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THE RELATIVE SENSITIVITY OF AN OLFACTORY IDENTIFICATION DEFICIT IN INDIVIDUALS WITH SCHIZOTYPAL PERSONALITY FEATURES

by

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B.S. Duke University, 2002

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ABSTRACT

Olfactory identification deficits have received recent attention as a potentially useful endophenotype for schizophrenia. Examination of this deficit in individuals with schizotypal personality features (SPF) offers an alternative approach to multiple confounds present when examining individuals with schizophrenia. The aim of the current study was to compare the relative sensitivity of performance on measures of olfaction identification and sustained attention to the presence of SPF. Twenty-six undergraduates were defined as having SPF based on scoring in the top 10% of the Abbreviated Schizotypal Personality Questionnaire (SPQ-B; mean age 19.6, SD = 1.1; 62% female). These individuals were compared to twenty-six controls (scoring lower than half a standard deviation above the mean; mean age 19.8, SD = 1.6; 62% female). All participants were administered the Schizotypal Personality Disorder (SPD) section of the Structured Clinical Interview for DSM IV Axis II Personality Disorders (SCID-II). In addition, participants were administered the Brief Smell Identification Test (B-SIT) and a six-minute degraded-stimuli Continuous Performance Test (CPT). Group differences in performance indices of the CPT did not approach statistical significance. Similarly, there were no statistically significant group differences for males or females in performance on the B-SIT.

Correlational analyses examined cognitive performance with a dimension score derived by summing quantitative ratings from the SPD items on the SCID-II. The SPD dimension score showed a statistically significant positive correlation with several performance indices of the CPT, including omission errors ($r_s(52) = .51$, $p < .001$) and commission errors ($r_s(52) = .38$, $p < .005$). In contrast, the B-SIT scores were not correlated with the SPD dimension score for males or females.

Contrary to our hypothesis, results from the current study suggest that olfactory identification deficits may not represent a robust endophenotype consistently found in samples with schizotypal personality features. With regard to sustained attention, our differential findings suggest that schizotypal traits may be more adequately assessed through an interview by trained clinicians who use clinical judgment to determine the presence of phenotypic aspects of SPD (e.g., SCID-II), rather than relying on self-report measures (e.g., SPQ-B). Implications as well as limitations and future directions of these findings are discussed.

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CHAPTER ONE: INTRODUCTION

Schizotypal personality disorder (SPD) includes a chronic pattern of symptoms that begin by early adulthood. Though individuals with SPD are not at risk for developing schizophrenia, they experience a constellation of symptoms that appear to be attenuated forms of symptoms seen in schizophrenia. These symptoms include perceptual distortions, magical ideation, interpersonal deficits, and odd or eccentric behavior. Past research has suggested a genetic relationship between schizophrenia and SPD, as SPD is diagnosed in approximately 10 to 15% of first-degree relatives of individuals with schizophrenia (American Psychiatric Association, 2000; Cadenhead & Braff, 2002; Silverman, Siever, Horvath, & Coccaro, 1993).

Individuals with SPD and schizophrenia have shown similar deficits across several neurobiological and behavioral markers. These biobehavioral markers have been referred to as endophenotypes and reflect characteristics not apparent to the naked eye that are thought to be a consequence of genes related to the disorder (Cadenhead & Braff, 2002). Some of these endophenotypes include structural brain differences (Kawasaki et al., 2004), cerebral asymmetry (Takahashi et al., 2002), information processing deficits (Braff, 1981; Cadenhead, Swerdlow, Shafer, Diaz, & Braff, 2000), thought and perception disturbance (Perry, Minassian, Cadenhead, Sprock, & Braff, 2003), eye-tracking impairment (Keefe et al., 1989; Siever et al., 1990), and spontaneous movement abnormalities (Walker, Lewis, Loewy, & Palyo, 1999).

Findings involving individuals with schizophrenia have been difficult to interpret due to the possibility of confounding effects related to the use of antipsychotic medications, chronicity of psychotic illness, hospitalization duration, and active symptom effects. Therefore, research in populations with similar genetic risk, such as individuals with SPD, offers an alternative approach that can avoid these potential confounds. Additionally, research on endophenotypes in

schizophrenia and schizophrenia spectrum disorders is useful in determining not only a particular trait related to a gene but also the location of that gene. Long-term benefits to identifying schizophrenia-related genes include prevention strategies and improved treatment (Bedwell, Esposito, & Miller, 2004). Gene identification can also help identify what cognitive faculties remain intact and thus serve as protective factors that prevent the full expression of schizophrenia symptomology (Raine & Lencz, 1995). Despite these benefits, existing endophenotypes for schizophrenia have not been sufficiently sensitive and specific to help in this regard (Keri & Janka, 2004), indicating a need for refinement of existing endophenotypes and development of new ones.

CHAPTER TWO: LITERATURE REVIEW

Olfaction and Schizophrenia Spectrum Disorders

Although individuals with schizophrenia experience deficits across several domains of cognitive and social functioning, olfactory deficits are one particular endophenotype of interest found in individuals with schizotypic personality features (Park & Schoppe, 1997) and schizophrenia (Martzke, Kopala, & Good, 1997; Moberg et al., 1999). The olfactory system is unique from other sensory systems because of its close association to memories, emotions, and moods. In addition, the olfactory system is linked to several brain systems and is mediated by cognitive and emotional domains in the brain. Mediation occurs via the amygdala and the olfactory complex which send olfactory information to other parts of the brain (Brodal, 1998). One example is the olfactory system's reciprocal relationship with the hypothalamus via the amygdala. This connection is an important one as the hypothalamus governs digestion and appetite in the body. Olfactory pathways are also connected with other brain structures, including the hippocampus and thalamus (Brodal, 1998). Within the olfactory system, the olfactory bulbs are responsible for the majority of the sensory information processing and play an important role in odor discrimination. Only a few synapses lie between the receptors in the olfactory epithelium and the primary olfactory complex establishing one of the most direct connections between the sensory environment and the brain (Moberg et al., 1999). Therefore, assessment of olfactory functioning may be one of the most noninvasive and direct measures of neurological functioning in these related pathways.

