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Rui Tang
Southern Methodist University, rtang@smu.edu

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PATHOLOGICAL PERSONALITY TRAITS AND NEUROPSYCHOLOGICAL FUNCTION

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Pathological Personality Traits and Neuropsychological Function

Rui Tang

Southern Methodist University
Abstract

Traditional categorical diagnosis in DSM-5 has received widespread criticism due to its extreme heterogeneity, poor diagnostic reliability, poor validity and high comorbidity. The alternative trait model introduced the domain of psychoticism, which captures the trait of positive schizotypy. Positive schizotypy has been linked to vulnerability to schizophrenia spectrum disorders, which has shown several areas of neuropsychological dysfunction. Considerable evidence has demonstrated that the dimensional model has superior reliability and validity and ties to important clinical constructs such as neuropsychological function. Little research has tied the dimensional model of personality pathology to neuropsychological domains including processing speed and executive function. The current study examined the association of DSM-5 psychoticism trait and neuropsychological tests performances, specifically Texas Assessment of Processing Speed, Wisconsin Card Sorting Test, and Verbal Fluency in a college student sample. Results indicated that unusual belief is associated with WCST preservative responses, and psychoticism is associated with impaired semantic fluency. Further research is warranted before definite conclusions concerning the impairment of processing speed, set-shifting component of executive function, and psychoticism domain and facets.

*Keywords:* psychoticism, processing speed, executive function
Pathological Personality Traits and Neuropsychological Function

Compared to the traditional categorical model of personality disorders, the trait model of personality pathology included in section III in DSM-5 captures personality pathology on a dimensional level. Specifically, the trait psychoticism primarily captures the positive features of psychotic spectrum disorders including schizotypal personality disorder, schizotypy and schizophrenia. Previous studies have indicated that these psychotic spectrum disorders are associated with impaired processing speed and executive dysfunction. In order to avoid the confounding factors such as diagnostic treatment and medication, as well as to further validate the DSM-5 trait model, current study aims at testing the association of DSM-5 trait psychoticism with processing speed and executive function.

**Dimensional versus categorical model of mental illness**

Many constructs are conceptualized categorically. In other words, things like botany, colors, or medical conditions have been treated as completely homogenous, with absolute defining features and no borderline cases (Frances, 1982). While a categorical system does offer several pragmatic advantages, such as convenience for making decisions of treatment, case communication and conceptualization, it has several drawbacks (Trull & Durrett, 2005). In fact, the reality of a construct is usually continuous, but the measuring instrument functions best at one point of the continuum, and the interpreter thus concludes that this region is a qualitative boundary (Grayson, 1987). Furthermore, in reducing dimensions to typologies, information with important predictive value may be lost (Frances, 1982). In fact, this limitation of categorical diagnosis also applies to mental illness. Indeed, past research has indicated that psychopathology is described more accurately in a dimensional model than a categorical one (Markon, Chmielewski, & Miller, 2011), as a categorical classification system usually has considerable
heterogeneity within diagnostic categories (Nelson, Seal, Pantelis, & Phillips, 2013), high comorbidity rates, low diagnostic reliability (Chmielewski, Clark, Bagby, & Watson, 2015), and the need for frequently used wastebasket NOS diagnosis (Brown & Barlow, 2009; Widiger & Trull, 2007). Personality psychopathology is no exception (Markon et al., 2011; Widiger & Trull, 2007). In fact, over the past two decades the field has gradually moved to dimensional models of personality pathology (Blashfield, 1993). For example, researchers have characterized and redefined personality pathology by using trait models independent of a diagnostic nomenclature perspective, such as Cloninger’s seven factor model (Cloninger, Svrakic, & Przybeck, 1993) and Five Factor Model of personality (Widiger, Trull, Clarkin, Sanderson, & Costa Jr, 1994). Indeed, the dimensional approaches (which have validated higher and lower-order structure of adaptive and maladaptive personality traits) capture personality pathology’s rich complexity more accurately than other models (Clark, 2007; Haslam, 2003; Huprich & Bornstein, 2007; Trull & Durrett, 2005; Verheul, 2005; Widiger & Frances, 2002; Widiger & Mullins-Sweatt, 2005; Widiger & Samuel, 2005).

