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Neurological soft signs: Effects of trait schizotypy, psychological distress and auditory hallucination predisposition

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ABSTRACT

Schizotypy is regarded as a trait vulnerability for psychotic disorders, yet alone is insufficient for development of a diagnosable disorder. Additional symptoms and psychological distress are necessary for help seeking and transition from an at risk mental state to a clinical diagnosis. The present study investigated the interaction between trait schizotypy, state auditory verbal hallucination (AVH) predisposition, distress and handedness for the expression of neurological soft signs (NSS), a neurodevelopmental vulnerability factor for psychosis. Cluster analysis formed schizotypy groups statistically across the dimensions captured by the SPQ. It was hypothesized that schizotypy and AVH predisposition would interact, resulting in significantly greater NSS. Psychological distress and handedness were hypothesized to be significant covariates, accounting for some variance in the expression of NSS between the groups. A sample of University students ($n = 327$) completed the Schizotypal Personality Questionnaire, Launay-Slade Hallucination Scale, General Health Questionnaire and the Neurological Evaluation Scale (NES). Cluster Analysis revealed four schizotypy groups. Distress was not a significant covariate in any analysis. As expected, those with high overall schizotypy and high AVH predisposition expressed significantly greater Motor-Coordination NSS compared to those with high schizotypy and low AVH predisposition. Within the Mixed Interpersonal and Cognitive-Perceptual Schizotypy cluster, those with low AVH predisposition expressed significantly more Motor-Coordination NSS than those with high AVH predisposition. These findings suggest motor coordination NSS are detectable in schizotypy, and AVH predisposition appears to interact with these traits. This study highlights the importance of considering both trait and subclinical state risk factors when investigating risk for psychosis.

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1. Introduction

Schizotypy is a multidimensional construct which represents a heightened vulnerability for psychotic disorders (Kwapil et al., 2013; Salokangas et al., 2013). The schizotypal personality trait is characterized by unusual experiences of perception, oddities in speech and behavior, disorganised and disrupted thought content, paranoia/suspiciousness and flattened affect (Kwapil and Barrantes-Vidal, 2015). The multidimensional structure of schizotypy is believed to mirror that of schizophrenia, with associated phenomena grouped through factor analysis into positive, negative, and disorganised traits (Raine et al., 1994; Stefanis et al., 2004; Mason, 2015). As a result, schizotypy has become central in the investigation of psychosis risk. However, schizotypal trait is not itself sufficient for conversion to psychosis; transition to psychotic disorders requires multiple psychopathological risk factors (Barrantes-Vidal et al., 2015). Schizotypy has been found to consistently account for more than half the variance associated with subclinical psychotic phenomena, but does not account for all of it (Rössler et al., 2013). Therefore other factors must combine with schizotypal dimensions to contribute to the development of psychotic disorders. As such, research has focused on a multiple hit model for psychosis risk (e.g. Keshavan, 1999; McDonald and Murray, 2000), where neurodevelopmental and trait biological risk factors interact with state risk factors (such as psychological distress, and psychotic-like experiences (PLEs; e.g. auditory hallucinations)), to increase risk for transition. Trait factors here are perceived to be stable and reasonably consistent across time and situations. Trait and neurodevelopmental factors are often present from birth, however it may only be possible to measure or capture them at different points during development. On the other hand, state risk factors fluctuate according to internal or external factors. Trait and state factors can then be combined to gain a perspective of an individual's stable vulnerability as well as their current and transient vulnerability as a result of fluctuating experiences such as distress. Distress can be triggered by events in an individual's environment or other subjective psychological experiences. The presentation of *trait* schizotypy with *state* auditory verbal hallucination (AVH) predisposition is one combination which may lead to the emergence of additional psychological vulnerabilities including psychological distress (Cella et al., 2008), disruptions in metacognitive processes (Barkus et al., 2010), and delusion formation

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(Krabbendam et al., 2005). The greater the number of additional "hits" an individual encounters, the higher the risk of transition to psychotic disorders, with risk increasing in a dose-dependent fashion (Binbay et al., 2012; Pedersen and Mortensen, 2001). The "hit" may lead to the expression of state risk factors, or may indeed be the exacerbation or presence of compounding state risk factors operating against trait vulnerability.