Olfactory processing has been studied in a variety of different ways ranging from olfactory identification, olfactory acuity, olfactory discrimination, to olfactory recognition memory. Olfactory identification refers to the ability to identify an odor from several alternative

choices while olfactory acuity refers to the lowest concentration at which an individual is able to detect a particular odorant. Typically, forced-choice tasks are used to assess olfactory identification while olfactory acuity has been measured using serial dilutions of specific odorants. Olfactory discrimination differs from identification in that individuals are typically required to choose a target odor from a series of odorants in which all odors are identical except for one. Measures of olfactory discrimination require intact acuity but not identification of the odor (Martzke et al., 1997). Olfactory recognition memory can be assessed using a task in which participants are presented with an odorant and then asked to distinguish the odor from a set of odorants after a short or long delay. In individuals with schizophrenia, numerous studies have demonstrated deficits on tasks of olfactory identification (Brewer et al., 2001; Goudsmit et al., 2004; Houlihan, Flaum, Arnold, Keshavan, & Alliger, 1994; Kohler et al., 2001; Kopala, Good, Martzke, & Hurwitz, 1995; Malaspina et al., 2002; Malaspina et al., 1994; Moberg et al., 1997; Serby, Larson, & Kalkstein, 1990; Stedman & Clair, 1998; Wu, Buchsbaum, & Moy, 1993). Research on olfactory acuity and olfactory memory recognition in patients with schizophrenia has led to inconsistent findings partially due to the lack of reliability in olfactory threshold tasks and the scarcity of published research on olfactory memory (Doty, McKeown, Lee, & Shaman, 1995). Deficits in odor memory in patients with schizophrenia have been reported in two published articles (Campbell & Gregson, 1972; Wu et al., 1993). Several studies on olfactory performance in schizophrenia have measured olfactory sensitivity, with results ranging from hypersensitivity (Bradley, 1984; Kopala, Clark, & Hurwitz, 1992; Sirota et al., 1999) and normal sensitivity (Geddes, Huws, & Pratt, 1991; Good, Martzke, Honer, & Kopala, 1998; Kohler et al., 2001; Kopala et al., 1992; Striebel, Beyerstein, Remick, Kopala, & Honer, 1999) to

hyposensitivity (Gross-Isseroff, Stoler, Ophir, Lancet, & Sirota, 1987; Serby et al., 1990; Sirota et al., 1999).

Sirota and colleagues (1999) have suggested that olfactory deficits in individuals with schizophrenia are exacerbated by the use of neuroleptic drugs. In their study, olfactory detection threshold sensitivity in individuals with schizophrenia was significantly impaired during a drug-free period, but medication further decreased olfactory sensitivity in these patients. However, others have found no moderating effects of medication status (Brewer, Edwards, Anderson, Robinson, & Pantelis, 1996b; Kopala et al., 1992; Wu et al., 1993) or smoking (Brewer et al., 1996b; Kopala et al., 1992). In one study, individuals experiencing schizophrenia for a longer duration of time exhibited greater olfactory deficits when compared to younger individuals with schizophrenia (Moberg et al., 1997). The authors noted that older individuals had used neuroleptics for a longer duration and were not able to rule out the impact of neuroleptic use on olfactory performance. This research suggests that individuals with schizophrenia possess deficits in olfactory function that may be further impacted by the use of neuroleptic medication.

Research on neurobiological and neuroanatomical features of olfactory dysfunction in individuals with schizophrenia reveal similar results. In a study by Turetsky et al. (2000), olfactory bulb volume of individuals with schizophrenia was measured using magnetic resonance imaging (MRI) scans. When compared with controls, individuals with schizophrenia had a 23% smaller bulb volume. With regard to structural differences in brain structures involved in olfaction, it has also been reported that the size of the hippocampus and amygdala are abnormal in individuals with schizophrenia (Exner, Boucsein, & Degner, 2004). A recent study on microtubule-associated protein 2 (MAP2), a marker of neuronal differentiation, was conducted with a focus on MAP2 expression in the glomerular layer of the olfactory bulb in individuals

with schizophrenia. Results obtained from the study indicated that subjects with schizophrenia display a reduced MAP2 expression when compared with healthy controls suggesting that neuronal structure is dysregulated in this primary olfactory region (Rioux, Ruscheinsky, & Arnold, 2004). Postmortem research on the olfactory epithelium in individuals with schizophrenia revealed abnormal densities and ratios of olfactory epithelium neurons (Arnold et al., 2001). Furthermore, olfactory event-related potentials may also be abnormal in individuals with schizophrenia (Becker et al., 1993). Overall, these findings suggest that behavioral deficits in olfaction may be associated with structural and functional abnormalities in the olfactory bulb.

Nonpsychotic relatives of individuals with schizophrenia also have been shown to exhibit similar yet attenuated neuropsychological deficits which appear to increase in severity with the degree of genetic relationship (Cannon et al., 1994; Faraone et al., 2000; Kremen et al., 1994). First-degree relatives have displayed deficits in auditory sensory gating (Waldo, Adler, & Freedman, 1988) and eye movement dysfunction (Levy, Holzman, Matthysse, & Mendell, 1993), as well as abnormalities in structural brain imaging (Staal, Hulshoff Pol, Schnack, van der Schot, & Kahn, 1998) (in addition to many other endophenotypes of schizophrenia). Behavioral studies also indicate that relatives of persons with schizophrenia have deficits in olfactory identification ability which were not accounted for by smoking habits, age, or sex (Kopala et al., 2001). Turetsky, Moberg, Arnold, Doty, & Gur (2003) compared MRI scans of olfactory bulbs in first-degree relatives of individuals with schizophrenia to a control group and found that the relatives displayed decreased right olfactory bulb volume despite no differences between left olfactory bulb volume. In addition, a recent study found that affected and unaffected monozygotic twins discordant for schizophrenia performed significantly lower on tasks of olfactory identification in comparison to healthy, unaffected co-twins (Kopala, Good, Torrey, & Honer, 1998). However,

performance on the olfactory identification tasks did not differ between the affected and unaffected twins discordant for schizophrenia. These findings suggest that olfactory deficits may reflect genetic vulnerability for schizophrenia.

