia", that can potentially manifest into observable disorders. When these unobservable CNS anomalies are combined with adverse learning and social influences (i.e., environmental factors), observable "schizotypes" (e.g. individuals with heightened social anhedonia and/or psychosis-like experiences; Lenzenweger, 2006) emerge, and the likelihood of psychosis conversion increases. More simply, schizotypy is a reflection of latent genetic and environmental interactions (Lenzenweger, 2006; Meehl, 1962). Schizotypy represents a continuum ranging from endophenotypes only observable in the laboratory (i.e., subclinical experiences) to severely debilitating clinically clustered symptoms of schizophrenia. Thus, the schizotypy model implies shared – though not necessarily universal – etiological, developmental, and phenomenological processes which underlie both subclinical and clinical manifestations.

Studying schizotypy offers several advantages. First, schizotypy encompasses a broad spectrum of conditions including the litany of psychotic disorders listed within the DSM-5, the prodrome, and subclinical manifestations within a monolithic conceptual framework (Kwapil & Barrantes-Vidal, 2014). Schizotypy, then, facilitates research and provides explanatory power on

the etiology, risk, resilience, expression, and early treatment of schizophrenia-spectrum conditions under a single, conceptual framework (Kwapil & Barrantes-Vidal, 2014). Second, schizotypy research does not generally possess the myriad of confounds that complicate patient studies including medication effects, frank psychosis, chronic illness, repeated hospitalizations, stigma, and previous treatments. Elevated schizotypal traits are typically studied within college-age students, who are within the peak age of schizophrenia onset (Chapman, Chapman, Kwapil, Eckblad, & Zinser, 1994) and may be able to comply with more rigorous and complicated experimental protocols or testing procedures that take place outside the confines of a laboratory (Holmlund et al., 2019; Kwapil & Barrantes-Vidal, 2015).

There are multiple methods to operationalize schizotypy within the context of psychosis risk, including biological relatives of individuals with schizophrenia, adolescents, and early adults with various clinical presentations as assessed by clinical interviews such as the Structured Interview of Psychosis-risk Syndromes (e.g., SIPS; Miller et al., 2003), and individuals with self-reported (i.e., psychometric) schizotypal traits. The latter approach represents the majority of schizotypy research to date and is the focus of the proposed project. This population is often identified by psychometric classification using schizotypy questionnaires, such as the Schizotypal Personality Questionnaire (SPQ; Raine, 1991), the Chapman Scales (Chapman et al., 1994), Oxford-Liverpool Inventory of Feelings and Experiences (Mason & Claridge, 2006), the Wisconsin Schizotypy Scales (Edell, 1995), and the more recent Multidimensional Schizotypy Scale (Kwapil, Gross, Silvia, Raulin, & Barrantes-Vidal, 2018). Though these self-report measures vary somewhat in terms of their conceptual scope, they each possess convergent validity with functional deficits such as decreased rates of employment and independent living, poorer academic achievement, unhealthy attachment styles (e.g., anxiety and avoidance), and a

higher likelihood of substance use pathology (Barrantes-Vidal, Lewandowski, & Kwapil, 2010; Berry, Band, Corcoran, Barrowclough, & Wearden, 2007; Cohen & Davis, 2009). Collectively, it is clear that schizotypy is a multidimensional construct that is comprised of three super-ordinate factors: positive (e.g., magical thinking, unusual perceptual experiences, ideas of references), negative (e.g., social anhedonia, constricted affect), and disorganized (e.g., odd speech and behavior; Callaway, Cohen, Matthews, & Dinzeo, 2014; Raine, 2006). Much research has been conducted detailing and validating the disparate social, emotional, and cognitive processes underlying the three schizotypy factors (Kemp, Gross, Barrantes-Vidal, & Kwapil, 2018; Raine, 2006).

Schizotypy Deficits

Schizotypy is associated with disruptions in an array of functions related to thoughts, behavior, neurocognition, and emotion. With regards to neurocognition, schizotypy has been linked with basic cognitive impairments such as attention (Xavier, Best, Schorr, & Bowie, 2015) and processing speed (Chun, Minor, & Cohen, 2013) as well higher-order cognitive abilities such as executive control (Kane et al., 2016; Louise et al., 2015). Sahakyan and colleagues have conducted a series of studies (Sahakyan & Kwapil, 2018, 2019; Sahakyan, Kwapil, & Jiang, 2019; Sahakyan, Kwapil, Lo, & Jiang, 2019) examining different aspects of memory (e.g., episodic, recognition, directed forgetting) with the multidimensional schizotypy. Broadly, their research suggested that memory impairment in negative schizotypy is driven by reduced signal mechanisms (i.e., aberrant encoding) whereas memory deficits in positive schizotypy are driven by increased noise mechanisms (i.e., false alarms). While many of these cognitive functioning deficits mimic those in schizophrenia, the magnitude of such effects are much smaller and nuanced (Badcock, Clark, Pedruzzi, Morgan, & Jablensky, 2015; Chun et al., 2013).

Interestingly, schizotypy is associated with pronounced self-perceived cognitive deficits that are similar magnitude to schizophrenia (Chun et al., 2013). Regardless, neurocognitive performance in schizotypy further signals the continuum across the schizophrenia spectrum. Unlike neurocognition, schizotypy is associated with a variety of aberrant hedonic processes that are similar in magnitude to schizophrenia. Schizotypy and schizophrenia exhibit chronically elevated (i.e., trait) negative affect relative to healthy controls (Cohen, Callaway, Najolia, Larsen, & Strauss, 2012; Cohen & Minor, 2010). With regards to state affect, recent research suggests that aberrant momentary affect varies as a function of schizotypy factors. For example, positive and disorganized schizotypy experiencing elevated state negative affect whereas negative schizotypy experiencing decreased positive affect (Chun, Sheinbaum, & Kwapil, 2017; Kwapil, Brown, Silvia, Myin-Germeys, & Barrantes-Vidal, 2012). Of note, Cohen and colleagues (Cohen et al., 2012) found that schizotypy was associated with *greater* reductions in state positive affect (i.e., anhedonia) in response to neutral-, bad-, and good-valanced stimuli relative to schizophrenia, a disorder with putatively greater pathological state in nearly every conceivable domain. Unsurprisingly, schizotypy has also been robustly linked with increased psychiatric symptoms such as elevated anxiety and depressive conditions (Campellone, Elis, Mote, Sanchez, & Kring, 2016; Najolia, Buckner, & Cohen, 2012).

Social dysfunction is common in schizotypy and manifests in a broad set of functional systems including basic perceptual abilities. For example, schizotypy has been linked to poorer performances on tasks related to interpersonal sensitivity, irony comprehension, and theory of mind (e.g., the skills to understand the intentions and beliefs of others; Barragan, Laurens, Navarro, & Obiols, 2011; Miller & Lenzenweger, 2014; Morrison, Brown, & Cohen, 2013; Rapp et al., 2010). Impairments in emotion perceptions are also prominent in schizotypy. Studies have

found that individuals with elevated negative and disorganized traits (Brown & Cohen, 2010; Morrison et al., 2013) exhibit a systematic bias for perceiving neutral and positive faces as more negative. These deficits, which are common in schizophrenia as well (Green et al., 2008; Le, Holden, Link, & Granholm, 2018), impair the ability to integrate information about others thereby leading to potentially inappropriate or aversive social interactions.

Schizotypy is also associated with reduced quantity and quality of social motivation and behavior. Schizotypy is typically associated with depleted and less diverse social networks along with decreased rates of intimate and satisfactory relationships (Badcock, Barkus, Cohen, Bucks, & Badcock, 2016; Brown, Silvia, Myin-Germeys, & Kwapil, 2007). Personal and contextual factors contribute to this objective social disconnectedness including the previously noted theory of mind and emotion perception deficits, reduced social roles, and potentially stigmatizing and socially distancing behaviors from the general public (Perry, Henry, Sethi, & Grisham, 2011). Moreover, positive schizotypy is partly characterized by social anxiety while negative schizotypy, in turn, is partially defined by social anhedonia, thus suggesting an equifinality toward the deleterious social disconnectedness. Further understanding the etiological processes underlying schizophrenia-spectrum disorders concerning the social environment is critical as social networks begin to diminish before the onset of a first psychotic episode (White, Luther, Bonfils, & Salyers, 2015).

Beyond the structural properties of one's social network (e.g., size, density, frequency of contact) is social support, or the perceptions that one has the existence or availability of people to rely on and from whom one can experience care, empathy, affection, acceptance, and value through supportive behaviors (e.g., hugging, listening ear, advice; Uchino, 2004). Social support is conceptually related to loneliness, which can be defined as the perceived isolation from family,

friends, and the general community (Cacioppo & Hawkley, 2009). Indeed, loneliness in schizotypy is prominent (Badcock, Shah, et al., 2015). However, social support is broader in scope and incorporates the availability of others to aid during times of need rather than solely focused on the degree of inclusion/exclusion with certain others (i.e., loneliness).

Psychotic-like Symptoms, or PLS

Schizotypy is defined, in part, by a trait-like tendency to experience psychotic-like symptoms (PLS), which are of particular interest to the current study. PLS encompass a broad range of subclinical and less clinically distressing psychotic symptoms that include perceptual aberrations (i.e., hearing and or seeing things that others cannot) along with feelings that one is losing control of their thoughts or that familiar things are strange (Barrantes-Vidal, Chun, Myin-Germeys, & Kwapil, 2013). While PLS is a core feature of positive schizotypy, individuals with elevated negative and disorganized schizotypal traits also experience PLS in daily life to a milder degree (Barrantes-Vidal et al., 2013; Chun et al., 2017; Raine, 2006). The study of PLS is clinically important as PLS has been linked with increased liability to experience frank psychosis (Calkins et al., 2017). Given the close ties of PLS and schizotypy, the risk factors for these two constructs overlap significantly, thereby increasing our understanding of the etiology of the schizotypy construct itself. PLS has also been associated with contextual factors such as increased substance use and stress, which themselves are correlates of positive schizotypy.

Mechanisms of PLS

The field has identified promising mechanisms underlying PLS, and hallucinations more generally, ranging from genetic (i.e., FOXP2 gene; Sanjuán et al., 2006) to neurophysiological (i.e., atypical resting-state networks; Alderson-Day et al., 2016; Ford et al., 2014) underpinnings. Stress also appears to play a prominent role in the experience of PLS (Holtzman et al., 2013).

Indeed, researchers have posited a neurodevelopmental, diathesis-stress model for PLS that suggests abnormalities in the hypothalamic-pituitary-adrenal and dopamine systems moderate normative maturation and associations between stress-responsive and dopaminergic brain regions (Trotman et al., 2013). More simply, these models suggest that adolescents and early adulthood who are vulnerable to PLS and frank psychosis, such as schizotypy, are more likely to experience feelings of stress when faced with environmental strain (e.g., daily hassles, major life events, trauma exposure; Bentley et al., 2016). However,s researchers have also long found that social support plays a crucial role in mitigating the deleterious role of stress, which is consistent with the stress-buffering hypothesis. Cohen and Wills (1985) in their landmark review classic noted that perceive social support may prevent or reduce stress appraisals via influences on emotion-linked physiological responses (i.e., mediating the beneficial effects of positive affect, predictability, and self-worth appraisals). Increased social support has been linked with diminished cortisol reactivity in response to a social stressor (Eisenberger, Taylor, Gable, Hilmert, & Lieberman, 2007).