**Schizotypal Personality Disorder, Psychotic Disorders, Schizotypy, and Psychoticism**

In addition to personality pathology, the field of psychotic disorder has also started to move towards a dimensional approach to psychosis and schizophrenia in recent years (Regier, 2007). In fact, there’s a growing consensus that dimensional views of psychotic disorders may be a more valid representation of the population distribution (Nelson et al., 2013). Schizophrenia and other psychotic spectrum disorders not only share genetic, biological, and neurocognitive abnormalities (Fagerlund, Pagsberg, & Hemmingsen, 2006; Siever & Davis, 2004), they also have the underlying trait of positive schizotypy. Positive schizotypy refers to a constellation of heritable and longitudinally stable personality traits characterized by abnormality in the content
of thought and perceptual oddities, such as hallucination and delusions (A. Fossati, Raine, Carretta, Leonardi, & Maffei, 2003; Kwapil & Barrantes-Vidal, 2015; Nelson et al., 2013; Tarbox & Pogue-Geile, 2011; Wuthrich & Bates, 2006). It has been estimated that between 5% and 20% of the population reports positive schizotypy symptoms, and these symptoms were thought as a source of predisposition to psychosis (Barrantes-Vidal, Grant, & Kwapil, 2015; Ericson, Tuvblad, Raine, Young-Wolff, & Baker, 2011; Kendler, Myers, Torgersen, Neale, & Reichborn-Kjennerud, 2007; Verdoux & van Os, 2002). Moreover, researchers have found that these traits tend to lie on a continuum with no obvious cut-off point to discriminate the presence or absence of the psychotic spectrum disorder (Chmielewski & Watson, 2008; Claridge & Beech, 1995; Krueger & Markon, 2014; Nestadt et al., 1994; however, see Russell-Smith, Maybery, & Bayliss, 2010). Thus, the study of schizotypy offers a dynamic, multidimensional model that is not constrained by diagnostic boundaries. It opens the possibility of examining the nature of the construct with fewer confounding factors (e.g., ongoing medication treatment, multiple hospitalization, prolonged functional impairment secondary to chronic psychosis or social deterioration) that patient samples usually have (Cicero, Martin, Becker, Docherty, & Kerns, 2014; Siever & Davis, 2004). By examining psychotic traits dimensionally, the assessment can be extended to a broader non-clinical population, and thus provides insight in prevention of development of such psychopathologies as well as helps researchers better understand the nature of cognitive impairment associated with schizotypy. The Personality Inventory for DSM-5 (PID-5) was created to assess the DSM-5 alternative dimensional personality pathology model, previous research has demonstrated the reliability and validity of the PID-5 (Hopwood, Thomas, Markon, Wright, & Krueger, 2012). It offers a dimensional, psychologically based model of pathological personality that examines pathological traits from
five personality domains (Kwapil & Barrantes-Vidal, 2015). Specifically, psychoticism is one trait domain that describes unusual beliefs and experiences, eccentricity and perceptual dysregulation, all of which captures positive schizotypy (American Psychiatric Association, 2013). Thus, the domain of psychoticism, and its facets are chosen for current study of positive schizotypy in a nonclinical sample.

**Psychotic Spectrum and Cognitive Ability**

Patients with psychotic spectrum disorders have demonstrated general neuropsychological deficits compared to healthy controls (Aylward, Walker, & Bettes, 1984; David, Malmberg, Brandt, Allebeck, & Lewis, 1997). However, such association is not always consistent and straightforward. While individuals diagnosed with schizophrenia and individuals whose family members have been diagnosed with schizophrenia have shown general IQ impairment, individuals with schizotypal traits have not shown these deficits (Bora et al., 2014; David et al., 1997; Fuller et al., 2002; Meier et al., 2014; Niendam et al., 2003; J. A. O'Connor et al., 2012; Siever & Davis, 2004; Siever et al., 2002; Trestman et al., 1995; Woodberry, Giuliano, & Seidman, 2008). These inconsistent findings may be due to the heterogeneous nature of psychotic spectrum disorders or the multiple dimensions subsumed under general IQ. Therefore, one way to better understand the association is to examine the specific domains of neuropsychological function associated with positive schizotypy (Meier et al., 2014).

One specific neuropsychological functional impairment associated with psychotic spectrum disorders is processing speed deficit (Meier et al., 2014). Processing speed can be measured by the number of correct responses a participant is able to make during a time-limited task (Knowles, David, & Reichenberg, 2014). It represents a general dimension that involves demands on several higher-order processes, i.e. perception, working memory, sustained attention
and visuomotor coordination (Dickinson, Ramsey, & Gold, 2007; Mitropoulou et al., 2005; Van Hoof, Jogems-Kosterman, Sabbe, Zitman, & Hulstijn, 1998). Patients with schizotypal personality disorder, compared to healthy controls or patients with other personality disorders, have shown visual-processing abnormalities, impaired working memory, and limited information processing capacities (Cadenhead, Perry, & Braff, 1996; Farmer et al., 2014; Harvey et al., 1996; Harvey, Reichenberg, Romero, Granholm, & Siever, 2006). In fact, individuals who have their first episode of psychosis already started to show processing speed deficit, indicating its unique association with psychotic spectrum disorders (Leeson et al., 2010; J. A. O'Connor et al., 2012).