Given the purported deficits in olfactory ability in individuals with schizophrenia and their first-degree relatives, it could be expected that individuals with schizotypal personality features also exhibit similar deficits on tasks of olfaction. One study tested olfactory threshold and olfactory discrimination in individuals with psychometrically defined schizotypy (Mohr, Rohrenbach, Laska, & Brugger, 2001). Schizotypy was measured using scores from the Magical Ideation scale designed by Eckblad and Chapman (1983). Results from this study revealed elevated thresholds for males scoring high on the Magical Ideation scale. These findings were not found in females, and differences in olfactory discrimination between groups did not approach statistical significance. It appears that only one study has examined the relationship between olfactory identification and schizotypal personality symptoms in particular. Park and Schoppe (1997) assessed olfactory identification and olfactory acuity in males and females scoring high on the Schizotypal Personality Questionnaire (SPQ: Raine, 1991), a well-established measure for identifying individuals at risk for meeting diagnostic criteria of SPD. Results from their study showed that males scoring within the top 10% on the SPQ showed deficits on the University of Pennsylvania Smell Identification Test (UPSIT: Doty, Shamam, & Dann, 1984), a task used to measure olfactory identification. Additionally, comparisons between the negative factor of the SPQ (interpersonal deficits) and UPSIT errors in schizotypic males showed a statistically significant positive correlation. Males and females with schizotypal symptoms did not differ from healthy controls on tasks of olfactory acuity. This research suggests that olfactory identification deficits likely exist in males with schizotypal features,

including those diagnosed with SPD. The findings in females with schizotypy symptoms were moderated by the menstrual cycle, which is further described in the next section.

A replication and extension of Park and Schoppe's (1997) study would provide useful information to further distinguish olfactory dysfunction as an endophenotype of schizophrenia. Such research in smell identification has often been limited by more expensive and time consuming measures of olfaction. However, the Brief Smell Identification Test (B-SIT: Doty, 2001; Doty, Marcus, & Lew, 1996) is a 12-item version of the 40-item University of Pennsylvania Smell Identification Test (Doty, Shamam et al., 1984) that takes approximately 5 minutes to administer. The B-SIT has been shown to be as effective as the UPSIT in measuring olfactory dysfunction with correlations ranging from 0.83 to 0.89 (Doty, 2001; Doty et al., 1996). In addition, research has demonstrated that it can distinguish between different symptom subtypes of schizophrenia in a manner similar to the UPSIT (Goudsmit et al., 2003).

Olfaction Deficit Differences Related to Schizophrenia Subpopulations

Although olfactory deficits have been studied widely in schizophrenia, some studies have found further differentiation in olfactory deficits within specific subtypes of the schizophrenia population. While individuals with schizophrenia often have been conceptualized as one homogenous disease entity, a subgroup of individuals with schizophrenia distinguished as deficit syndrome schizophrenia have been distinguished from non-deficit syndrome schizophrenia using neuroimaging techniques and neuropsychological measures. The deficit syndrome is characterized by negative symptoms of alogia, blunted affect, and avolition as well as marked social dysfunction and social behavior deficits (Carpenter, Heinrichs, & Wagman, 1988; Kirkpatrick, Buchanan, Breier, & Carpenter, 1993). Studies have found that olfactory impairment may be more strongly correlated in individuals with schizophrenia who exhibit

predominant negative symptoms (deficit syndrome: Brewer, Edwards, Anderson, Robinson, & Pantelis, 1996a; Geddes et al., 1991). A study by Goudsmit et al. (2003) found that smell identification deficits were most severe in deficit syndrome schizophrenia, compared to non-deficit syndrome, and were highly correlated with social dysfunction, a key feature of the deficit syndrome.

Another important subtype that has been studied within schizophrenia research is gender. A research study by Kopala, Clark, and Hurwitz (1989) on gender differences in olfactory function found that males with schizophrenia performed worse on measures of olfactory identification than females with schizophrenia. However, males with schizophrenia performed slightly better on measures of olfactory acuity when compared with females with schizophrenia, but level of acuity was not statistically significant when compared with healthy controls. It has been postulated that estrogen levels may contribute to this discrepancy. With respect to the potential role of estrogen, research in women with schizophrenia found that postmenopausal females, who have lower levels of estrogen, had increased olfactory identification errors on the UPSIT when compared with premenopausal females (Kopala, Good, & Honer, 1995). Several other studies have hypothesized a protective effect of estrogen, noting that females with schizophrenia experience fewer impairments in brain structure, fewer hospitalizations, and require lower doses of neuroleptic treatment (Flor-Henry, 1990; Grigoriadis & Seeman, 2002; Seeman, 1983; Vanurová, Yamamotová, Motlová, Muchl, & Titlbach, 2001). Park and Schoppe (1997) found that performance on the olfactory identification task varied according to the menstrual cycle in women. Specifically, women in the first 10 days of the menstrual cycle (when estrogen is lowest) showed greater olfactory identification deficits than women in the last 20 days of the menstrual cycle (when estrogen is highest). Schizotypal females and healthy

controls did not differ significantly on measures of olfactory acuity (rather than identification) performance. Thus, estrogen levels may contribute to differences in olfactory identification performance between males and females with schizophrenia and among women with schizophrenia spectrum symptoms.