Research by Barrantes-Vidal and colleagues (2013) and others (Schlier, Winkler, Jaya, & Lincoln, 2018; Swendsen, Ben-Zeev, & Granholm, 2011) has provided evidence that state social support, or lack thereof, plays a role in the endorsement of state PLS. Moreover, Aghvinian and Sergi (2018) found that schizotypy was associated with lower perceived social support in cross-sectional studies (i.e., laboratory questionnaires). Multiple studies (Robustelli, Newberry, Whisman, & Mittal, 2017; Sündermann, Onwumere, Kane, Morgan, & Kuipers, 2014) have been conducted examining social support within ultra-high risk and first episode populations – which are typically comprised of adolescent and early adults – exclusively using laboratory questionnaires or clinical impressions. Broadly, these studies have found that poor perceived

social support (i.e., worse relationship quality with family and friends) were associated with aspects of PLS (e.g., unusual thoughts, perceptual abnormalities), suspiciousness, and depression (Aghvinian & Sergi, 2018; Robustelli et al., 2017).

Several reasons may explain why social support an important component in the exacerbation of PLS. First, according to the 'social regulatory cycle' theory (Reeck, Ames, & Ochsner, 2016), a mutual process of regulating negative affect takes place amongst dyads (i.e., social buffer). Higher levels of social support may foster increased feelings of safety that facilitate adaptive behaviors and symptom improvement. However, in the absence of sufficient social resources, negative affective states may be insufficiently regulated leading to an increase in the likelihood that PLS will occur in those at genetically putative high risk. Moreover, social dysfunction has been previously linked with poor internal/external reality testing – a mechanism theoretically underlying hallucinations – in schizophrenia (Divilbiss et al., 2011). Importantly, social connectedness and psychosis, assessed via ambulatory data collection, are connected and both fluctuate over time in a neurotypical sample (Schlier et al., 2018), individuals with high schizotypal traits (Kwapil et al., 2012), and patients with schizophrenia spectrum disorders (Ben-Zeev, Morris, Swendsen, & Granholm, 2012). These studies suggest that state social support may moderate the likelihood that PLS will occur in those with schizotypal traits. Indeed, state social disconnection was a moderator between trait schizotypal traits and psychotic-like symptoms in a non-clinical sample (Barrantes-Vidal et al., 2013). Importantly, interactions between objective social variables (i.e., frequency of social contact) and schizotypy were non-significant, signifying the value of subjective appraisals of social experiences (Barrantes-Vidal et al., 2013). However, there are null findings as well. Chun and colleagues (2017) observed associations between state social support and psychotic-like symptoms a in college sample, but moderation was not found

with schizotypy scores derived from clinical interview. Similarly, Schlier and colleagues (2018) examined PLS in a community sample and observed that perceived social exclusion was associated with some aspects of PLS (i.e., intrusive thoughts, perceptual sensitivity) but not others (i.e., hallucinations) on the same and following day. Positive schizotypy is marked with elevations in social anxiety and general distrust of the public despite a desire for closer social relations (Brown, Silvia, Myin-Germeys, Lewandowski, & Kwapil, 2008). Thus, poor perceived social support may intensify feelings of negative affective states and psychotic-like symptoms in those with a propensity towards increased beliefs of social rejection such as individuals with elevated positive schizotypal traits. This is an important issue to resolve, in that social support has been long recognized as a tool to improve physical and mental health outcomes (Uchino, 2008) and is a staple in many interventions for psychosis (Addington, Piskulic, & Marshall, 2010; Penn et al., 2004; White et al., 2015).

Prior research has evaluated social support as a monolithic influence on PLS. This "nomothetic" model fails to appreciate that social support is multidimensional and likely idiographic in its effects on PLS. Source of support can vary including from family, friends, romantic partners, community ties, co-workers (if employed), or the study body (if attending an academic institution). Parsing apart social support allows for greater specificity of effects and potentially reveals unexpected directions of associations. Much of the research delineating these specific sources of social support (e.g., family, friends, romantic partners) have used laboratory-based, self-report measures such as the Multi-dimensional Scale of Perceived Social Support (MSPSS; Zimet, Powell, Farley, Werkman, & Berkoff, 1990) and the Social Support Questionnaire (Sarason, Levine, Basham, & Sarason, 1983). Not surprisingly, different aspects of social support are more relevant for specific a given outcome or context. For example, support

from a romantic partner is more strongly associated with health benefits for men than support from family or friends (Lewis & Butterfield, 2007). Moreover, social support from a spouse has been found to buffer the negative effects of work stress but has less of an effect on stress from family dynamics (Ryan, Wan, & Smith, 2014). Instead, social support from friends appears to be a greater source of distress relief for issues related to the household likely due to friends being less implicated in family dynamics (Adams, King, & King, 1996). Within clinical populations, Wilcox and colleagues (2010) found that perceived support from a romantic partner and family members, and importantly not from friends and military peers were significantly associated with less severe traumatic symptoms in U.S. veterans diagnosed with post-traumatic stress disorder (PTSD). Shnaider and colleagues (2017) sought to replicate these findings in a clinical trials study for PTSD and hypothesized that increased romantic and family social support would moderate treatment effects. Surprisingly, however, social support from romantic partners was *positively* associated with pre- and post-treatment traumatic symptoms. Shnaider and colleagues (2017) theorized that their sample may have been comprised of individuals with PTSD in more supportive relationships with romantic partners who make additional efforts to be supportive as PTSD symptomatology worsens.

Expressed emotion (EE) is common in schizophrenia and is defined as a family environmental construct that assesses how much criticism, hostility, and/or emotional over-involvement a family member expresses about a patient (Hooley, 2007). Generally speaking, having high levels of EE within the family environment has generally been associated with poorer outcomes for schizophrenia including greater PLS severity and relapse (Butzlaff & Hooley, 1998), employment status (Amaresha & Venkatasubramanian, 2012), number of hospitalizations (Banerjee & Retamero, 2014), and social functioning (Hooley & Hiller, 2000).

Though there has been less research on high EE within schizotypy, studies have shown that they are related to increased depression and distress (Premkumar et al., 2019). As such, high EE can be perceived as low social support (Atadokht, Hajloo, Karimi, & Narimani, 2015; Sadath, Muralidhar, Varambally, Gangadhar, & Jose, 2017). However, results from a landmark study conducted by Rosenfarb, Bellack, and Aziz (2006) demonstrated that for African American patients with schizophrenia, more criticism and intrusive behaviors (i.e., higher EE) were associated with *better* patient outcomes. Specifically, the authors found that increased relatives' critical comments and intrusive behaviors (coded on a collaborative speaking task between patient and their family members) were associated with lower levels of odd or unusual thinking over 2 years (Rosenfarb et al., 2006). This seemingly paradoxical finding was replicated more than a decade later (Gurak & Weisman de Mamani, 2017). Gurak and Weisman de Mamani (2017), using content analysis, found that assertiveness and emotional expressiveness were highly valued in their African American sample and likely interpreted as sincere while Euro-Americans viewed this communication style as loud and hostile. As such, two primary themes in family member speech samples were evident within the high EE family members relative to low EE family members: high-EE family members appeared to be more direct and expressive and more often discussed the importance of family collectivism and interdependence. Finding from Shnaider and colleagues (2017) and Gurak and Weisman de Mamani (2017) highlights potential individual differences in social support to pathological states, which are consistent with idiographic models. To date, most research, even those involving ambulatory techniques, investigate social support and PLS using a global or unidimensional index of social support. This is likely due to the assumptions that etiological mechanisms underlying PLS are putatively equivalent (i.e., nomothetic model) in schizotypy. However, a more granular (i.e., considering

sources of social support) and idiographic approach is needed to understand the complexity of PLS (Docherty et al., 2018; Wright & Zimmermann, 2019).

Past and Present Assessment of PLS

Another salient issue that arises when attempting to understand the complexity of the PLS concerns the historical assessment of PLS, which has primarily relied on laboratory-based self-report questionnaires or clinical interviews such as the Community Assessment of Psychic Experience or the SIPS (Miller et al., 2003; Mossaheb et al., 2012). While the use of these questionnaires and clinical interviews are beneficial in some respects, for example in identifying broad or trait level risk factors for PLS, there are several issues with these assessment methods. First, these broad risk factors are present in many clinical populations, thus limiting their practical utility (Chan et al., 2016; Nielssen, Wallace, & Large, 2017). Second, laboratory-based self-reports, such as recalling instances of PLS within the last 2-4 weeks, suffer from critical limitations including vulnerability to a host of recollection biases (see Trull & Ebner-Priemer, 2009 for review). Third, clinical interviews have been subject to a myriad of reliability and validity concerns (Elvevåg et al., 2016). For example, clinician biases can result in systematically ascribing psychosis-spectrum explanations for culturally distinct behaviors (i.e., normative behavior in certain cultures; Schiffman, Ellman, & Mittal, 2019).

Limited understanding of PLS may also be due to the limited consideration of temporal resolution, or the ability to discern information conveyed across multiple units of time (e.g., seconds, minutes, weeks, years; Cohen et al., 2019). Ambulatory assessment, which involves naturalistic and time-intensive data collection, uniquely facilitates studying the complexity of PLS. Previous ambulatory studies have noted that PLS within individuals fluctuates as a function of a broad range of state-related variables, such as affect and context (Barrantes-Vidal et al.,

2013; Chun et al., 2017; Kwapil et al., 2012). For this reason, it would appear inappropriate to make inferences about an isolated and imminent PLS using static variables that are only distally related. By repeatedly measuring moment-to-moment PLS in the physical and psychological contexts in which they occur, ambulatory data captures an individual's patterns of PLS occurrences and their dynamic predictors on a matched temporal scale, thus leading to potential treatment targets. The few ambulatory studies examining dynamic PLS in the daily lives of schizotypy and the general community (Barrantes-Vidal et al., 2013; Schlier et al., 2018) have collectively noted that contextual factors, namely broadly defined social support, play an influential role in the endorsement of PLS in daily life. What is still unknown, however, is the precise interplay between social support and PLS (i.e., how are the two constructs causally and/or concurrently linked?).