While there are many ways to quantify the processing speed deficit associated with schizotypal traits, an easy to administer yet often overlooked method is digit symbol coding (DSC) on Wechsler scales. Despite the narrow measurement approach, it encompasses many higher order cognitive operations including perceptual and decision processing, as well as encoding and transformation of information (Dickinson et al., 2007; Morrens et al., 2008; Van Hoof et al., 1998). Several meta-analyses have found larger effect sizes between patients diagnosed with schizophrenia and healthy controls on the DSC than the effects of other cognitive measures (Henry & Crawford, 2005; Knowles et al., 2014). Even when age, gender and education-level are matched, schizophrenia patients still show the greatest impairment on processing speed index (Michel et al., 2013). Research has also indicated that it is the only index differentiating individuals diagnosed with schizophrenia from their unaffected siblings both before and after the development of the illness (Niendam et al., 2003). Furthermore, studies have shown that DSC impairment appears early in the course of psychosis, compared to other neuropsychological domains, and this deficit remains even with amelioration of psychotic symptoms from treatment (Leeson et al., 2010).
Thus, it seems that processing speed, as measured by Wechsler digit symbol coding, represents the central cognitive deficit in schizophrenia (Knowles et al., 2014). However, some studies did not find information processing impairment in patients with schizotypal traits (Mitropoulou et al., 2005; Park, Holzman, & Lenzenweger, 1995). It is possible that processing speed impairment associated with schizophrenia patients was due to medication effect (Knowles et al., 2014), although there are some other studies that did not find the impairing effect of medication (Braff, 1981; Dickinson et al., 2007; Jogems-Kosterman, Zitman, Van Hoof, & Hulstijn, 2001; Leeson et al., 2010). As such, it is unclear whether the positive schizotypy is associated with processing speed deficits (Farmer et al., 2014; Gooding, Kwapił, & Tallent, 1999; Siever et al., 2002). Furthermore, schizotypal patients tend to have comorbid negative symptoms such as depression, which has been associated, although inconsistently, with poor cognitive functioning (Addington & Addington, 1993; American Psychiatric Association, 2013; Fujino et al., 2014; Jogems-Kosterman et al., 2001). Thus, it is unclear whether it is positive schizotypy or other factors that have contributed to the impairment of processing speed. In order to demonstrate a clearer association between impairment on processing speed and positive schizotypy, it should be examined in a non-clinical population by controlling confounding factors such as usage of antipsychotic medication and chronic hospitalization (Cadenhead et al., 1996; Noguchi, Hori, & Kunugi, 2008).

Secondary to the DSC deficit among psychotic spectrum disorder individuals is impaired performance on semantic fluency on verbal fluency test (Henry & Crawford, 2005). Verbal fluency is a multifactorial task that evaluates the spontaneous production of words under restricted search conditions (Braff, 1981). It includes phonemic fluency and semantic fluency. Phonemic fluency requires the subjects to say as many words as possible beginning with a given
letter, excluding proper nouns or numbers; whereas semantic fluency requires recalling words from the same semantic category (such as animal), beginning with any letter. On both verbal fluency tests, clustering is one important cognitive component. On phonemic fluency, phonemic clustering includes consecutive words that share any phonemic characteristics (such as rhymes), whereas on semantic fluency, semantic clustering occurs when consecutive words belong to a shared semantic subcategory, such as diet (Harvey et al., 2006; Troyer, Moscovitch, & Winocur, 1997). Verbal fluency is one of the most frequently used measurement of executive function (Alvarez & Emory, 2006). Executive function is not general fluid intelligence, nor can it be properly evaluated by traditional intelligence tests (Ardila, Pineda, & Rosselli, 2000; Heitz et al., 2006). Rather, it is the overall hierarchy brain processing that encompasses heterogeneous skills which permits adaptive balance of maintenance and shifting of cognitive and behavioral responses to environmental demands, permitting action control and goal-directed behavior (P. Fossati, Amar, Raoux, Ergis, & Allilaire, 1999; Reichenberg & Harvey, 2007). Thus, executive dysfunction will manifest problems in life such as difficulties with devising, following and shifting plans, all of which can be found among psychotic spectrum disorder individuals (Braff, 1981).