Sustained Attention in Schizophrenia Spectrum Disorders

Another more established endophenotype that has been widely studied in schizophrenia is deficits on tasks of sustained attention. The continuous performance test (CPT) was first developed to assess sustained attention in brain-damaged patients (Rosvold, Mirsky, Sarason, Bransome, & Beck, 1956). During the past several decades, the CPT has been the most widely used measure of vigilance deficits in individuals with schizophrenia (Neuchterlein, 1991) and has been found to be both a reliable and valid assessment of sustained attention for use in research settings and preventive intervention programs (Cornblatt & Keilp, 1994; Halperin, Sharma, Greenblatt, & Schwartz, 1991). The CPT is a computerized measure that involves the presentation of a variety of stimuli in rapid succession. While various versions of the task exist, the CPT-AX version is most similar to the version used in the present study (Wohlberg & Kornetsky, 1973). Single random letters are presented on a computer monitor, most commonly at the rate of one per second. The CPT-AX entails responding to a predefined target stimulus (i.e., pressing the spacebar after "X" but only if an "A" preceded it). The target sequence occurs relatively infrequently with other random letters appearing the majority of the time. The task often lasts for over 5 minutes, which places demands on sustained attention. During the task, a number of measures are recorded including *hit rate* (correct detection of "X" preceded by "A" stimuli), *response time* for correct detection, *commission errors* (responding to non-target stimuli), and *omission errors* (failure to respond to correct presentation of target stimuli). Past

research has demonstrated that individuals with schizophrenia make more errors on the CPT when compared with healthy controls and individuals with other psychiatric illnesses (Liu et al., 2002; Nuechterlein, 1983).

Different versions of the CPT exist with each varying in regard to complexity of targets as well as modality and speed of stimulus presentation. The CPT Identical Pairs (CPT-IP) places more demand on working memory than the CPT-AX and involves indicating when two identical number sequences are presented in succession (Cornblatt, Risch, Faris, Friedman, & Erlenmeyer-Kimling, 1988). The degraded stimuli CPT uses a pattern of white noise in order to visually blur the image (Nuechterlein, 1983). Other versions of the CPT-AX task do not blur the image. When examining various versions of CPT in schizophrenia patients, Cornblatt & Keilp (1994) found that more difficult forms of the CPT, including the CPT-IP and the degraded stimuli CPT, best distinguished relatives of individuals with schizophrenia from healthy controls (Chen et al., 1998; Finkelstein, Cannon, Gur, Gur, & Moberg, 1997; Franke, Maier, Hardt, Hain, & Cornblatt, 1994; Laurent et al., 1999; Maier, Franke, Hain, Kopp, & Rist, 1992; Mirsky, Ingraham, & Kugelmass, 1995; Mirsky, Yardley, Jones, Walsh, & Kendler, 1995).

Sustained attention has been measured in first-degree relatives of individuals with schizophrenia. Keefe and colleagues (1997) measured sustained attention in 83 first-degree relatives and noted that relatives made significantly more CPT commission errors than controls while omission errors did not differ significantly. The authors noted that omission errors did correlate significantly with positive symptoms of schizotypy (R^2 = .15). A recent meta-analysis conducted by Snitz, Macdonald, & Carter (2006) examined a variety of cognitive endophenotypes in unaffected first-degree relatives of patients with schizophrenia. False alarms and d-prime (a performance index of commission and omission errors) on the CPT-AX and CPT-

IP showed the largest effect size (d = 0.60 to 0.66) when compared to other cognitive tests. Overall, this meta-analysis suggests that the CPT is a useful endophenotype for genetic liability to schizophrenia.

The CPT has also been examined in individuals with symptoms of schizotypy, a broader continuum of symptoms related to SPD. Lenzenweger, Cornblatt, & Putnick (1991) used the CPT-IP to assess sustained attention in healthy controls and individuals scoring high on the Perceptual Aberration Scale (PAS: Chapman, Chapman, & Raulin, 1978), a measure of disturbances and distortions in the perception of different objects. Results from their study showed that schizotypic individuals had poorer performance than comparison subjects on an index of the CPT-IP measuring discrimination ability (d') as well as hit rate. A comparable study on CPT-IP performance in schizotypic individuals found that individuals scoring high on the PAS exhibited slower reaction time on the CPT-IP than controls (Lenzenweger, 2001). Using the SPQ, Chen, Hsiao, & Lin (1997) found that adults scoring high on the Interpersonal factor had poorer d' performance accuracy on the degraded CPT. Gooding, Matts, & Rollmann (2006) divided groups based on positive and negative aspects of schizotypy using scales from the Chapman Psychosis-proneness scale (Chapman et al., 1978). They found that both positive and negative psychosis-prone individuals exhibited poorer performance on a performance index of the CPT-IP measuring discrimination ability, d', but found no differences in reaction time. Bergida & Lenzenweger (2006) also noted that d' on the CPT-IP showed a negative correlation (R^2 = .01, small effect size) with the Cognitive-Perceptual factor of the SPQ.

By contrast, Bedwell, Kamath, & Baksh (2006) used the CPT-AX to measure sustained attention in college students with schizotypy, psychometrically-defined using the abbreviated version of the SPQ (SPQ-B: Raine & Benishay, 1995). Individuals with schizotypy made

significantly more omission errors than controls (d = 0.54, medium effect size). Similar to the study above, increased CPT errors were related to only the Cognitive-Perceptual factor. A study by Moriarty and colleagues (2003) appears to be the first to examine sustained attention in individuals formally diagnosed with schizotypal personality disorder (SPD). Individuals were administered the single visual non-degraded CPT-AX task. The results of this study revealed a large effect size (d = 0.98) for increased omission errors and a medium effect size for commission errors (d = 0.49) in the SPD group compared to nonpsychiatric controls.

Overall, individuals with schizophrenia, their first-degree relatives, and individuals with both clinical and subclinical schizotypy often make more errors than healthy controls on various versions of the CPT, with omission errors comprising the more robust error type in the schizotypy samples. This body of research has helped establish performance on the CPT as a robust endophenotype of schizophrenia and schizotypy. Therefore, the use of the degraded CPT-AX task in the current study will serve as a comparison for the relative sensitivity of the B-SIT as an endophenotype for schizophrenia-spectrum genetic effects.