Person-specific Models

PLS are dynamic over time and fluctuate in part as a response to an individual's natural environment. The temporal complexity of PLS may be better understood by using ambulatory assessment techniques, which already have allowed researchers to chart the daily mood, functioning, and general expression of schizotypy using a rich data set. Broadly speaking, ambulatory technologies have been used to remotely track clinically significant symptomatology (Torous et al., 2018) within the last decade. The goal of such endeavors is to support tailored interventions, and more broadly, "precision medicine". Precision medicine can improve the accuracy and ecological validity of diagnosis and symptom assessment at the individual level (Fernandes et al., 2017) and is defined as, "…an emerging approach for treatment and prevention that takes into account each person's variability in genes, environment, and lifestyle". Many ambulatory technologies provide large streams of sophisticated and person-oriented data streams

of clinically significant constructs (e.g., mood, social support, PLS, functioning, impulsivity, suicidality, stress) within the context of an individual's environment and lifestyle. More simply, these large streams of longitudinal data uniquely facilitate modeling within-person (i.e., person-specific) psychological processes – consistent with the notion of tailored interventions. However, current analytic strategies for ambulatory assessments are somewhat antithetical to this endeavor. Historically, ambulatory data has been analyzed by pooling (via means or sums) data across time or individuals to model differences between periods in which psychopathological states, like PLS, did and did not transpire (Trull & Ebner-Priemer, 2009). Collapsing or narrowing assessments across time and individuals increases reliability and minimizes measurement error. However, these collapsing techniques may be inappropriate with ambulatory data as many effects (i.e., mood, social support, PLS) fluctuate over time (Barrantes-Vidal et al., 2013; Kleiman et al., 2017). Thus, aggregate analyses across heterogeneous individuals may yield results that may not apply to even a single individual. More relevant to the current project, nomothetic models of social support associated with PLS may be equivocal (see expressed emotion section above). Social networks are diverse across individuals, and there are likely differences in the presence, strength, and/or direction of the social support-PLS linkage across individuals with their dynamic natural environment. Thus, the putative mechanisms of social support connecting to clinically relevant PLS issues may be person-specific, varying from one individual to another and changing over time. The creation of person-specific, or idiographic, profiles of the functional dynamics between clinical symptoms (e.g., social support and PLS) may be useful for addressing heterogeneity and realizing the potential of a precision medicine approach to psychopathology (Wright & Zimmermann, 2019).

To this end, there has been recent progress towards person-specific models of psychological processes using ambulatory techniques. This coincides with the acknowledgment that individuals are unique, complex, and ever-changing, despite the assumptions of homogeneity made by many researchers and statistical analyses (Molenaar, 2004). Fatseas and colleagues (2015), noted that person-specific risk factors may represent a substantial, but largely hidden, determinant of chronic substance use. In their ambulatory study, Fatseas and colleagues (2015) investigated lagged associations between substance-specific cues (e.g. seeing a syringe) or personal cues unique to that individual (e.g. seeing the specific person with whom the substance is used) with subsequent cravings and substance use the next few hours. They found that only person-specific cues, and not substance-specific cues, were associated with increases in craving and substance use over subsequent hours of the day, suggesting robust and longer duration of these person-specific cues and cravings linkage.

In a collection of studies (Clasen, Fisher, & Beevers, 2015; Fisher, 2015; Fisher, Reeves, Lawyer, Medaglia, & Rubel, 2017), Fisher and colleagues utilized different statistical techniques to model person-specific processes via ambulatory data collection methodology. In one study examining symptomatology within individuals with generalized anxiety disorder, Fisher (2015) investigated person-specific dynamic assessment using person-specific exploratory and confirmatory factor analyses for the identification of latent symptom dimensions. Person-specific factor analyses returned models with 3 (n = 8) or 4 (n = 2) latent factors with excellent fit. In another study, Clasen and colleagues (2015) investigated temporal relationships between low self-esteem and sadness using smartphones. They applied dynamic factor modeling to explore the idiosyncratic structure of cross-lagged regressions for each of their participants. Once each model was constructed, standardized coefficients were extracted from each model for use in

group-level, regression analyses. Using this methodology, researchers found that individuals who demonstrated mood-reactive self-esteem reported higher levels of rumination at baseline, more persistent sad mood over three weeks, and increased depression symptoms at the end of three weeks above and beyond a trait-like index of self-esteem.

Finally, researchers have used a promising statistical approach called group iterative multiple model estimation, or GIMME, that identifies temporal networks that exist at the group (i.e., sample) and individual levels, providing estimates for these relations separately for each individual. More simply, GIMME facilitates simultaneous modeling of idiographic (i.e., person-specific) processes and nomothetic (i.e., general) structure for generalization across people using intensive longitudinal assessments. Foster and Beltz (2018) recently provided a useful primer on the use of GIMME via simulated ambulatory data of 50 individuals. Researchers sought to understand the dynamic relationships between negative affect and alcohol use. At the group level (i.e., nomothetic model), negative affect and alcohol use were associated via two connections concurrently: (1) alcohol use predicted elevated shame, and (2) being upset predicted alcohol use. However, individual networks revealed different associations between negative affect and alcohol use for two exemplary individuals. For an exemplary male, higher levels of alcohol use were generally associated with lower levels of same-day negative affect, suggesting self-medication. However, the exemplary female exhibited *positive* same-day associations between alcohol use and shame and feeling upset, suggesting heightened negative affect on higher alcohol use days. Wright and colleagues (2019) also used the GIMME model with empirical ambulatory data in a sample of individuals with personality disorders who completed daily diaries over 100 days. Constructs used in this daily diary study included functioning, interpersonal dominance, social affiliation, positive affect, negative affect, and stress. Importantly, researchers had no a

priori hypothesis and, instead, sought to showcase the degree of heterogeneity of individuals models. Their group-level results indicated that stress robustly predicted negative affect on the same day even after controlling for the autoregression of prior negative affect as well as the other covariates in the models. Person-specific models revealed dramatic heterogeneity for each participant in the sample in terms of the magnitude of effects, direction, and lagged associations amongst the six constructs. Importantly, Wright and colleagues (2019) provided all person-specific models which highlighted heterogeneity between individuals and how within-subjects analyses can complement between-subjects analyses.

Present Study

No two similarly diagnosed individuals are the same. Individuals vary in presentation, prognosis, and treatment responsiveness due to their unique histories, comorbidities, and biological makeups (Fisher et al., 2017; Molenaar, 2004). Yet, heterogeneous individuals are often assumed to be homogeneous in research and clinical settings.

Much evidence (Millman et al., 2018; Schlier et al., 2018) points to the role of social processes, particularly perceived social support, in the intensity of PLS in schizotypy. Prior research on this matter has historically used laboratory-based questionnaires or clinical impressions, which fails to appropriately capture the dynamic nature of PLS. Moreover, temporally matched predictor variables are needed to understand the contextual vulnerability factors that lead to PLS. Ambulatory studies have been conducted examining associations between perceived social support and PLS in an individual's natural environment, yet results have been mixed (Barrantes-Vidal et al., 2013; Chun et al., 2017). This is reasonable given the complex relationships between *sources* of social support and PLS between and within individuals.

The present study, and first to our knowledge, sought to evaluate the dynamic associations between varied sources of social support and PLS. More specifically, the current study sought to understand the social support network features that underlie PLS and assessed how common this network was across individuals. The present study evaluated how social support across multiple domains (e.g., family, friends, significant other, academic) was related to PLS and assessed how common this network was across individuals by modeling general- and person-specific associations between social support and PLS. This study employed ambulatory assessment methods over 15 days, which provided sufficient longitudinal and "idiographic" data streams for modeling of person-specific psychological processes. Previous literature on the multidimensional social support, primarily using the MSPSS (cited over 7200 times; Zimet et al., 1990), has identified family (1), friends (2), and significant others (3) as vital sources of social support and thus were queried in the proposed study. Furthermore, given that the study investigated social support and PLS in a high-risk sample comprised of college-aged students, an additional important and relevant source of social support was also queried. Academic support is crucial as academic stress among college students has increased in the last decade (Mortenson, 2006). Academic social support (4) from the academic institution was queried as it has been linked with students' academic achievement and well-being (Ullah, 2007).

Study Aims/Hypotheses

Aim 1. Research has shown that decreased perceived social support is linked with increased experiences of PLS (Sündermann et al., 2014). This has been replicated in both cross-sectional studies using laboratory-based questionnaires and in ambulatory studies (Barrantes-Vidal et al., 2013; Millman et al., 2018). Importantly, social support has historically been examined as a unidimensional construct with limited regard to its multiple facets (i.e., sources).

The first aim of the present study sought to replicate previous research and examined the associations between unidimensional (i.e., composite score) of perceived social support and PLS using ambulatory collection methods. It was hypothesized that decreased social support would be linked with PLS at the nomothetic, or general, level.

Aim 2. The second aim of the present study was to extend previous research by examining the different sources of social and their links to PLS. More simply, the present study sought to establish a general (i.e., nomothetic) structure of PLS from intensive longitudinal (i.e., ambulatory) assessments. Etiological mechanisms underlying PLS, such as unidimensional social support, are putatively expected to be common across. As research by Rosenfarb and colleagues (2006) demonstrate, partitioning social support into its different sources may reveal unexpected links with PLS. Based on prior literature, it was hypothesized that decreased social support from family, but not the other facets of social support, would be linked with increased PLS at the nomothetic level.

Aim 3. The third and primary aim of the current study was to model person-specific (i.e., idiographic) processes of PLS from intensive longitudinal (i.e., ambulatory) assessments. This novel analysis, at least in respect to the PLS literature, would reveal heterogeneity across participants in terms of the magnitude of effects, direction, and lagged associations among the social support-PLS linkage and provide further support for tailored interventions within psychopathology. It was hypothesized that the social support sources would exhibit significant autoregressions, or lagged prediction of the same variable. More importantly, the present study was designed to model heterogeneity and reveal person-specific processes of PLS. As such, it was hypothesized that each individual in the current study would have a unique person-specific model that differed from the general structure of PLS.

Methods

Participants and Procedures

This study was approved by the Louisiana State University (LSU) Institutional Review Board. Participants were recruited from the Louisiana State University Subject Pool via the online SONA system and were compensated with research credit that may be applied to undergraduate psychology courses in partial fulfillment of a research assignment. Participants filled out an online version of the consent form and demographic questions along with study questionnaires and infrequency items (Chapman & Chapman, 1983). After completion of these tasks, participants were given instructions on how to download a mobile app (PIEL Survey; Jessup, Bian, Chen, & Bundy, 2012) and complete the ambulatory portion of the study (see below for a description of the ambulatory phase). De-identified data was sent from the mobile app via e-mail (active cooperation of the participant is required) to the research coordinator at the end of their study participation. Exclusion criteria were the following: under the age of 18, not fluent in English, and having a diagnosis or treatment for schizophrenia, or have received inpatient psychiatric treatment (requiring an overnight stay). In all, a total of 86 undergraduates completed both the online questionnaires and ambulatory portions, representing a normative sample in terms of schizotypy and psychotic like-symptoms (PLS).

The current study aims and hypotheses (largely within-person) required an enriched, "high-risk" sample of schizotypy and PLS. Therefore, an inclusion criterion was used to create a psychometric "high-risk" sample. Importantly, this was done before any data analyses. The inclusion criterion was as follows: participants were required to endorse "True" on at least two out of four "critical" items from the Positive subscale of the Multidimensional Schizotypy Scale (see below for MSS description; Kwapil et al., 2018). These four critical items are listed below.