It is recognized that schizotypy has neurodevelopmental origins (Raine, 2006), therefore consideration needs to be given to whether other neurodevelopmental factors are associated with schizotypy. One such neurodevelopmental factor is neurological soft signs (NSS). The presence of NSS along the psychosis continuum has provided important insights into risk for psychotic illness (Bombin et al., 2005; Dazzan and Murray, 2002). NSS refer to subtle neurological irregularities that are not a component of a properly defined neurological syndrome, but rather are believed to reflect inefficiencies in the communication and processing between different brain regions (Chan and Gottesman, 2008). Research has linked NSS to the atrophy and abnormal activation of the cerebellum and inferior frontal gyrus, among other areas (Zhao et al., 2014). Phenotypically, NSS are observed as abnormalities in motor functions, sensory functions, disinhibition and complex motor sequencing (Buchanan & Heinrichs, 1989). The Neurological Evaluation Scale (NES; Buchanan and Heinrichs, 1989) is one of the more common measures of NSS. Factor analyses of the scale have demonstrated solutions ranging from one to five factors (i.e. Mohr et al., 1996; Emsley et al., 2005; Sanders et al., 2005). However, most analyses generally reflect a separation between motor and sensory dysfunction (i.e. Keshavan et al., 2003; Sanders et al., 2000, 2005).

There is a consensus that NSS are significantly more prevalent in schizophrenia patients compared to the general population (Zhao et al., 2013). NSS are consistently found in first episode medication-naïve patients (Mayoral et al., 2008; Zabala et al., 2006), their relatives (Gabalda et al., 2008; Mechri et al., 2009), at-risk mental state (ARMS) patients (Tamagni et al., 2013), and those with the schizotypal personality trait (Barkus et al., 2006; Barrantes-Vidal et al., 2003; Chan et al., 2010b; Kaczorowski et al., 2009). Collectively these results suggest that NSS are a neurodevelopmental marker inherent to psychosis risk (Bachmann et al., 2005, 2014). In schizophrenia NSS are related to the severity of negative symptoms and disorganised behavior (i.e. Mohr et al., 1996; Arango et al., 2000), however are not as conclusively linked to positive symptomatology (i.e. Browne et al., 2000). Concerning schizotypy, positive correlations have been documented between Motor Coordination NSS and overall schizotypy (i.e. Chan et al., 2010b; Mechri et al., 2010); however some studies report non-significant associations (i.e. Bollini et al., 2007; Prasad et al., 2009; Theleritis et al., 2012). Likewise, positive associations have been reported between negative schizotypy and greater overall NSS (i.e. Bollini et al., 2007; Kaczorowski et al., 2009; Theleritis et al., 2012). This is similar to the association found between the negative symptoms of schizophrenia and NSS, however again this finding is not consistent across schizotypal studies (Mechri et al., 2010).