While there are many models of executive function, Stuss and Benson’s model of attention and executive function is unique in that it links different components of executive functioning to different neurological basis, thus it can help generate an initial hypothesis of cognitive dysfunction associated with different neurological basis based on imaging studies (Stuss, Shallice, Alexander, & Picton, 1995). For example, functional imaging studies provided evidence of dysfunction in the dorsolateral prefrontal cortex in psychotic patients (Arabzadeh et al., 2014), and this area is associated with switching, which is an essential component of
executive function (Chan, Shum, Touloupolou, & Chen, 2008). Verbal Fluency is an exemplary measurement that demands mental switching between subtasks (Chan et al., 2008). In this task, switching is defined as the ability to shift efficiently between different phonemic or semantic clusters, and thus it reflects the ability to shift mental sets (Abwender, Swan, Bowerman, & Connolly, 2001; Robert et al., 1998; Russell-Smith et al., 2010). Indeed, schizophrenia diagnosis was also associated with a smaller number of semantic switches. (Robert et al., 1998). In other words, schizophrenia patients tend to have less flexibility in shifting mental concepts. Moreover, schizophrenia diagnosis was associated with more impairment on semantic fluency than phonemic fluency (Bokat & Goldberg, 2003; Brébion, David, Bressan, & Pilowsky, 2006; P. Fossati et al., 1999; Gourovitch, Goldberg, & Weinberger, 1996; J. D. Henry & Crawford, 2004; Knowles et al., 2014; Reichenberg & Harvey, 2007; Robert et al., 1998; Rossell, Rabe-Hesketh, Shapleske, & David, 1999; Sanfilipo et al., 2002).

However, it is unclear whether positive schizotypy has a unique association with the impairment on semantic fluency. One study has shed some light on this problem. In this study, researchers found that schizophrenia patients with delusion had poorer semantic fluency than patients without delusion while phonemic fluency was similarly impaired, proposing that it is delusion rather than the diagnosis of schizophrenia that has weakened the association between unrelated units of words in semantic memory (Rossell et al., 1999). Thus, it highlighted the role of delusion, which is part of positive schizotypy, in impaired semantic fluency performance. Nevertheless, the role of positive schizotypy was inconsistent in past verbal fluency studies. For example, while some studies found that positive schizotypy was related to increased number of correct words on verbal fluency thus indicating high executive function (Robert et al., 1998; Tsakanikos & Claridge, 2005), a majority of studies found positive schizotypy was related to
decreased executive function (Gooding et al., 1999; Leeson et al., 2010; Matheson & Langdon, 2008; Siever et al., 2002). Furthermore, impaired processing speed could contribute to impairment on switching for individuals with schizophrenia diagnosis (Brébion et al., 2006). It is unclear whether schizotypy can explain the impairment on verbal fluency over and beyond the role of impaired processing speed. Therefore, it is hypothesized for the current study that individuals with positive schizotypy traits will show impaired switching on both phonemic and semantic fluency tests.

The impairment of switching can also be tested through a non-verbal test, given that verbal IQ might influence verbal fluency as they are moderately correlated with each other (Ardila et al., 2000). For example, Wisconsin Card Sorting Test (WCST) is a frequently used non-verbal test for switching, and it is also consistent with Stuss and Benson’s executive function model (Chan et al., 2008). Impaired switching on WCST is determined by the number of perseverative responses, which are defined as failure to suppress inappropriate responses due to the inability to inhibit a particular conceptual perspective (Franke, Maier, Hain, & Klingler, 1992; Li, 2004; Nieuwenstein, Aleman, & de Haan, 2001). Past studies have found that individuals with schizophrenia or schizotypal personality tended to have a higher frequency of perseverative responses when completing WCST, compared to healthy controls (Cadenhead et al., 1996; Carew, Lamar, Cloud, Grossman, & Libon, 1997; Haut et al., 1996; Lenzenweger & Korfine, 1994; Reichenberg & Harvey, 2007). The perseverative response might be due to poor insight and inefficiency of solving problems, and thus reflects prominent cognitive impairment (Alvarez & Emory, 2006; Cadenhead et al., 1996). In fact, meta-analyses found that there was a large effect size difference in several WCST scores between schizophrenia and normal controls, specifically on WCST perseverative responses (Haut et al., 1996; Johnson-Selfridge & Zalewski,
2001; Laws, 1999). However, given the heterogeneous diagnostic criteria of schizophrenia, the unique role of positive schizotypy in perseverative responses is unclear. One study found that individuals with magical ideation (part of DSM-5 psychoticism, i.e. positive schizotypy) demonstrated similar level of perseverative responses with individuals with elevated negative schizotypy (Gooding et al., 1999), while some other studies did not find any association between positive schizotypy and poor WCST performance (P. Fossati et al., 1999; Noguchi et al., 2008; Park et al., 1995). Given such inconsistent pattern, it is necessary to examine the unique role of positive schizotypy (i.e. psychoticism) in poor WCST performance, especially impaired switching (Laws, 1999; Nieuwenstein et al., 2001). It is hypothesized that higher level of psychoticism is associated with poorer WCST performance, such as impaired switching, manifested as perseverative responses. Furthermore, this strength of such association is hypothesized to be comparable to the association between psychoticism and impaired switching on verbal fluency.