Collectively, these four critical items exhibited either the highest point biserial correlation or highest P [proportion] value with the MSS Positive subscale. This approach (i.e., using critical items) allows for greater sensitivity to identify the "high-risk" sample of schizotypy and PLS. Similar procedures (i.e., superior item-subscale correlations, high discrimination values) were used by Gross and colleagues when they developed a brief form of the MSS (see MSS-B in Gross, Kwapil, Raulin, Silvia, & Barrantes-Vidal, 2018) and the MSS brief form included all the "critical items" used this in this study. Also, the first two items exhibited strong conceptual overlap with the ambulatory measured PLS items (see below for a description of state PLS items). As noted earlier, a total of 86 undergraduates completed both the online questionnaires and ambulatory portions, representing a normative sample in terms of schizotypy and PLS. Twenty-three participants qualified using this inclusion criterion of "critical items". In line with recommendations from simulation studies of primary analyses to recover group and individual models (see Analysis 2 below; Lane et al., 2019), the analyses were limited to those with at least 60 completed sessions (n = 18). One participant was also excluded due to no variance in PLS. The current study, therefore, enrolled 17 participants (see Table 1 for sample demographics; 88% identified as female and 59% identified as White) for this largely within-person analytical study. The following critical items were derived from the MSS Positive subscale.

1. Sometimes when I look at ordinary objects, they seem strange or unreal. [highest point biserial correlation + strong conceptual overlap with state PLS items]
2. I often worry that someone or something is controlling my behavior or thoughts [strong conceptual overlap with state PLS items]
3. I believe that dreams have magical properties. [highest P value]

4. I believe that there are secret signs in the world if you just know how to look for them. [highest P value]

Measures

Schizotypy. The Multidimensional Schizotypy Scale (MSS; Kwapil et al., 2018) was used for the inclusion criteria. The MSS is a 77-item measure that employs a True/False format about the current experiences. The MSS items were selected based on content validity, item response theory, classical test theory, and differential item functioning. The MSS has three superordinate factors: positive, negative, and disorganized. The MSS has high item discrimination and strong internal reliability (coefficient $\alpha > 0.85$ for all subscales, consistent with Kwapil et al., 2018). The study primarily used the Positive schizotypy subscale for inclusion criteria (i.e., psychometric "high-risk" participants) and analyses. The MSS Positive subscale consists of 26 True/False items tapping disruptions in the content of thought (that range from magical ideation to full-blown delusions), perceptual oddities (including illusions and hallucinations), and suspiciousness/paranoia.

Ambulatory Phase. Participants were asked to complete seven daily surveys via a mobile application for 15 days (i.e., potential $k = 105$ per participant; see "Power Analysis" for the rationale of the proposed sampling rate). After completion of online consents and surveys, participants were instructed to install the PIEL Survey application (Jessup et al., 2012) on their smartphones. The PIEL Survey is an open-source EMA mobile app developed for research purposes. They were given extensive instructions on how to complete the ambulatory portion and were in contact with research staff throughout their study participation. Participants were asked to make momentary ratings of mood and multidimensional social support. Importantly, participants were also asked questions regarding the occurrence of PLS in the present moment.

Participants were instructed to complete these surveys seven times daily at equally spaced intervals between 11 a.m. and 11 p.m. for fifteen days. A brief review of questions about the ambulatory social support and PLS items is listed below.

Social Support. The MSPSS (Zimet et al., 1990), a widely used 12 item self-report questionnaire and consists of three sources of social support that includes family, friends, and significant others. As the MSPSS is considered the gold-standard social support questionnaire with strong psychometric properties (Chronbach $\alpha < 0.85$ for each factor; see Zimet et al., 1990), selected MSPSS items that exhibited the highest loading value from their respective factor were used for the current study. Previous research has also noted the importance of academic social support (e.g., institution, faculty members) toward mental health outcomes and functioning for college-aged individuals (Hughes, 2007; Muirhead & Locker, 2008). Thus, data on academic social support was gathered as well. The academic social support items were based on the Social Support at University Scale (Hughes, 2007), which has adequate internal consistency reliability (Chronbach $\alpha = .68$ across two distinct studies; Hughes, 2007; Muirhead & Locker, 2008). An average of these two academic social support items was used in all analyses. Each of the social support items (listed below) was preceded by the stem, "Right now…". All items were rated on a Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

Family
…I get the emotional help and support I need from my family.
Friends
…I have friends with whom I can share my joys and sorrows.
Significant others
…There is a special person in my life who cares about my feelings.
Academia
…I am getting on well with my fellow students
…There is group cohesion at university

Psychotic-like Symptoms. PLS was computed as the highest score (as done in Kwapil et al., 2020) based on five items derived from three previous ambulatory research studies (Barrantes-Vidal, Chun, Myin-Germeys, & Kwapil, 2013; Chun, Sheinbaum, & Kwapil, 2017; Kwapil et al., 2020) involving schizotypy (coefficient $\alpha < .74$ across all studies). As detailed by Barrantes-Vidal and colleagues (2013), psychotic-like symptoms may not be recognized as such by individuals with a psychotic disorder and those at elevated risk for psychotic disorder; thus, studying PLS via self-reports must be accomplished indirectly. Moreover, these specific items represented a wide breadth of odd or unusual experiences (i.e., incorporating sub-clinical delusional beliefs for example) than typical ambulatory assessment questioned related strictly to frank visual or auditory hallucinations, which have a low-base rate within a college-aged sample (Kwapil et al., 2012). Thus, these specific state PLS items had a higher likelihood of occurrences. Second, these state PLS items exhibited strong psychometric properties within the context of ambulatory studies as noted earlier. These items have also been previously used in an enriched schizotypy sample and have been linked with social constructs related to social support (i.e., social stress, feeling close to others, others care about me, alone because not wanted). Each item was rated on a Likert scale from 1 (not at all) to 7 (very much).

Right now my thoughts are strange or unusual.
Right now my sight or hearing seems strange or unusual.
Since the last signal, I have heard or seen things others could not.
Right now I feel that someone or something is controlling my thoughts or actions.
Right now familiar things seem strange or unusual.

Statistical Analyses

Descriptive. This analysis included descriptive statistics aimed at providing information on the experience of state social support and PLS. Significance tests were conducted with key

demographic variables (i.e., age, gender, ethnicity) to ascertain whether effects of interest may be related to these variables. This analysis also focused on the dynamic nature of PLS and perceived social support over time. To examine this, intraclass correlations (ICC) were created for state PLS and social support. ICC is a measure of reliability that reflects both degrees of correlation and agreement between measurement of units that are organized into groups; groups in these analyses were each separate session. Correlations were used to examine the inter-relationships between pertinent study variables.

Analysis 1. Ambulatory data is commonly analyzed using multi-level modeling (MLM) because MLM accounts for the nested nature of ambulatory data (i.e., days nested within-subject). Participants were set as a random factor and state variables were group mean-centered (by testing session). Thus, MLM was used to test whether unidimensional (i.e., composite score) of perceived social support was linked with PLS at the nomothetic level. The analysis was computed using the R "Lme4" package (Bates et al., 2014). Extreme scores (>3.5 SD) were Winsorized (i.e., replaced with values 3.5 SD) for all state variables. Analysis 1 corresponds with the first aim of the present study.

Analysis 2. To understand how multidimensional social support may influence state PLS at the nomothetic level, MLM was used again with participants set as a random factor and state variables were group mean-centered (by testing session). The different sources of social support (i.e., family, friends, significant other, academic) were entered simultaneously, and state PLS was set as the criterion variable. This analysis corresponded to the second aim of the study.

A recent innovative analytic approach, Group Iterative Multiple Model Estimation (GIMME; (Gates & Molenaar, 2012), has emerged as a reliable model-building procedure for arriving at general- and individual-level patterns of effects underlying dynamic processes.

GIMME, which is available as an R package (Lane & Gates, 2017), identifies dynamic relations that exist at the group and individual levels, providing estimates for these relations separately for each individual. Mathematically, GIMME uses unified structural equation models (uSEMs; Gates et al., 2010; Wright et al., 2019), which are a type of structural vector autoregressive model. GIMME estimates both contemporaneous (same measurement occasion) and lagged (e.g., between two consecutive measurement occasions) directed associations between variables by combining structural equation and vector autoregressive models, respectively. GIMME originated in the neuroimaging field (Gates et al., 2010), but has been broadened in scope to incorporate ambulatory data (Beltz et al., 2013). GIMME networks are evaluated using alternative model fit indices (Brown, 2014). Specifically, at the group level, a standard 75% criterion was be used: a connection between two constructs was required to be significant (according to a chi-square difference test with one degree of freedom for an individual's model) for at least 75% of participants to be estimated for everyone in the sample. At the individual level, an optimal solution was selected according to the Akaike Information Criterion (Akaike, 1974). Final models (containing the group- and individual-level connections for each participant) were evaluated with data model fit indices, with two of four required to meet cut-offs to indicate excellent fit (Brown, 2014): root mean square error of approximation (RMSEA) $\leq .05$, standardized root mean square residual (SRMR) $\leq .05$, comparative fit index (CFI) $> .95$, and non-normed fit index (NNFI) $> .95$. Additional details and instructions on the use of the GIMME method within the context of ambulatory assessment were readily available (Foster & Beltz, 2018; Lane et al., 2019). Of note, Foster and Beltz (2018) recently provided a useful primer on the use of GIMME via simulated ambulatory data. Moreover, Wright and colleagues (Wright et al., 2019) provided a more in-depth description of the GIMME model using empirical

ambulatory data in a sample of individuals with personality disorders who completed daily diaries over 100 days. Importantly, Wright and colleagues (2019) provided the GIMME input syntax, individual data files, output files, diagrams, and further GIMME use instructions on an online repository. In sum, GIMME models both inter-individual similarity (via general-level connections) and intra-individual variation (via person-specific models with individual-level connections) which allows for both sample-level inferences and generalization across samples and populations while still while accurately capturing the heterogeneity offered by ambulatory data of individual differences. GIMME represented an appropriate and efficient statistical technique for the proposed project due to its use of uSEM to identity density and direction of concurrent and lagged associations between social support and PLS. Therefore, GIMME was used to model general- and individual-level patterns of effects underlying the dynamic social support-PLS linkage, thus corresponding to the second and third aim of the present study.

One noteworthy assumption of the GIMME model is that the variables of interest are stationary, or have constant mean, variance, and co-variance across time. To account for this assumption, previous research (Foster & Beltz, 2018; Wright et al., 2019) has sampled participants (via mobile assessment) once a day (i.e., relatively equal intervals) over a protracted period (i.e., 100 days). However, it may be appropriate to assume that a longer lag between surveys has an equivalent effect to those shorter lags within surveys. For example, the last measurement occasion on one day and the first occasion on the next day may have the same relationship as those within a survey burst on the same day. If this assumption can be met, then the stationary effects could also be met with some flexibility. While there is some evidence that PLS and social support changes as a function of time (Coppersmith, Kleiman, Glenn, Millner, & Nock, 2019; Kimhy et al., 2017), there is little evidence that the co-variance between these

constructs fluctuate across time. Moreover, previous literature (Kwapil et al., 2012; Oorschot, Lataster, Thewissen, Wichers, & Myin-Germeys, 2012) has observed significant lagged associations for PLS in successive timepoints via ambulatory assessment, suggesting at least some stability in the time course of PLS. Therefore, the assumption of stationary effects for PLS and social support can be met with an ambulatory survey burst methodology (i.e., seven surveys per day for 15 days in the proposed study).