Current Aims & Hypotheses

Although one previous study has examined olfactory functioning in individuals self-reporting schizotypal features (Park & Schoppe, 1997), it does not appear that scores on an olfactory identification task have been compared to scores on a CPT task in individuals with schizotypal personality features. In addition, olfactory identification ability has not been assessed in individuals who meet diagnostic criteria for SPD. The present study aims to compare the relative sensitivity of sustained attention and olfaction identification as endophenotypes of schizophrenia. The relative sensitivity of an endophenotype is crucial for its potential as a marker for abnormal genes; therefore, the relative effect sizes of between group differences will

be used as an approximation of sensitivity. When comparing effect sizes in previous research articles, the reported effect sizes for olfactory identification were larger than those reported for any performance indices of the CPT. The purpose of the current study is to compare the B-SIT and CPT directly within the same sample to determine if olfactory dysfunction is more sensitive to subclinical schizotypy than sustained attention. This finding would provide additional support for olfactory dysfunction as a useful endophenotype for schizophrenia.

It is hypothesized that: 1) males scoring in the top 10% on the SPQ-B will make more errors on the olfactory identification task (B-SIT) when compared with male controls (scoring below a half a standard deviation above the mean); 2) females scoring in the top 10% on the SPQ-B will make more errors on the B-SIT when compared with female controls, but only after covarying for the fluctuation of estrogen levels that occur during the menstrual cycle; 3) individuals scoring in the top 10% on the SPQ-B will make more omission errors on the sustained attention task (CPT), yet have similar reaction time and commission errors when compared with controls; and 4) group differences for olfactory identification will show a larger effect size than the group differences for sustained attention. Finally, we hypothesize that findings from the four hypotheses will be more robust in individuals who meet diagnostic criteria for SPD when compared with individuals who scored in the top 10% on the SPQ-B but did not meet diagnostic criteria for SPD.

CHAPTER THREE: METHODOLOGY

Phase I

Participants for Phase I

A large number of university undergraduates (N = 1,328) completed an online questionnaire via a departmental psychology website. Responses were discarded because of incomplete responding (11.1%), repeat entries (0.98%) and invalid responding (based on validity scales described below; 9.6%). The diagnosis of schizotypal personality disorder cannot be made until the individual is at least 18 years of age. Therefore, a minimum age criteria for all participants was set at 18. An upper age limit was set at 55 years, due to age-related decline of olfactory ability (Doty, Shaman et al., 1984). All participants fell between the age criteria of 18 to 55 years.

This resulted in 1,040 participants for analysis, with a mean age of 20.56 (SD = 3.64; range = 18 to 52). 69.4% of the participants were female; 66.2% were Caucasian, 14.8% Hispanic, 13.8% African-American, 4.4% Asian, 0.29% American Indian, and 0.48% described themselves as Pacific Islander. Participants had a mean SPQ-B score of 9.06 (SD = 4.51; range = 0 to 21). Females had a mean SPQ-B score of 8.87 (SD = 4.46; range = 0 to 21), while males had a mean SPQ-B score of 9.49 (SD = 4.61; range = 1 to 21).

Procedure for Phase I

Participants learned of the online questionnaire through a departmental website, which posts a variety of experiments for students to choose. Students received academic credit toward a psychology course for completing this survey. The content of the online questionnaire was described to participants as questions about "psychological experiences." Participants were not aware that the questionnaire was intended to measure schizotypy in particular. Upon choosing to

participate in the experiment from the department website, volunteers were directed to an informed consent webpage. The webpage had detailed informed consent procedure as well as information about the study. Participants were asked to provide permission for the investigator to contact them directly for future research studies. After completing the online informed consent procedure, participants answered an initial demographic questionnaire, which included their name and contact information. In addition, participants were asked if they had any first-degree biological relatives diagnosed with schizophrenia or schizoaffective disorder. Following this, participants were asked questions in a fixed random order from the scales detailed below. The four scales included: 1) the 22-item Abbreviated Schizotypal Personality Questionnaire (SPQ-B: Raine & Benishay, 1995); 2) the 27-item Fp Scale from the Minnesota Multiphasic Personality Inventory-II (Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989); 3) the 13-item Social Desirability Scale (Crowne & Marlowe, 1960); and 4) the 8-item scale modeled after the Infrequency Scale of Personality Research Form (Calkins, Curtis, Grove, & Iacono, 2004; Jackson, 1984). Thus, the questionnaire (excluding the initial demographic questions) consisted of 70 questions and took approximately 20 minutes to complete. Following the test administration, students viewed an online debriefing form, and were given the opportunity to receive results about the study.

As a result of the ethical and legal complications of involving minors, participation were limited to adults (≥18 years), which was clearly stated on the online consent form.

Measures for Phase I

Abbreviated Schizotypal Personality Questionnaire (SPQ-B; Appendix A). The SPQ-B is a 22-item short form of the of the 74-item Schizotypal Personality Questionnaire (SPQ; Raine, 1991). In order to screen individuals for the presence of schizotypal symptoms, Raine and

Benishay (1996) developed the 22-item SPQ-B using the most reliable items from the 74-item SPQ, a self-report questionnaire measuring the nine diagnostic criteria for schizotypal personality disorder (SPD) as outlined in the DSM-IV-TR (American Psychiatric Association, 2000). The SPQ-B consists of 3 main factors; Cognitive-Perceptual, Interpersonal, and Disorganized. The Cognitive-Perceptual factor, aligned more with the positive symptoms of schizophrenia, includes symptoms of odd beliefs, magical thinking, and unusual perceptual experiences. The Interpersonal factor consists of symptoms of social anxiety, constricted affect, and lack of close friendships and reflects negative symptoms of schizophrenia. The Disorganized factor is associated with both positive and negative symptoms of schizophrenia and includes questions about odd speech and odd behavior. In one study, approximately 59% of a sample of university students in the top 10% of the full SPQ total score met diagnostic criteria for SPD (Raine & Benishay, 1995). Intercorrelations between the SPQ-B factors and the full factor SPQ has been reported to range from .89 to .94. In a previous study, the internal reliability of the SPQ-B ranged from .72 to .80., while test-retest reliability, over 2 months, ranged from .86 to .95 (Raine & Benishay, 1995). Therefore, the SPQ-B appears to be an adequate screening measure for identifying individuals at high risk of meeting DSM-IV-TR (American Psychiatric Association, 2000) diagnostic criteria for SPD.