Given the inconsistent associations between categorical model of psychotic spectrum disorders in DSM-5 and neuropsychological impairment, studying psychoticism traits in the general population can clarify the unique role of positive schizotypy in neuropsychological dysfunction features by excluding confounding factors such as diagnostic treatment, as well as to further validate the DSM-5-dimensional model (Claridge & Beech, 1995; Meijers, Harte, Jonker, & Meynen, 2015).

**Current Study**

**Research Hypothesis**
The literature reviewed above primarily suggested links between cognitive function deficits across several domains and psychotic spectrum disorders. Therefore, this study aims at exploring the associations between DSM-5 trait psychoticism and neuropsychological dysfunctions; specifically processing speed and the executive function, especially switching. It is hypothesized that higher psychoticism, as measured by PID-5, will be related to greater impairment of processing speed and lower executive function, particularly difficulty in switching in verbal fluency, as well as more preservative responses in Wisconsin Card Sorting Test.

**Research Methods**

**Participants.**

Participants were undergraduate students who participated in a larger study for research credits at Southern Methodist University. 107 participants (77.3% female) between age 18 and 28 (M=19.39 SD= 1.43) completed both the online assessment of demographic information and their personality traits through Personality Inventory for DSM-5 (PID-5) and in-person neuropsychological assessment. Participants self-identified as the following races: 7.5% Asian, 2.8% African American, 85% White, and 3.7% More than one race. 5.7% of the participants identified as Hispanic or Latino. As prescribed medications have potentially negative effects on neuropsychological functions, such as psychomotor functioning, concentration, and memory (Biringer, Rongve, & Lund, 2009; Senturk et al., 2007; Stein & Strickland, 1998), medication information is also asked as part of demographic information. The commonly used prescribed medications that have neuropsychological affects are antidepressant, anxiolytics, stimulants, antihypertensives, antiepileptics and antihistamines. In terms of medication usage, 13.1% of the participants are on antidepressants, 4.7% are on anxiolytics, 15.9% are on stimulants, 0.9% are on antihypertensives and antiepileptics, and 13.1% are on antihistamines. The only restricting
criterion is language, in which only people whose first language is English were allowed to participate, as past study indicated that bilingual English speakers had lower receptive and expressive English vocabularies than monolingual English speakers, which might have some influence on verbal neuropsychological tests (Portocarrero, Burright, & Donovick, 2007). No other eligibility requirements, preparation, pre-requisites, disqualifiers, or course restrictions were imposed.

**Measures.**

*Personality Pathology measures.*

*Personality Inventory for DSM-5 (PID-5).* The PID-5 has 220 items which assess 25 facets subsumed within five higher-order domains that capture DSM-5 personality pathology dimensionally (Krueger, Derringer, Markon, Watson, & Skodol, 2012). The Five domains include negative affectivity, detachment, antagonism, disinhibition and psychoticism (American Psychiatric Association, 2013). Each question is answered on a 4-point Likert scale ranging from *very false or often false* (0) to *very true or often true* (3). In current study, only the domain of psychoticism is used. The domain of psychoticism has three facets, namely eccentricity, perceptual dysregulation, and unusual beliefs and experiences. All three facets capture the features of positive schizotypy in psychotic spectrum disorders dimensionally. The PID-5 psychoticism scales have coefficient alphas ranging from .78 to .95 in the sample.

*Neuropsychological Measures.*

Each participant was individually administered a battery of neuropsychological tests by advanced undergraduate research assistants. Each research assistant underwent 2 months of intensive training by a doctoral-level graduate student and passed three mock assessment
sessions before conducting assessment with participants. During training, the research assistants were instructed how to administer and score the tests step by step. Practice examples were given during the training for research assistants to practice, and questions were answered if there was anything unclear. To help ensure valid and reliable assessment, each administration was supervised by the doctoral student if the research assistant has any questions, and reliability checks were conducted throughout the course of the study. To ensure the accuracy of the results, each scoring of the test was checked by two other research assistants until agreement was made among all three research assistants. Weekly meetings were held to address any administration or scoring issues that may have arisen in the previous week. The doctoral graduate student could be contacted to address any questions that the research assistant had.