Power Analysis

Power analyses for uSEMs (i.e., the GIMME model) were difficult to estimate given the number of parameters that needed to be accounted for. One alternative method to conduct power analysis for complicated statistical analyses is to use simulated data. Prior research (Gates & Molenaar, 2012; Lane & Gates, 2017) simulated data to determine the minimum of participants and observations (per participant and overall) needed to find a reliable effect under the GIMME parameters. Lane and Gates (2017) used Monte Carlo simulations to demonstrate that GIMME is successful (i.e., reliable and significant effects) for use on data when time series are at least 60 observations (i.e., surveys) along with 5 to 10 continuous variables for a minimum of 10 participants. Previous ambulatory research using college-aged samples (Ashurst et al., 2018; Kwapil et al., 2012; Phillips, Phillips, Lalonde, & Prince, 2018) noted a response rate of around 70% per participant. To account for the potential of missing data (i.e., up to 30%), it is prudent to over-sample in terms of surveys per participant. As such, a minimum of 100 observations per participant was needed (i.e., to account for the potential 30% of missing data) to achieve the required 60+ observations (i.e., surveys) that were demonstrated in Lane and Gates (2017). The current study asked participants to complete seven daily surveys/sessions via a mobile application for 15 days (i.e., k = 105 per participant). As noted earlier, this study enrolled 17

participants and the average ambulatory sessions (i.e., observations) per participant was 87.17, which is above the requisite number of participants and observations per participant seen in the simulation study conducted by Lane & Gates (2017).

Results

Descriptive analyses

See Table 1 for sample characteristics. Associations between demographic variables (e.g., gender, age, ethnicity) and pertinent study variables (i.e., ambulatory state items) that might have informed subsequent analyses were computed. Overall, age was not significantly associated with state social support items or state PLS. Due to the sample size, there was not enough power to conduct group differences analyses for ethnicity and gender on study variables (descriptive statistics based on ethnicity and gender are presented in Tables 2 and 3). Closer examination revealed that individuals who identified as Black (n = 2) reported less state social support compared to participants who identified as White (n = 10) or Other (n = 3), while individuals who identified as male (n = 2) reported more state social support than individuals who identified as female (n = 15). Moreover, individuals who identified as Black and American Indian reported increased state PLS relative to individuals who identified as White or Other. Individuals who identified as female also reported increased state PLS compared to individuals who identified as male. When ethnicity and gender were included in subsequent primary analyses such as MLM analyses, results did not substantially change. In terms of ambulatory assessments, five participants were initially excluded from analyses due to insufficient observations per participant (i.e., < 60 observations); an additional one participant was excluded due to no variability in PLS (i.e., same response on Likert scale at every ambulatory session). Therefore, this study enrolled 17 participants and the average ambulatory sessions (i.e., observation) per participant was 87.17 (11.71), with the minimum and maximum observations as 60 and 103 respectively.

Table 1. Descriptive and demographic data (N= 17)

Variable	*M (SD) or %*
Demographics	
Age	20.29 (3.87)
Gender (% female)	88%
Ethnicity (% Caucasian)	59%
MSS - Positive Schizotypy	7.35 (3.81)[a]
Ambulatory Assessment	
Number of sessions (k)	87.17 (11.71)
Social Support - Family	4.35 (1.95)[b]
Social Support - Friends	4.92 (1.81)[b]
Social Support – Significant Other	4.47 (2.01)[b]
Social Support - Academic	4.13 (1.73)[b]
Social Support - Composite	4.47 (1.58)
PLS	2.50 (1.87)

Note. [a] Possible range: 0 - 26; [b] Possible range: 1 - 7

Table 2. Average of social support composite (within-person) by ethnicity and gender (N = 17)

Ethnicity	Count	Mean	SD
African American/Black	2	3.03	.91
American Indian	1	3.46	-
Asian American	1	4.44	-
Caucasian/White	10	4.23	1.41
Other	3	6.50	.03
Gender			
Female	15	4.34	1.55
Male	2	5.31	1.24

Table 3. Average of psychotic-like symptoms (within-person) by ethnicity and gender (N = 17)

Ethnicity	Count	Mean	SD
African American/Black	2	3.05	1.53
American Indian	1	3.68	-
Asian American	1	1.98	-
Caucasian/White	10	2.64	1.77
Other	3	1.31	.42
Gender			
Female	15	2.55	1.62
Male	2	1.88	.14

Correlations

Correlations were used to examine the inter-relationships between age, positive schizotypy, and state variables (see Table 4). Positive schizotypy exhibited moderate associations between state social support items (r's = -.46 to -.49, p's < .10), with the exception social support from friends (r = -.17, p = .52). Surprisingly, positive schizotypy was not associated with state PLS. Associations between state PLS and state social items were modest and non-significant (i.e., small effect size; all r's <.24). As expected, large associations were observed (i.e., large effect size) among the state social support items (r's = .58 to .89, p's < .05). In subsequent MLM models with state PLS as the criterion variable (see below), multicollinearity did not appear to be an issue as indicated by relatively low VIFs among state social support items (VIFs < 1.5).

Table 4. Bivariate correlations among age and positive schizotypy with average ratings (within-person) of state social support variables and psychotic-like symptoms (N = 17)

	Age	1	2	3	4	5	6	7
1. Positive schizotypy	.18	-	-.49*	-.17	-.48*	-.42^{+}	-.46^{+}	-.07
2. Social Support - Family	.14		-	.61*	.75*	.59*	.86*	-.17
3. Social Support - Friends	-.01			-	.69*	.69*	.86*	-.17
4. Social Support – Sig. Other	.11				-	.58*	.89*	-.23
5. Social Support - Academic	-.36					-	.82*	-.20
6. Social Support - Composite	-.02						-	-.22
7. PLS	.27							-

+ p < .10
* p < .05

ICC

The stability of state variables was examined next. As noted earlier, ICC is a measure of reliability that reflects both degrees of correlation and agreement between measurement of units that are organized into groups; groups in these analyses were each separate session. Temporal stability and reliability estimates using ICC for study variables can be viewed in Table 5. State

PLS were relatively modest in frequency and intensity overall though there was variability (M = 2.50, SD = 1.87). *All* participants reported experiencing state PLS at some point and 76% of participants (13/17) endorsed state PLS ≥ 5 (out of 7) on at least one of their testing sessions. The state PLS score showed modest reliability across sessions (ICC = .68). Regarding state social support variables, the range of ICC values (range = 0.81 to 0.88) indicated a higher degree of stability (i.e., less variability over sessions).

Table 5. ICC values for ambulatory assessment items (N = 17; k = 1482)

	ICC
Social Support - Family	0.84
Social Support - Friends	0.81
Social Support - Significant other	0.84
Social Support - Academic	0.86
Social Support - Composite	0.88
PLS	0.68

Study Aims/Hypotheses

Aim 1. *Associations between unidimensional social support and PLS at the nomothetic, or group, level*

Contrary to expectations, the model was not significant (X^2 = .06, p = .80; see Table 6 and Model 1) and the composite social support index did not significantly predict state PLS via MLM analyses [BE(SE) = -.01 (.04)]. These results suggested that unidimensional state social support was not significantly linked with state PLS at the group level when using ambulatory collection methods.

Aim 2. *Associations between different sources of social support and PLS at the nomothetic, or group, level*

Using MLM, perceived social support from family emerged as the only significant predictor of state PLS when *all* sources of social support (e.g., family, friends, academic, significant others) were entered simultaneously (model: $X^2 = 10.8$, $p < .05$; see Table 6 and Model 2). Consistent with expectations decreased perceived social support from the family was concurrently associated with increased state PLS at the group level [BE(SE) = -.12 (.03), $p < .05$]. As noted earlier, VIF values for state social support items were below 1.5, indicating a relatively low concern of multicollinearity among state social support predictor variables.

Table 6. Multi-level modeling for the prediction of state psychotic-like symptoms by state social support items

Model 1	Fit Statistic - X^2	B	SE	t value
	.06			
Social Support - Composite		.01	.04	.25
Model 2	**Fit Statistic - X^2**	**B**	**SE**	**t value**
	*10.8**			
Social Support - Family		-.12	.03	-2.80*
Social Support - Friends		-.01	.04	-.19
Social Support - Sig. Other		.03	.04	.81
Social Support - Academic		.07	.04	1.62

* p < .05

For GIMME analyses, state variables submitted to analyses included: PLS and the four social support items (e.g., family, friends, significant other, academia). All five autoregressive (i.e., lagged) paths for each state variable were freely estimated for each individual. Coefficients for the autoregressive paths can be viewed in Table 7. Large significant values for the autoregressive effects indicate relative consistency across days for a given variable (holding constant the influence of any other variables that predict the target variable). Conceptually, the autoregressive weight has been described as a measure of inertia or stability in the variable of interest. More specifically, a given session's measure can be predicted well by the prior session's measure on that construct.

Inconsistent with MLM results (see Model 2), GIMME did not detect any group-level connections; that is, there were no identical connections of the same directionality present across the majority (i.e., > 75%; note though that the only criterion was that connections' inclusion significantly improves model fit). Table 7 includes the counts, along with the average and standard deviation of coefficient, of individuals with each possible path with the column variables predicting the row variables. These findings highlight the heterogeneity associations between state social support and PLS. For example, state family social support significantly predicted contemporaneous state PLS (i.e. improved the model fit) in only 1 of the 17 individual models and state family support did not exhibit any significant lagged associations with state PLS. Overall, 76% of individual models (13 out of 17) exhibited at least a significant path between (inclusive of any directionality and time-lag) a social support item and PLS. State PLS was predicted by contemporaneous state social support items in 47% of the models, with each source of social support being linked to state PLS at least in one of the models. When examining lagged associations, state PLS was predicted by at least one of the prior session's state social support items in only 18% of the models. These relatively modest percentages may indicate that PLS arises due to a separate process – apart from poor perceived social support. Interestingly, state PLS predicted multidimensional social support both contemporaneously (29% of the models) and at the next session (i.e., lagged effect, 18% of the models), signaling a directionality (i.e., PLS → social support) that is understudied in the literature. Of note, increased PLS appears to predict poor perceived social support in most cases. However, there were a select few instances in which increased PLS actually predicted *increased* social support (elevated academic social support for one individual and elevated, lagged significant other social support for another individual). The lack of significant group-level findings (i.e., no identical connections of the

same directionality across the majority) clearly illustrates the heterogeneity of the social support – PLS linkage in terms of density and direction of concurrent and lagged associations.