Differences in research design, including the schizotypy and NSS scales used, along with the status of participants (healthy controls versus healthy relatives of schizophrenia patients), may contribute to disparities in findings. It is also possible that NSS are related to another state component of psychosis risk such as AVH predisposition, which is conceptually separate from, but related to, schizotypy. Supporting this assertion are findings of NSS varying according to schizophrenia clinical course (e.g. Bachmann et al., 2005; Prikryl et al., 2012), suggesting they could comprise both state and trait features (e.g. Bachmann et al., 2014). It is proposed that NSS, as neurodevelopmental markers for psychosis risk, would be present in increased levels in those with a trait risk for psychosis (i.e. those with schizotypal traits). Indeed, it is possible that NSS may contribute to the expression of schizotypal traits in an individual. NSS may fluctuate around this heightened baseline depending on co-occurring state risk factors, similar to the variation in NSS seen as a result of clinical course in schizophrenia (Bachmann et al., 2005; Prikryl et al., 2012). Those with heightened NSS may be sensitive to additional taxing from the presence of high emotional states such as distress. The distress may perturb an already taxed system to lead to increased inefficiency and expression of NSS. Those with increased levels of schizotypy also demonstrate poor emotion regulation (for review, see Giakoumaki, 2016) and consequent higher levels of depression and anxiety (e.g. Lewandowski et al., 2006). Indeed, those with schizotypal traits and co-occurring axis 1 psychiatric disorder (most frequently mood disorders and ADHD) have documented significantly greater NSS compared to schizotypy alone (Keshavan et al., 2008; Prasad et al., 2009). Therefore high levels of distress are related to both schizotypy and heightened NSS. To account for this, it makes sense to control for general levels of distress in the current study. Distress, a state variable, is hypothesized to tax an already inefficient neurological system, to result in further disruptions in NSS. Thus state distress *may* exert a co-varying effect on the expression of neurodevelopmental risk variants for psychosis, and is hypothesized to account for some of the differences in NSS expression in schizotypy.

Another commonly reported biological marker along the psychosis continuum is reduced hemispheric symmetry, whereby the typical left hemisphere preference for language functions (e.g. Josse and Tzourio-Mazoyer, 2004) is either reversed or absent in individuals with schizophrenia (e.g. Kawasaki et al., 2008; Bleich-Cohen et al., 2009) and schizotypy (e.g. Mohr et al., 2003; Suzuki and Usher, 2009). In clinical studies handedness is often used as a proxy for hemispheric specialization, with right-handedness usually being indicative of left hemisphere language preference and right hemisphere visual facial processing preference (e.g. Bourne, 2006; Josse and Tzourio-Mazoyer, 2004). The observed reduction in hemispheric asymmetry for those expressing schizotypal traits has implications in the current study. Accordingly, handedness will be assessed and controlled for in order to accurately investigate differences between those expressing higher levels of schizotypal dimensions compared to those who are not.

Previous studies have made use of correlational analyses where one dimension of schizotypy is often considered to be related to one dimension of NSS. However, the dimensions of schizotypy are strongly related to one another and do not occur in isolation. Indeed there is position that an individual who scores highly on all dimensions of schizotypy could be viewed at heightened risk to those who, for example, merely express the negative dimension of schizotypy. An alternative to the previous correlational approach to schizotypy is to utilize cluster analysis to form groups statistically across the dimensions of schizotypy. This allows for individuals to be elevated on more than one schizotypy dimension simultaneously (Suhr and Spitznagel, 2001), therefore complementing correlational approaches rather than conforming to a categorical approach to psychosis risk. Cluster analysis clarifies inconsistencies evidenced by correlational approaches where individuals may have a mixed profile of positive and negative schizotypal dimensions, rather than being elevated on one dimension only (see Barrantes-Vidal et al., 2010 for further discussion). Since the current research is interested in the elevated expression of schizotypy across the schizotypal dimensions this approach is believed to be appropriate. Previous schizotypy research has found the number of clusters to vary from three to four-group cluster solutions (e.g. Suhr and Spitznagel, 2001; Aguilera Ruíz et al., 2008; Barrantes-Vidal et al., 2003; Goulding, 2005). Most often, clusters were characterized as: high overall schizotypy, positive schizotypy (with unusual perceptual experiences and cognitive disorganization characteristics), negative schizotypy (with introverted and anhedonic characteristics), and low overall schizotypy. The current study is using the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) to form clusters, and the number of clusters yielded will be based on model fit. In the context of NSS and schizotypy the cluster approach has been used once previously (Barrantes-Vidal et al., 2003). The findings of this study only reached trend level significance, which may have been due to the use of an ad hoc NSS scale which is to our knowledge, not a validated NSS measure

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