*Controlled Oral Word Association (COWA)*. It is a verbal fluency test measures phonemic and semantic fluency, both of which assess the switching and clustering component of executive function (Benton, Hamsher, & Sivan, 1989). During the phonemic fluency test, participants were asked to name as many words as they can that begin with a particular letter (i.e. F, A, S.) without giving any proper nouns or numbers. During semantic fluency test, participants will be asked to give as many words in a certain category (i.e. animal, vegetables) as possible within one minute. COWA was selected because of its measurement of cognitive flexibility as a way of assessing executive function. In the phonemic fluency task, clusters are defined as groups of contiguous words that begin with at least the same first two letters, or differ only by one vowel, or words that rhyme, or homonyms (Troyer et al., 1997). In the semantic fluency task, clusters are defined as groups of contiguous words belonging to the same semantic subcategory, including living environment, human use, zoological categories and diet (Carew et al., 1997; Troyer et al., 1997). Switching is calculated as the number of transitions between clusters,
including single words, in the phonemic and semantic fluency tests (Harvey et al., 1996). Cluster size is counted beginning with the second word in the sequence, whereas cluster switch is the transition between adjacent or overlapping clusters where clusters comprise at least two clusters (Abwender et al., 2001). Errors and repetitions will be included in the calculations of cluster size and switching because any word is produced provides information about the underlying cognitive processes regardless of whether or not it contributes to the total correct number of words generated (Troyer, Moscovitch, Winocur, Leach, & Freedman, 1998).

*Wisconsin Card Sorting Test (WCST, Kongs, Thompson, Iverson, & Heaton, 2000).* The WCST is another non-verbal test of the switching component of executive function. It requires that the participants match two decks of 64 cards to one of four key cards, on the basis of three possible categories, namely, color, number and shape. After ten consecutive right responses, the administer will change the matching principle without telling the subject, and the test ends when subjects used all 128 cards or completed all six categories. The variable of interest is the number of perseverative responses, as it indicates the individual’s difficulty in switching as part of executive function. Perseverative responses measure one’s cognitive flexibility (Henry & Crawford, 2005). Similar to switching in verbal fluency, WCST preservation taps into set-shifting nonverbally (Henry, 2006).

*Texas Assessment of Processing Speed (TAPS).* This is a cost-effective measure recently developed to measure processing speed (Grosch & Cullum, 2012). It requires participants to quickly fill in numbers within one minute that are associated with common shapes and has a maximum score of 75. It has been shown to strongly correlate with coding on the WAIS-IV (r > .74). TAPS has been found to be less correlated with digit span than Coding on Wechsler scales. As Digit span is a measure of working memory, it suggests that TAPS may be a purer
measure of processing speed, as digit-shape relations in TAPS may be more difficult to
memorize compared to digit-symbol relations in Coding (Fields, Didehbani, Hart, & Cullum,
2015).

**Procedures.**

Data were collected from a total sample of 107 undergraduate students as part of a larger
study. Participants first spent about an hour completing questionnaires through an online survey.
All participants gave informed consent prior to participation and were informed of their right to
withdraw from the study at any point in time without penalty. All were invited to come to the lab
to participate in the second part of the study, in which they were administered several
neuropsychological assessments (including Wisconsin Card Sorting Test, Controlled Oral Word
Association and Texas Assessment of Processing Speed) by trained research assistants. To
control for potential order effects, test administration order was counterbalanced. Upon request,
participants were presented with a research summary that contained background information as
well as the research hypotheses. Participants were compensated with course credit according to
the rules set by the department. Ethical approval for the study was acquired from the Institutional
Review Board at the university.

**Results**

Descriptive statistics among study variables are displayed in Table 1. Means and standard
deviations of all neuropsychological tests, including Texas Assessment of Processing Speed,
Wisconsin Card Sorting Tests, and Verbal Fluency tests were also displayed in Table 1, and the
results were consistent with previous studies using these tests in a college student sample
(Hammers & Suhr, 2010; Haut et al., 1996; Troyer, 2000; Troyer et al., 1997).
Table 2 displays the psychometric properties of PID-5 psychoticism scale. Alpha ranges from .78 to .95, indicating high internal consistency. Furthermore, average interitem correlation ranges from .30 to .59, indicating that most items are reasonably homogenous, and they do contain sufficiently unique variance so as to not be isomorphic with each other. The mean and standard deviations of the three facets were consistent with previous studies of college students (Krueger et al., 2012; McGee Ng et al., 2016).

Bivariate and partial correlations (Table 3) were conducted to examine the association between psychoticism domain/facets scores and four neuropsychological variables. The Benjamini-Hochberg (BH) procedure was used to control false discovery rate (Benjamini & Hochberg, 1995). The correlation between psychoticism domain and its facets and neuropsychological tests were similar when medication is controlled versus not controlled. Specifically, processing speed, measure by TAPS, was not significantly correlated with the psychoticism domain or any of its facets. Non-verbal executive function, which was indexed by WCST perseverative responses, was significantly and negatively correlated with unusual beliefs facet (r = -0.20). Thus, higher level of psychoticism was associated with poorer WCST performance, specifically impaired switching. As hypothesized, there was a similar association between verbal executive function and psychoticism domain/facets. Semantic switching, which indicated the degree of preservation, was significantly and negatively correlated with the psychoticism domain (r = -0.22), as well as its two facets, namely, perceptual dysregulation (r = -0.25) and unusual belief (r = -0.20). However, phonemic switching was non-significantly correlated with the psychoticism domain and all of its facets.