Table 7. Number of individual models with each path present and average strength and standard deviation of coefficient (N = 17)

	Contemporaneous effects (N/M/SD)				
	Social Support - Family	Social Support - Friends	Social Support - Sig. Others	Social Support - Academic	PLS
Social Support - Family	-	4/.39/.07	3/.34/.07	2/.50/.06	**1/-.74/.05**
Social Support - Friends	7/.48/.06	-	5/.28/.12	2/.63/.14	**3/.02/.07**
Social Support - Sig. Others	3/.39/.09	2/.62/.11	-	3/.42/.08	**1/-.10/.04**
Social Support - Academic	1/.20/.06	4/.42/.09	4/.39/.09	-	**1/.35/.09**
PLS	**1/-.33/.09**	**2/-.79/.04**	**4/-.11/.09**	**1/-.48/.08**	-
	Lagged effects (N/M/SD)				
	Social Support - Family	Social Support - Friends	Social Support - Sig. Others	Social Support - Academic	PLS
Social Support - Family	17/.22/.09	2/.09/.08	3/-.10/.09	2/.02/.09	**1/-.26/.08**
Social Support - Friends	1/.24/.09	17/.10/.09	1/.23/.10	0	**1/-.29/.10**
Social Support - Sig. Others	3/-.09/.09	2/.03/.10	17/.29.09	3/-.09/.08	**1/.36/.11**
Social Support - Academic	1/.40/.11	1/.38/.10	0	17/.38/.08	**0**
PLS	**0**	**1/-.24/.08**	**0**	**2/.20/.10**	**17/.22/.09**

Note. Cells reflect the column variable predicting the row variable; bold font reflects associations of interests in the present study

Aim 3. *Examining the different sources of social and their links to PLS using person-specific models of GIMME*

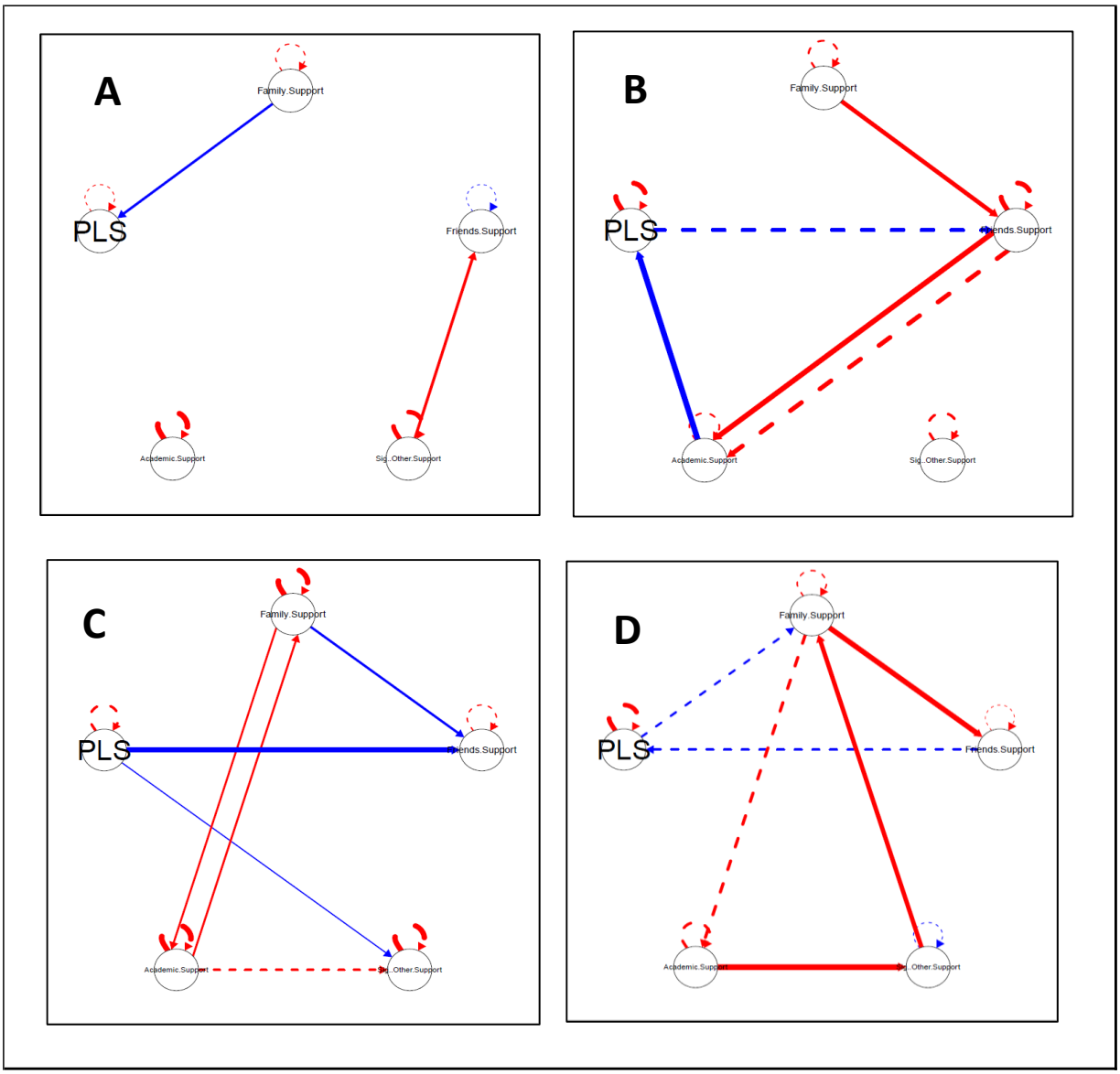
As noted earlier, GIMME produces person-specific (i.e., individual-level) models for each participant in the sub-sample. These individual network models were evaluated with alternative fit indices, with two of four required to meet cut-offs to indicate excellent fit (Brown, 2014): RMSEA ≤. 05, SRMR ≤ .05, CFI ≥ .95, and NNFI ≥ .95. All individual final network models generally fit the data well (Average: X^2=31.73, df=25.35, CFI=.98, NNFI=.97, RMSEA=.05, SRMR=.05). Everyone in the current study had a unique person-specific model and there was no general structure of PLS. For all five variables, estimates ranged from small, nonsignificant, negative values to large, significant, positive values when looking across individuals. A selection of individual models and their "maps" is presented in Figure 1 for demonstration purposes. Red paths indicate positive ("hot") values while blue reflect negative ("cool") values. Path width corresponds to the absolute value. Each participant's map welcomes a thorough interpretation, as might be expected when working with a patient or client in an applied clinical setting (e.g., repeated assessment throughout an intervention). In terms of overarching observations, there was a high degree of heterogeneity in terms of strength, direction, and lagged associations for the global structure of state PLS. That is, some individuals have more significant paths than others, suggesting that state social support components and state PLS are more intertwined, whereas for others these variables function separately or are governed by separate processes. These results suggested that these variables are linked with one another and carry over from session to session in their effects. However, there was high heterogeneity in these effects, with one individual sharing little in common with the next. Thus, a single model

describing the general structure of PLS with group-level effects would fail to address the high degree of heterogeneity in the social support-PLS linkage across individuals.

As shown in Figure 1, inspecting each individual's model and map revealed interesting dynamics about their daily PLS and social support processes. For instance, Participant A had a relatively simple profile, with only poor social support from family concurrently predicting increased state PLS. This indicates that social support from other sources such as friends, significant others, and academics was largely divorced from the family social support and state PLS interplay. However, more intertwined dynamics were observed for Participant B in which poor academic social support predicted concurrent state PLS. A cascading effect then occurred such that increased state PLS in one situation led to poor social support from friends at the next session (i.e., lagged effect), indicating that state PLS tended to influence future interpersonal relationships. Also, it appeared that social support from friends played a central role in daily processes such that it was also connected to PLS, family social support, and academic social support. There also appeared to be associations between the same variables across models, yet they differed in their directionality and temporal sequence. For Participant C, increased state PLS predicted poor concurrent social support from friends and a significant other. This captures potentially the deleterious effects of state PLS causing poor interpersonal relationships, or at least poorly perceived social support. Participant D's individual-level model revealed a different narrative, in that state PLS emerged due to poor social support from friends from earlier in the day (i.e., lagged associations). A hypothetical scenario could be that an interpersonal dispute that occurred at one session led to the unfolding of state PLS over hours to the next survey. Interestingly for Participant D, there appeared to an individual mediation model occurring such that poor social support from friends led to increased state PLS, which in turn led to poor familial

social support at the next session. The temporal profiles of Participant C and D highlight that state PLS as a construct unfolds over time differently for individuals. More specific interpretations could be generated for just these four individuals, though the overarching goal was to demonstrate the richness of person-specific models and show their relevance to the dynamics of social support-PLS linkage in daily life.

Figure 1. Diagrams of person-specific (i.e., individual-level) models for four participants with differing patterns of social support and psychotic-like symptoms associations.



Note. Solid lines depict contemporaneous connections and dashed lines depict lagged connections. There was no group-level structure; thus, all lines depict individual level connections (uniquely estimated for the participant) that also have associated β weights. All four models had excellent or moderate fit. A) Participant with notable poor family social support predicted increased PLS [Model fit: X^2 = 37.43, df = 28, CFI= .97, NNFI = .95, RMSEA= .06, SRMR= .06]. B) Participant with poor academic social support predicted increased PLS, which in turn predicted poorer friends social support at next session [Model fit: X^2 = 34.02, df = 25, CFI= .97, NNFI = .95, RMSEA= .07, SRMR=.06]. C) Participant with increased PLS predicted poorer social support from friends and significant other [Model fit: X^2 = 53.93, df = 24, CFI= .97, NNFI = .95, RMSEA= .11, SRMR=.05]. D) Participant with poorer friends social support predicted increased PLS at next session [Model fit: X^2 = 36.43, df = 24, CFI= .98, NNFI = .96, RMSEA= .08, SRMR=.06].

Discussion

General Summary & Overview

The current study used ambulatory techniques to evaluate the dynamic role of different *sources* of social support (e.g., family, friends, significant other, academic) in the intensity of PLS in schizotypy using general and person-specific models. This was done by leveraging ambulatory assessment methods over 15 days, which provided sufficient longitudinal and "idiographic" data streams for modeling person-specific psychological processes. From a nomothetic (i.e., general structure) perspective, it was hypothesized that decreased social support would be linked with PLS. However, from an idiographic (i.e., person-specific) perspective, it was hypothesized that each individual in the current study would have a unique person-specific model that differed from the general structure of PLS. There were two notable findings from this study. First, contrary to expectations, there was little empirical support that unidimensional social support or even different facets of social support (e.g., family, friends, significant other, academic) were linked with PLS at the group or nomothetic level. Second, person-specific models revealed dramatic heterogeneity across participants in terms of the magnitude of effects, direction, and lagged associations among the social support-PLS linkage. Implications, particularly concerning schizotypy and interventions, are discussed below. Overall, the current findings extended the literature on the social support-PLS linkage in schizotypy and provided further support for tailored interventions within psychopathology.