Infrequency-Psychopathology Scale from the Minnesota Multiphasic Personality Inventory-II (Fp; Appendix B). The Fp scale is comprised of items that are rarely endorsed in the keyed direction by patients as well as by normals (Butcher et al., 1989). These scales are sensitive to individuals who are exaggerating psychopathology because many of the items represent particularly rare symptoms of psychopathology (Graham, 2000).

Abbreviated Marlowe–Crowne Social Desirability Scale (MC; Appendix C). The Abbreviated Marlowe–Crowne Social Desirability Scale is a 13-item self-report scale based on the 33-item version that examines whether participants answer according to what they perceive to be socially appropriate responses (Crowne & Marlowe, 1960). The 13-item form was found to have acceptable internal consistency reliability (r = .76) comparable to the standard form and other short forms (Reynolds, 1982). The 13-item version of the Marlowe-Crowne Social Desirability Scale was also found to have strong reliability with the Marlowe-Crowe Standard form (r = .93).

Scale modeled after the Infrequency Scale of the Personality Research Form (Appendix D). An 8-item scale modeled after the Infrequency Scale of the Personality Research Form was used as a validity scale that measures whether participants responded in a random or inattentive manner when filling out items on the questionnaire (Calkins et al., 2004; Jackson, 1984). Items on this scale are rarely endorsed (e.g. "I visited Easter Island last year"). Therefore, endorsement of such items suggests that the respondents did not consistently attend to item content.

Phase II

Participants for Phase II

Participants from Phase I were recruited to participate in Phase II by creating two smaller subgroups using the SPQ-B total score. To help control for invalid and random responding, participants were excluded from the study if they endorsed more than one item from the Infrequency scale. Participants also were excluded if they did not answer more than 1 item from the questionnaire or scored greater than two standard deviations above the mean on the Social Desirability Scale. Data were screened for dual entries from the same participant name, phone

number, or birth date. Multiple entries were deleted from the dataset to decrease bias in gender norms from having multiple entries by the same individual.

Participants were considered to have schizotypal personality features (SPF) if they scored in the top 10% on the SPQ-B in our sample, consistent with suggestions by others (Raine & Benishay, 1995). The second group consisted of "control" participants that scored below a half standard deviation above the mean of all valid respondents. The mean SPQ-B score from our initial valid sample from Phase I (69.4% female, N = 1,040) was 9.49 for males (SD = 4.61, range: 1 to 21) and 8.87 for females (SD = 4.46, range: 0 to 21). The top 10% of our sample included participants with a SPQ-B total score above 16 for males and 15 for females. Controls were defined as males and females scoring below 12 (below half a standard deviation above the mean). Participants that met these criteria were recruited from the larger sample, with an ongoing effort to match the age, gender, and ethnicity distribution between groups. Individuals were informed not to drink alcohol or use any other substances 24 hours prior to the study. One individual was excluded on the basis of recent substance abuse as the use of alcohol could impact performance on measures of sustained attention.

Following recruitment efforts, participants included 26 individuals considered to have SPF (mean SPQ-B = 18.08, SD = 1.62, range: 15 to 21) and 26 individuals that met criteria as controls (mean SPQ-B = 6.27, SD = 1.93, range: 3 to 10). The groups were well-matched on: gender (SPF: 62% female; controls: 62% female), age (SPF mean = 19.64, SD = 1.10, range: 18 to 23; controls mean = 19.75, SD = 1.55, range: 18 to 26), race (SPF: 65% Caucasian, 23% African-American, 8% Hispanic; controls: 73% Caucasian, 19% African-American, 8% Hispanic), and corrected visual acuity (SPF: 57.7% - 20/15 acuity, 26.9% - 20/20 acuity, 11.5% - 20/30 acuity, 0.04% - 20/40 acuity; controls: 46.2% - 20/15 acuity, 38.5% - 20/20 acuity, 11.5%

- 20/30 acuity, 0.04% - 20/40 acuity). Visual acuity was measured using a standard Snellen wall chart (see Table 1). Participants with visual acuity less than 20/40 (from visual acuity chart – see below) were discontinued from participation in the study.

Previous research has suggested that biological relatives of individual with schizophrenia have a higher prevalence of schizophrenia-spectrum symptomotology and may possess latent genes for schizophrenia (American Psychiatric Association, 2000; Cadenhead et al., 2002; Silverman et al., 1993). In order to control for these effects, the initial potential control participants reporting a biological relative with a diagnosis of schizophrenia or schizoaffective disorder (0.03%) were not recruited to participate in Phase II of the study. Within the final SPF group (N = 117), 5.13% reported a biological relative with schizophrenia. These SPF participants were not excluded, as biological relatives with schizophrenia are commonly present in schizotypal personality disorder, which is thought to reflect shared genetic liability.

After administration of the SCID-I, four individuals in the SPF group met criteria for Major Depressive Disorder (no psychotic features), one met criteria for Generalized Anxiety Disorder, two met criteria for Bulimia Nervosa, one met criteria for Substance Abuse and Dependence, and one met criteria for Bipolar I Disorder (no psychotic features). One individual met diagnostic criteria for Schizotypal Personality Disorder (SPD). Two individuals reported the use of psychotropic medications (Paxil and Effexor). In the control group, one individual met criteria for Major Depressive Disorder (no psychotic features), one met criteria for Generalized Anxiety Disorder, two met criteria for Substance Abuse, one met criteria for Bipolar I Disorder (no psychotic features), and one reported a previous diagnosis of Attention-Deficit Hyperactivity Disorder. One control reported the use of psychotropic medication (Adderall). No controls met criteria for SPD.