Table 4-7 displays the multiple regression results. In order to examine the individual contributions of the independent variables to the effect on dependent variables, four multiple
regressions were conducted. The first dependent variable was processing speed score, indexed by Texas Assessment of Processing Speed. In step 1, sex and years of education were entered as predictors, all six types of medication usage were entered as predictors in step 2, and the three facets of psychoticism domain were entered in step 3. In model three, stimulant appeared to have negative impact on processing speed when other variables were controlled, although the model was insignificant in all three steps. The second dependent variable was preservative responses on WCST, and the three steps were the same as in the first dependent variable model. As seen in Table 5, model 3 becomes significant when the three psychoticism facets were added into the model ($\Delta R^2 = .09, p<.05$). Specifically, unusual belief ($\beta = -.50, p<.01$) and antihypertensives ($\beta = -.20, p<.05$) were significant predictors.

Similarly, when semantic fluency switching was entered as dependent variable and the three steps were the same as aforementioned models (Table 6), only step 3 was significant when the three psychoticism facets were entered ($\Delta R^2 = .08, p<.05$). However, none of the three facets was a significant predictor in the model, possibly due to its high inter-correlation between the facets. Finally, phonemic fluency was entered as dependent variable, predicted in three steps with the same variables aforementioned. None of the three steps was a significant model, and none of independent variables was significant predictor.

**Discussions**

The aim of this study is to examine some specific neuropsychological deficits that are associated with psychoticism based on DSM-5 traits models of psychopathology. The goal of current study is aligned with the call of the American Psychiatric Association and the *DSM-5* committee for more research on the Psychoticism domain. It is also aligned with goal of the
National Institute of Mental Health’s Research Domain Criterion Project (RDoC) which highlights cross-cutting dimensional models of psychopathology instead of the current categorical disorders. In current study, processing speed measured by TAPS did not show any correlation with the psychoticism domain and its three facets. It is likely that TAPS is not sensitive enough to capture the impairment that was captured by Wechsler coding in previous studies. In fact, while previous studies demonstrated that patients with psychosis was associated with impaired processing speed, some other studies did not find that information processing impairment is associated with psychoticism traits (Knowles et al., 2014; Mitropoulou et al., 2005). The current study implied that stimulants might have a negative impact on processing speed, and antihypertensives negatively could also impact WCST performances, which are consistent with findings of impairing effect of medication on neuropsychological tests (Knowles et al., 2014). It is also possible that it is dosage and frequency of medication usage, which was not examined in the current study, which could better explain the impairing effects on the neuropsychological test results (Johnson-Selfridge & Zalewski, 2001). What is more, previous studies used TAPS in NFL players with history of concussion (Fields et al., 2015), adults with Alzheimer’s disease and mild cognitive impairment (M. S. Grosch et al., 2012), as well as cancer survivors (Grosch & Cullum, 2012), whereas current study used college undergraduates. Therefore, the range of psychoticism may be too narrow to be captured by TAPS. Thus, it is unclear whether TAPS has the sensitivity and specificity of measuring processing speed in current population of college students.

WCST is a complex cognitive task that involves abstract reasoning, set-shifting and ability to learn (Li, 2004). As hypothesized, the current results indicated that the standardized score of preservative responses on WCST is significantly and negatively correlated with unusual
belief. In other words, the more unusual belief one has, the more preservative responses one makes on WCST. This result is in agreement with previous studies comparing patients with psychotic spectrum disorders and healthy controls on the frequency of preservative responses (Fey, 1951; Franke et al., 1992; Haut et al., 1996; Laws, 1999; Lenzenweger & Korfine, 1994). The current study moved the field forward by demonstrating that the facet of unusual belief, a subcomponent of positive schizotypy, contributes to the preservative responses on WCST. This result is in agreement with the finding that magical ideation was associated with perseverative responses (Gooding et al., 1999). The result also agrees with the proposal in previous studies that thought disorder was related to deficits in set-shifting (Daneluzzo, Bustini, Stratta, Casacchia, & Rossi, 1998; Nieuwenstein et al., 2001). Most measurement in previous studies used symptom measurement or psychotic spectrum disorder diagnosis whereas current study examined the specific traits. Thus, current findings provide some support for neuropsychological differences through the lens of individual differences. This also explained that the low correlation between heterogeneous positive symptoms, in general, and WCST impairment due to symptom specificity (Nieuwenstein et al., 2001).