Nomothetic Analyses of Social Support and PLS

Inconsistent with expectations, the social support composite (i.e., unidimensional) score did not significantly predict PLS in the present study. Moreover, none of the different features of the social support network (e.g., family, friends, significant other, academic) were linked with

PLS at the group level, indicating that the putative mechanisms of social support connecting to clinically relevant PLS varies from one individual to another and likely changing over time. While somewhat surprising, there have been mixed findings in previous ambulatory studies examining associations between perceived social support and PLS (Barrantes-Vidal et al., 2013; Chun et al., 2017), indicating that there are complex relationships between sources of social support and PLS between and within individuals. As noted earlier, parsing apart sources of social support allows for greater specificity of predictive effects of PLS in schizotypy and potentially reveals unexpected directions of associations. For example, it is well established that expressed emotion (EE), defined as a family environmental construct that assesses how much criticism or emotional over-involvement a family member expresses about a patient, is typically associated with detrimental outcomes in schizotypy (Butzlaff & Hooley, 1998; Premkumar et al., 2013). However, Rosenfarb and colleagues (2006), among others (Gurak & Weisman de Mamani, 2017; Kymalainen & Mamani, 2008), observed that patients with schizophrenia who identified as African American experienced *lower* symptoms when they endured heightened criticism and intrusive behaviors (i.e., higher EE) from family members. Subsequent analyses found that assertiveness, emotional expressiveness, and discussion of family collectivism were highly valued in the sample that identified as African American. Thus, the differential associations between expressed emotion (i.e., social support) and symptoms in schizotypy highlight critical individual differences, which are consistent with idiographic models.

There could be several reasons why a group-level connection was not observed in the present study. First, the present data were collected at the onset of physical distancing/remote learning mandates due to novel Corona Virus Disease 2019 (COVID-19; see limitations section below). While emerging research suggests that physical distancing increased loneliness in

college-aged individuals (Wang et al., 2020), it may be that perceptions of social support were either inflated (via increased quantity and quality of interpersonal interactions) or decreased (potentially due to elevated isolation or interpersonal conflict) as individuals presumably spent more time with their relatives (i.e., parents, siblings), peers, or isolated in their respective setting. Moreover, perceptions of social support fluctuate as a response to daily interpersonal interactions. Increased focus on the context (i.e., situation) when maladaptive experiences and impairment manifest would shed insight into important social processes, including perceptions of others' behavior (i.e., perception of situational features) and an individual's interpersonal behavior and affect in the moment. Second, our sample was comprised of a non-clinical sample of college-aged individuals and they may have more resiliency resources (i.e., greater network of support, higher SES) relative to clinical populations, thus limiting generalizability. Using a clinical population (with presumably lower perceptions of social support and higher overall levels of PLS in daily life), researchers may find stronger and more consistent associations between social support and PLS that would support a group-level connection. Thus, future studies should attempt to evaluate general versus person-specific models of the social-support and psychotic symptoms in those with more severe functional deficits and forms of schizotypy (i.e., schizophrenia) with increased precision on the context to which their daily ratings revolve around.

Idiographic Analyses of Social Support and PLS

Social networks are diverse across individuals, and the current study's finding indicated that are substantial differences in the presence, strength, and direction of the social support-PLS linkage across schizotypy within their natural environment (see Figure 1). Of note, 76% of individual models exhibited at least one significant path between a social support source and

PLS, supporting clinical conceptualizations of known social deficits in schizotypy (Cohen, Mohr, Ettinger, Chan, & Park, 2015) and that there exists at minimum a link between these constructs. However, there was a high degree of heterogeneity in which the source of social support facet was linked to state PLS. More specifically, there were both expected and unexpected findings regarding directionality, which are common at the individual level of analyses and have critical clinical implications.

Regarding expected paths and directionality, various sources of social support significantly predicted contemporaneous and lagged PLS. State PLS was predicted by contemporaneous state social support items in 47% of the models, with each source of social support being linked to state PLS at least in one of the models. Overall, social support weakens the relationship between perceived stress and poor health and quality of life (Uchino, 2004). In the absence of social support, there may be increased emotion dysregulation leading to a higher intensity of PLS in schizotypy. Moreover, social dysfunction has been previously linked with poor internal/external reality testing – a mechanism theoretically underlying hallucinations – in schizophrenia (Divilbiss et al., 2011). Thus, poor perceived social support may intensify feelings of negative affective states and PLS in those with a tendency towards elevated sensitivity to social rejection or criticism such as individuals with elevated positive schizotypal traits (Horton, Barrantes-Vidal, Silvia, & Kwapil, 2014; Premkumar et al., 2014).

Interestingly, for select cases (29% of the models), increased social support predicted increased PLS. From a broad view, it may seem counterintuitive that more social support would be linked with increased PLS. However, as previously noted regarding EE, some individuals (notably schizophrenia patients who identified as African American; Rosenfarb et al., 2006) tend to experience elevated symptoms with less EE (i.e., greater social support). Less EE

communicative styles may be perceived by some individuals as less genuine and direct. Alternatively, Shnaider and colleagues (2017) observed that increased social support from romantic partners was positively associated with pre- and post-treatment traumatic symptoms in individuals with PTSD. These authors theorized that their patient sample may have been comprised of individuals in more supportive relationships with romantic partners and family members who made additional efforts to be supportive as PTSD symptomatology worsened.

State PLS also predicted social support both contemporaneously (29% of the models) and at the next session (18% of the models), signaling a directionality (i.e., PLS → social support) that is understudied in the literature. As previously noted, the profile for Participant C (see Figure 1) exemplifies these specific associations as increased state PLS predicted concurrent poor perceived social support from friends and significant others. It may be that the experience of PLS, along with other common schizotypy features such as suspiciousness or social anxiety, causes an individual with elevated schizotypal traits to engage in maladaptive coping strategies such as social withdrawal rather than potentially more adaptive coping strategies such as seeking social support (Beck & Rector, 2003). As noted earlier, schizotypy is marked with deficits in the frequency and intensity of social interactions in daily life (Barrantes-Vidal et al., 2013; Chun et al., 2017) and study findings via idiographic profiles indicated that state PLS led to poor interpersonal relationships, or at least with respect to poorly perceived social support.

Finally, there were select cases where increased PLS predicted increased perceived social support for some individuals, perhaps indicating that a coping mechanism occurred wherein experiencing PLS led some individuals to seek support. Alternatively, emerging research suggests that a subtype of "benign" positive schizotypy may exist in which PLS and other related experiences (e.g., magical ideation, odd beliefs) occur frequently but are not necessarily

distressing. More specifically, for select individuals high in positive schizotypy (and requisite low in negative and disorganized schizotypy), PLS has been linked with increased momentary happiness (Grant & Hennig, 2020) and trait subjective wellbeing (Mohr & Claridge, 2015). Mohr and Claridge (2015) posited that these individuals appear to benefit from adopting a "healthy" cognitive framework to explain and integrate their unusual experiences. This may explain why increased PLS was linked to increased perceived social support from very select individuals in the present study. Understanding the nuanced links between social support and PLS as they vary across individuals is critical as social support is an important treatment target in many interventions related to psychosis (Addington et al., 2010; Penn et al., 2004; White et al., 2015).

Implications for Schizotypy

Overall, schizotypy as a personality organization provides a valuable clinical tool for identifying a particular type of distress and functional deficit and helps direct individuals to appropriate pharmacological and psychosocial treatments and public assistance (Kwapil & Barrantes-Vidal, 2014). Schizotypy also provides key prognostic information regarding role functioning, illness trajectory, and co-occurring psychopathology (Lenzenweger, 2006). However, it is also clear that schizotypy endures issues (i.e., heterogeneity) as a scientific construct that have led to no identified "necessary and sufficient" genetic, epigenetic, neurobiological, or functional underlying mechanism (Docherty et al., 2018; Kirchner, Roeh, Nolden, & Hasan, 2018) and different remission trajectories even after receiving gold standard, empirically-based treatment. Within the DSM 5 schizophrenia spectrum disorders section, there are no diagnostic criteria unique to schizophrenia (i.e., the extreme tail of schizotypy) that are not observed in other disorders (Strauss & Cohen, 2017). These limitations obfuscate how disorders are categorically distinct from each other from a neurodevelopmental perspective and contribute

to less than ideal diagnostic reliability via clinical interviews and patient self-report (Chmielewski, Clark, Bagby, & Watson, 2015). Moreover, schizophrenia encompasses five symptoms reflecting abnormalities in a broad array of behavioral, social, language, perceptual, metacognitive, and affective systems; of which only two symptoms are required for diagnosis (thereby allowing for many different combinations of symptoms to meet criteria). Thus, while the taxonomy of psychopathology has identified important phenotypic manifestations, shifting the classification system of psychopathology could be improved by focusing on the person in *conjunction* with discrete categorical syndromes.

For example, rather than making assumptions or clinical heuristics about what individuals do based on their diagnoses, Figure 1 exemplifies how some individuals do share some patterns of connections based on statistical approaches and associated temporal networks. The profiles for Participants B, C, and D all had significant associations between state PLS and poor social support from friends. However, their profiles also revealed heterogeneity in terms of directionality and temporal links between these constructs. As noted earlier, Participant C's profile revealed that increased state PLS predicted poor concurrent social support from friends, while the opposite was true for Participant B (i.e., poor friendship social support → state PLS). Participant D's individual-level model revealed a different temporal profile from Participant C in that state PLS emerged due to poor social support from friends from earlier in the day (i.e., lagged associations). Thus, focusing on the person, rather than assuming homogeneity among processes and comparing across groups, may be useful as individuals are unique ensembles of dynamic processes. Therefore, appropriate treatment recommendations can be made based upon those unique processes (see *Future Directions* and Fisher et al. studies below). Ultimately, person-centered research may be highly relevant for frontline clinicians as they treat each

patient's unique presentation in all its complexity (e.g., co-morbidities, neurocognitive deficits, socio-economic status, complex environmental systems).

This study yielded individual models that revealed potentially rare patterns and identified higher-value treatment targets that maintained an individual's pathology, or PLS. However, the precise mechanisms that undie the idiographic social support and PLS results remain unclear. A potential explanation may be that poor perceived social support exists as one facet under the broader concept of social stress. Indeed, many types of social stressors have been linked with PLS in schizotypy including expressed emotion as noted earlier. Moreover, Millman and colleagues (2018) observed links between PLS and a composite score of social stress, which was comprised of 10 various self-report items that queried stress and tension in social relationships from the Behavior Assessment System for Children, Third Edition. These items tapped an array of social stressors including loneliness ("I am lonely"), social anhedonia ("My friends have more fun than I do"; "Other people are happier than I am"), and social anxiety ("I don't know how to act around others"). In an ambulatory study, thoughts about rejection were associated with PLS with high positive schizotypal traits (Barrantes-Vidal et al., 2013). Thus, many different types of social stressors have been linked with PLS in schizotypy. There are likely individual differences in various reactions (such as PLS) to different social stressors. Finally, the phenotype of schizotypal traits is highly variant over age, culture, gender, and socio-economic status (Fonseca-Pedrero et al., 2018), potentially explaining some of the heterogeneity of idiographic profiles. Future ambulatory studies would benefit from applying a person-centered approach to first understand the uniqueness of each individual (i.e., idiographic profile comprised of patterns across multiple social stress variables and PLS) to then draw inferences about what is common to many with schizotypy (i.e., a nomothetic "cause").