All participants provided informed consent prior to the research appointment and received either $5 per half hour of participation or course credit toward their psychology class.

Measures for Phase II

Visual Acuity Chart. Visual acuity was measured using a standard Snellen wall chart which provides a basic measure of visual acuity (the ability of the eye to focus). The chart has a series of letters, with the largest at the top. As the individual reads down the chart, the letters gradually become smaller. The chart was placed on a wall at eye level, 20 feet from the individual. Each participant was asked to read one row at a time from the top of the chart to the bottom. Each row of the chart assesses a distinct focus ability level which was originally normed on healthy individuals. The fractions (i.e.; 20/20, 20/30, etc.) are measures of sharpness of sight and reflect the ability to identify a letter of a certain size at a specified distance.

Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I). The SCID-I is a semi-structured clinical interview used to assess whether an individual meets diagnostic criteria for DSM-IV-TR Axis I Disorders (First, Gibbon, Spitzer, & Williams, 1997). The interview contains directions for scoring answers in order to derive DSM-IV-TR diagnostic labels. The SCID-I has been shown to be both a reliable measure for determining if an individual meets criteria for an Axis I DSM-IV-TR diagnosis with excellent interrater reliability (kappa = 0.85, range = 0.71 to 0.97) and diagnostic accuracy (82%), when compared with the "gold standard" of consensus diagnosis (Ventura, Liberman, Green, Shaner, & Mintz, 1998).

Schizotypal Personality Disorder Section of the Structured Clinical Interview for DSM IV Axis II Personality Disorders (SCID-II). The SCID-II is a semi-structured clinical interview used to assess whether an individual meets diagnostic criteria for an Axis II Personality Disorder (First, Gibbon, Spitzer, Williams, & Benjamin, 1997). The current study will be focusing on the

schizotypal personality disorder section. Items on the SCID-II are scored on a 3-point scale (absent/false = 1, subthreshold = 2, threshold/true = 3). A categorical diagnosis of Schizotypal Personality Disorder will be obtained when the number of "3's" reach the diagnostic threshold according to criteria in the 4th ed. of the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 2000). A dimensional index will be calculated by adding all 1-3 scores from the 9 items.

Brief Smell Identification Test (B-SIT). The B-SIT is a self-administered odorant test of microencapsulated smells (Doty, 2001; Doty et al., 1996). The 12-item measure is a shorter form of the 40-item University of Pennsylvania Smell Identification Test (Doty, Shamam et al., 1984). Previous findings have suggested that the B-SIT is as effective as the UPSIT in measuring olfactory dysfunction with correlations ranging from 0.83 to 0.89 (Goudsmit et al., 2003) and has a test-retest reliability of 0.71 over a period of one week (Doty, 2001; Doty et al., 1996). The measure involves selecting the correct multiple-choice identification out of 4 possible answers on 12 "scratch 'n' sniff" items (Doty, 2001; Doty et al., 1996).

Computerized Performance Test (CPT). The CPT task was created using Vigil/W v. 1.3.0 software package (ForThought, 1995). Stimuli were presented using a 22-inch NEC Multisync FP 2141^{SB} monitor and PC computer. Participants were seated 19 inches from the screen. Responses were collected using a standard keyboard. The CPT task was modeled after the A-X version (Wohlberg & Kornetsky, 1973), in which a series of random single letters are presented and the participants is asked to press the spacebar after observing a target sequence ("A" followed by "X") of two letters. The target consisted of the letter "K" followed by the letter "A," which occurred 20% of the time. Stimuli were presented in the center of the monitor at a constant rate of 1000 ms, with the target appearing for 50 ms followed by the blank screen

appearing for 950 ms. Each letter was approximately 1.5 cm wide and 1.5 cm high. The task began with one 30 second practice block consisting of 30 stimuli and 10 targets. The practice session had no decoys (i.e.; a letter other than "K" followed by "A" or "K" followed by a letter other than "A"). White noise on the background was automatically generated by the software package, utilizing a software program setting of stimuli noise at 99 and background noise at 99. During the practice session, participants were given verbal feedback by the examiner regarding their accuracy. Following this practice session, the full task was administered, consisting of 3 blocks. Each block contained 24 targets and 12 decoys resulting in 120 stimuli total. The task duration was approximately 6 minutes.

A response was marked as a correct detection when the subject responded to target trials ("K" followed by "A"). Responses to non-targets were marked as a commission error while failure to respond to a target wass marked as an omission error. Each block also included 12 "decoy" trials in which the stimulus presented was either "K" followed by a letter other than "A" or "A" preceded by a letter other than "K." Responses to a "decoy" trial were marked as a specific type of commission error called a false alarm.

The developers of the CPT software program used in the present study established construct validity through comparison of a similar degraded version of the CPT with other tests known to measure similar constructs (The Psychological Corporation, 1998). These tests included the Mesulam Figure Cancellation Tasks and the FAS Test. Results of these tests were highly correlated with the Vigil CPT Test. Trails A & B, used as a comparison for discriminant validity, showed low correlations with the degraded KA version of the CPT. Test-retest reliability over a 3 months period for the degraded KA version of the CPT was adequate for errors of omission ($r = 0.67$), errors of commission ($r = 0.79$), hit rate ($r = 0.66$), false alarm ($r =$

0.79), and reaction time ($r = 0.66$). Additionally, several studies have demonstrated the ability of the degraded stimuli CPT to distinguish between first-degree relatives of individuals with schizophrenia and healthy controls (Chen et al., 1998; Laurent et al., 1999; Maier et al., 1992; Mirsky, Ingraham et al., 1995; Nuechterlein, 1983).