Preservative responses reflect the inability to shift cognitive sets, and this component of executive function was also measured in semantic switching and phonemic switching. Semantic switching measures the ability to shift from one semantic category to another, and it depends on the integrity of semantic knowledge (Gourovitch et al., 1996). Current findings indicated that semantic switching was significantly negatively correlated with perceptual dysregulation and unusual belief, as well as the psychoticism domain. This finding is consistent with previous studies in which patients with psychotic spectrum disorders showed smaller number of switches than the controls (Bokat & Goldberg, 2003; Gourovitch et al., 1996; Robert et al., 1998).
Although the mechanism of such impairment is unclear, the inability to switch reflects the inability to disengage from the previous category and to shift to a new category (Bokat & Goldberg, 2003). Furthermore, it is important to identify the nature of the failure. Specifically, current study shows that psychoticism trait is only related to semantic switching whereas phonemic switching is intact. However, past studies have mixed results regarding the association between psychotic disorder and phonemic fluency. While some studies have shown that schizophrenia patients produced more phonemic words compared to healthy controls (Gourovitch et al., 1996), other studies show that schizophrenia patients are also impaired on phonemic fluency (Rossell et al., 1999). Moreover, while previous studies (P. Fossati et al., 1999; Rossell et al., 1999) have compared semantic switching among different disorders (e.g. depression, different types of schizophrenia), future studies should examine whether this impairment is unique to individuals with psychoticism traits, or is also commonly seen among other pathological personality traits.

In summary, while current study did not find any association between processing speed and psychoticism traits, current study did confirm that schizotypal traits have been related to deficiency in both nonverbal and verbal executive function tests. Specifically, individuals with higher schizotypal traits have demonstrated a disproportionately greater deficits on preservative responses on WCST and lower switching on semantic fluency.

There are some limitations to this study. A possible limitation of the results is the relatively small sample. Although type I error is reduced by adopting the Benjamini-Hochberg procedure, current results are preliminary and need to be replicated in larger populations. Current study primarily examined processing speed and executive function, and therefore, the issue of global IQ deficit was not addressed. Further research is warranted before definite conclusions
concerning the impairment of processing speed, set-shifting component of executive function, and psychoticism domain and facets.
Reference


obsessive-compulsive disorder symptoms, dissociative tendencies, and normal personality.

*Journal of Abnormal Psychology, 117*(2), 364.


Table 1  *Participant Characteristics*

<table>
<thead>
<tr>
<th>Variables</th>
<th>M(SD)</th>
</tr>
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<tr>
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</tr>
<tr>
<td>Education (in years)</td>
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<tr>
<td>Semantic_fluency_switches</td>
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<td>Phonemic_fluency_switches</td>
<td>28.85 (6.04)</td>
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</tbody>
</table>

*Note. N=107. WCST=Wisconsin card sorting Test.*

Table 2  *Descriptive Statistics for the PID-5 facets in the combined sample*

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<tr>
<th>Scale (no. of items)</th>
<th>M</th>
<th>SD</th>
<th>α(AIC)</th>
</tr>
</thead>
<tbody>
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<td>0.95 (.59)</td>
</tr>
<tr>
<td>Perceptual_Dysregulation (12)</td>
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<td>0.48</td>
<td>0.84 (.30)</td>
</tr>
<tr>
<td>Unusual Beliefs (8)</td>
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<td>0.48</td>
<td>0.78 (.31)</td>
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</tbody>
</table>

*Note. N=104. PID-5=Personality Inventory for DSM-5 (Krueger et al., 2012); AIC= Average interitem correlation.*
Table 3 PID-5 Domain/facet and neuropsychological variable correlations controlling medication (below the diagonal) versus without controlling medication (above diagonal)

<table>
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<tr>
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<td>.00</td>
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*Note.* N = 96, *p value is considered significant via Benjamini-Hochberg procedure.
Table 4: Hierarchical Regression Models Estimating Effects of Psychoticism on Processing Speed (n = 104)

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<th>Model 3</th>
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<td>SE</td>
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R²  | ΔR²  | p      | R²  | ΔR²  | p      | R²  | ΔR²  | p      |
---|-----|-------|---|-----|-------|---|-----|-------|
.01 | .01  | .567  | .01 | .01  | .567  | .01 | .01  | .567  |

*p < .05, **p < .01
Table 5: Hierarchical Regression Models Estimating Effects of Psychoticism on Preservation Responses on WCST (n = 104)

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*p < .05, **p<.01
Table 6: Hierarchical Regression Models Estimating Effects of Psychoticism on Semantic Switching (n = 104)

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*p < .05, **p < .01
Table 7: Hierarchical Regression Models Estimating Effects of Psychoticism on Phonemic Switching (n = 104)

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</tr>
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*p < .05, **p < .01