Future Directions

Many exciting avenues of future research can be conducted within intensive longitudinal data using idiographic approaches. The current study evaluated only one factor (i.e., social support) among various stressors that were relevant to the intensity of PLS. Other social processes beyond social support are linked with state PLS. For example, loneliness – a related but distinct construct from social support – has been linked with state PLS in schizotypy using both cross-sectional and ambulatory studies (Badcock et al., 2016; Le, Cowan, et al., 2019). Also, hallmark social cognitive deficits in schizotypy, such as theory of mind, attribution style, and emotion perception (Cowan, Le, & Cohen, 2019), or other more general cognitive biases like jumping to conclusions (Le, Fedechko, et al., 2019) impairs the ability to integrate and interpret information about others. This may lead to potentially inappropriate or aversive social encounters or interpretations (i.e., suspiciousness). Kimhy and colleagues (2017) leveraged recent advances in ambulatory recording technologies that have allowed for the measurement of physiological variables and demonstrated preliminary support for links between increased autonomic arousal (characterized by decreases in vagal input) and self-reported auditory hallucinations severity. Thus, the general and person-specific structure of PLS can be expanded in future studies to account for these other relevant interpersonal and physiological risk factors. Different questions of PLS will guide variable selection and sample characteristics.

As previously noted, schizotypy is a multidimensional construct that is comprised of three trait clusters of positive, negative, and disorganized (Raine, 2006). These factors differ dramatically in their presentation and are associated with unique patterns of symptoms and impairment (Kemp et al., 2018; Kwapil & Barrantes-Vidal, 2014), with the different trait clusters likely having distinct mechanisms. While PLS is a core feature of positive schizotypy,

individuals with elevated negative and disorganized schizotypal traits also experience PLS in daily life, though to a milder degree (Barrantes-Vidal et al., 2013; Chun et al., 2017). A gap in the literature is the relationship between PLS and the differing trait clusters of schizotypy. Little evidence has been gathered to document the theoretical mechanism between negative or disorganized traits and PLS. Ambulatory studies have found that stressful situations (Barrantes-Vidal et al., 2013) and loneliness (Le, Cowan, et al., 2019) were linked with positive and disorganized schizotypy during daily instances of PLS; however, interactions between negative schizotypy and stress or loneliness did not significantly predict PLS. Thus, future studies can expand nomothetic and idiographic models to understand how PLS occurrence and maintenance differ as function of schizotypy heterogeneity and social support networks.

Treatment outcomes across similarly diagnosed individuals differ dramatically (Fisher, 2015; Molenaar, 2004) and data-driven approaches using person-specific models may help to identify and match effective interventions to specific behavioral processes (Fisher et al., 2019; Torous & Keshavan, 2021). The creation of person-specific profiles of the functional dynamics between clinical symptoms (e.g., social support and PLS) may be useful for addressing heterogeneity and realizing the potential of tailored interventions (Wright & Zimmermann, 2019). More specifically, the use of individualized models to find commonalities in specific processes among individuals may be more advantageous than imposing a top-down structure that may not fit any given patient (Fisher, 2015). The results of such a person-specific assessment might resemble the diagrams presented in Figure 1 and could be interpreted by a clinician or presented for collaborative discussion with a patient across phases of an intervention. Indeed, Thonon and colleagues (2020) used a digital, pilot intervention to target multiple cognitive, emotional, and behavioral processes (e.g., mood, savoring, confidence, energy, step count, effort)

underlying motivation deficits and goal-directed behaviors in schizophrenia. Importantly, they used a single case approach (n = 3), with a pre-, post-, and follow-up ambulatory assessment (5 surveys per day over 14-day windows) to create person-specific, lagged models. These models revealed the effects of the digital intervention on daily motivation levels over time. Overall, the influences of different cognitive, emotional, and behavioral processes on the motivation outcome variable revealed heterogeneous processes across participants, and critically, these processes fluctuated within participants over phases of intervention (comparing baseline, intervention phase, and follow-up).

On a larger scale via an uncontrolled open trial, Fisher and colleagues (2019) collected intensive repeated measures data (4 surveys/day over a 30-day window) on 32 participants (major depressive disorder and generalized anxiety disorder as primary diagnoses) before therapy to perform within-person factor analysis and dynamic factor modeling. The results of these analyses were then reviewed by an expert panel to generate tailored modular treatment plans based on the Unified Protocol for Transdiagnostic Treatment of Emotional Disorders (Farchione et al., 2012). Outcome data indicated that participants responded well to treatment (large effect on reduction of depression ratings) and, importantly, with a fewer number of sessions relative to findings from a meta-analysis on CBT for depression (Johnsen & Friborg, 2015). Fisher and colleagues (2019) suggested that tailored modular therapies can facilitate increased efficiency by avoiding unnecessary treatment components and potentially frontloading the most efficacious modules, thereby helping patients recover faster. The use of intensive, ambulator assessments in clinical trials or other mental health settings facilitates research on ecologically valid mediators of change and the development of tailored interventions that are closely related to daily role functioning. Feasibility studies on the integration of ambulatory or

digital techniques within community mental health centers such as teaching practitioners how to interpret idiographic results in potentially high-risk circumstances are also needed.

Limitations

Several study limitations are worth mentioning. First, idiographic research requires a sample with enough observations per participant and variability in the study constructs. Five participants were excluded from analyses due to insufficient observations per participant. Moreover, the primary analytic procedure used in the current study (GIMME) required sufficient variability in the response options. As noted earlier, one participant was excluded because they repeatedly selected the same response option in PLS, resulting in a constant variable. Future research can potentially prevent low variance with the development of measures sensitive enough to capture day-to-day variability and lengthening the time frame (beyond the 15-day window) which could lead to more robust results. Given that mood, social support, and PLS are characterized by episodic fluctuations, it will be important to complete longer studies (e.g., a month or longer) with a larger sample size to fully capture the stability of these dynamic processes in daily life and to determine the feasibility of long-term monitoring to capture these dynamics. Second, it is important to note that there may be systematic differences in schizotypy that might preclude appropriate responses or compliance. For example, individuals high in schizotypy may not have close friends or acquaintances and social support might be diminished among those higher in schizotypy. Also, additional features of schizotypy such as social anxiety or suspiciousness may hinder meaningful interpersonal relationships, which could lead to perceptions of low social support and willingness to disclose. Thus, future research would benefit from investigating the role of common schizotypy concomitants (e.g., social anxiety, social disconnection, or suspiciousness) play in the social support-PLS linkage when using

ambulatory assessment methods. Third, the current study largely modeled the ambulatory or state items (via the highest loading value from their respective factor) after existing social support measures such as the MSPSS because the purpose of the study was to evaluate dynamic processes and structure of PLS rather than developing novel interview items. While this technique to adapt items from existing questionnaires is common in ambulatory studies (Kimhy, Myin-Germeys, Palmier-Claus, & Swendsen, 2012; Myin-Germeys et al., 2018), meta-analyses need to conducted to evaluate the content validity of this approach. Fourth, the sample was comprised of college-aged students and White female participants. Research has shown differential gender effects related to PLS in schizotypy, with individuals who identified as female reporting increased PLS due to stress (Scott et al., 2008; Stainton et al., 2021). Also, individuals who identified as female generally report increased perceived social support, but less satisfaction (Vaux, 1985). Future studies should attempt to evaluate general versus person-specific models of PLS in a broader sample, including more ethnically and gender-diverse individuals.

Finally, it must be noted that the data were collected just as the novel COVID-19 was declared a pandemic in March of 2020. Specifically, all participant data were collected *after* the sample's undergraduate institution mandated physical distancing and remote learning to prevent the spread of COVID-19. Unfortunately, information on the physical whereabouts of the individuals in the sample (i.e., moved home with parents, isolated in off-campus housing) was not gathered. Preliminary data have suggested that engaging in physical distancing behaviors has been associated with increases in acute stress and loneliness along with symptoms of anxiety and depression in college-aged individuals (Hossain et al., 2020; Wang et al., 2020). Interestingly, Lee and colleagues (2021) observed that psychosis risk was present in 13% of their sample of South Korean residents (i.e., general population), which is a marked increase compared to the

previously reported base rate (6%) before the pandemic. As noted earlier, it is possible that physical distancing (via remote learning) impacted the study sample's psychological functioning and perception of social support, particularly if they were more frequently socially isolated. With that said, a feature of person-specific research is the ability to understand how dynamic domains interface with each other in a specific time frame or context.

Closing & Summary

The current study examined dynamic social support and psychotic-like symptoms in schizotypy and showed that the structure of each individual's processes was unique in terms of the participants in terms of the magnitude of effects, direction, and lagged associations among the social support-PLS linkage. The findings were consistent with calls to understand psychopathology as a contextualized dynamic process that manifests within an individual in a complex system over time and circumstances (Cohen, Mitchell, Docherty, & Horan, 2016; Fisher, 2015). The use of person-specific or idiographic techniques provides the requisite building blocks to generate generalizable models of psychopathological processes that treat the individual as a whole system. An overarching goal is to move beyond identifying which individual or patient has a deficit in a given behavioral, cognitive, affective, or interpersonal domain, but understanding when, in which context, and how dysfunction in each of these domains interweaves with the others (Molenaar, 2004). The emergence of consumer-grade, ambulatory technologies provides an unprecedented opportunity for the collection and profiling of person-specific clinical data that holds promise to improve etiologic theories and long-term outcomes via tailored interventions (Fernandes et al., 2017; Wright & Zimmermann, 2019).

Appendix: IRB Approval

ACTION ON PROTOCOL APPROVAL REQUEST

Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
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TO: Alex Cohen
Psychology

FROM: Dennis Landin
Kinesiology

DATE: February 21, 2020

RE: **IRB#** 4339

TITLE: Social Support and Mental Health in Daily Life

New Protocol/Modification/Continuation: New Protocol

Review type: Full ____ Expedited __X__ **Review date:** 2/19/2020

Risk Factor: Minimal ___X___ Uncertain _____ Greater Than Minimal_____

Approved_____X_____ **Disapproved**_____

Approval Date: 2/19/2020 **Approval Expiration Date:** 2/18/2021

Re-review frequency: (annual unless otherwise stated)

Number of subjects approved: 30

LSU Proposal Number (if applicable)**:**

By: Dennis Landin, Chairman _____

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: When emailing more than one recipient, make sure you use bcc.**

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at http://www.lsu.edu/irb*

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Vita

Thanh P. Le, originally from Los Angeles, California, completed his Bachelor of Science in Psychology from the University of California, San Diego in 2011. During his undergraduate studies, he worked in two research labs examining the effects of alcohol and substance use on adolescent mental health and brain functioning. Before attending graduate school at Louisiana State University, Thanh worked as a Research Assistant for Dr. Eric Granholm's Recovery Research Center at the Veterans Affairs San Diego Healthcare System studying the efficacy of a clinical trial for patients with schizophrenia. Thanh's interest in clinical psychology and serious mental illness (SMI) led him to LSU in 2015, where he is currently studying to complete his Doctor of Philosophy in Clinical Psychology under the supervision of Dr. Alex S. Cohen. His current research interests are driven by two themes: (1) understanding dynamic social dysfunction within SMI and psychosis risk, and (2) leveraging mobile assessments and other digital health solutions in the comprehensive rehabilitation for psychopathology. Thanh is currently completing his predoctoral internship at the UCLA - Semel Institute for Neuroscience and Human Behavior (Major Mental Illness track) and is anticipated to graduate in August 2021. He has accepted a T32 Postdoctoral Fellowship (Clinical Research Training in Schizophrenia and Other Psychoses) at UCLA.