Procedure for Phase II

Research was conducted in the Clinical Cognitive Neuroscience Laboratory (Howard Phillips Hall, Room 409-O) located on campus. The research appointment began with a detailed informed consent procedure with the primary investigator. Participants were given the opportunity to ask questions, which were addressed at that time. They were told (written and orally) that participation could be discontinued at any point during the study without negative consequences and that participation in the study is entirely voluntary. Participants were asked to provide permission for the investigator to contact them directly for future research studies, which may include a longitudinal component of the current study. They indicated this consent with initials next to this statement and were be asked to provide complete contact information.

Participants were then administered a short questionnaire with mental and physical health questions by the primary investigator. Questions about current medication, drug use, allergies, current respiratory tract functioning, as well as history of smoking, and current status of smoking were also included. Female participants were asked extra questions concerning the timing of their menstrual cycle and use of estrogen-based oral contraceptives (as this has been shown to affect olfaction - see Introduction). In addition, participants were asked whether they have a known biological relative with schizophrenia. Subjects were administered the visual acuity test using the eye chart. Individuals who scored poorer than 20/40 on the measure were excluded from the study, as poor visual acuity could likely impact performance on the CPT.

All participants were administered the SCID-I and the 9 items from the Schizotypal Personality Disorder section of the SCID-II. Once the interview was complete, participants were administered the Brief Smell Identification Test (BSIT) and the Continuous Performance Test (CPT) in a counterbalanced order by participant. Following the test administration, students were given a debriefing form and the opportunity to receive results about the study. The debriefing forms included information about the purpose of the study as well as contact information.

CHAPTER FOUR: RESULTS

SPSS 12.0 was used for all analyses using an alpha level of .05, unless otherwise noted. Pearson correlations were used to assess the relationship between SPD dimension scores and SPQ-B factor scores as data was normally distributed. Data from both the BSIT and CPT performance indices represented non-Gaussian distributions (based on Kolmogorov-Smirnov tests with Lilliefors Significance Correction). Therefore, Mann-Whitney *U* tests and Spearman correlations were chosen to compare the groups, unless there was a need to covary – in which case ANCOVA was used.

Continuous Performance Test: SPF versus Control Group Comparisons

As there were no previous data to suggest gender differences on the CPT, overall group differences were compared by combining SPF males and females into one group and combining the control females and males into another group. SPF individuals (N = 26) made a mean of 2.62 (SD = 2.62) CPT omission errors compared with a mean of 2.42 (SD = 2.56) errors made by the control group (N = 26) (see Figure 1). This difference did not approach statistical significance ($U = 331.0$, $p = .90$). Individuals in the SPF group displayed a faster reaction time (mean = 400.7 ms, SD= 63.89) compared to healthy controls (mean = 437.31 ms, SD= 53.59), $U = 196.5$, $p = .01$, Cohen's $d = 0.62$; medium effect size. All other CPT performance indices did not approach statistical significance (see Table 2).

Brief Smell Identification Test: SPF Females versus Control Female Comparisons

The SPF females (N = 16) were able to correctly identify a mean of 10.38 (SD = 1.26) B-SIT items compared to a mean of 10.56 (SD = 0.96) items by female controls (N = 16). This B-SIT task difference did not approach statistical significance, $U = 120.5$, $p = .77$ (see Table 2).

In order to account for the fluctuation of estrogen levels that occur during the menstrual cycle, an analysis of covariance (ANCOVA) was conducted to account for the variance that estrogen level has on olfactory identification performance. Females who were not able to report the date of their last menstrual cycle were excluded from this analyses (one individual). The ANCOVA was conducted in two ways: 1) Similar to Park & Schoppe's (1997) study, the first day of reported menstruation was specified as the first day in the menstrual cycle. There were no significant differences in the duration between the start of menstrual cycle and the date of the study between SPF and control females. An ANCOVA was conducted to determine if there were group differences in B-SIT performance after controlling for the duration of the menstrual cycle to the date of the study. The results showed no significant difference for B-SIT performance between SPF and controls females, $F_{(1,29)} = 0.07$, $p = .94$; 2) During the typical 30-day menstrual cycle, the first 10 days (including menstruation) represent the days with the lowest estradiol levels. Following this, an increase in estradiol levels occurs and maintains for approximately 20 days. Consistent with previous research (Park & Schoppe, 1997), the group of female participants were divided into two phases consisting of females tested during the first 10 days of the menstrual cycle and females tested during the last 20 days of the menstrual cycle. There were no statistically significant differences in B-SIT performance between the two groups after controlling for the phase of the menstrual cycle, $F_{(1,29)} = 0.06$, $p = .94$ (see Figure 2).

Brief Smell Identification Test: SPF males versus Control Males Comparisons

The SPF males were able to correctly identify a mean of 9.70 (SD = 1.57) B-SIT items compared to a mean of 10.20 (SD = 1.40) items by male controls (see Figure 3). This B-SIT task difference did not approach statistical significance, $U = 38.0$, $p = .34$, Cohen's $d = 0.34$, small effect size (see Table 2).

SPD scores correlated with CPT and BSIT Performance Indices

In the present study, one individual met DSM-IV-TR diagnostic criteria for Schizotypal Personality Disorder (SPD). Therefore, one-sample t-tests were conducted to compare the individual meeting SPD criteria to: 1) the control group and 2) the group of individuals with schizotypal personality features (SPF; as measured by the SPQ-B). The purpose of this analysis was to evaluate whether the mean group performance across CPT and BSIT performance indices were significantly different from the performance of the individual meeting criteria for SPD.

The difference between the omission errors for our sample of controls (M = 2.42, SD = 2.56) and the larger number of omission errors (4) in the individual with SPD was statistically significant, $t(25) = 3.14$, $p = .004$ (Cohen's $d = 0.62$; medium effect size). Similarly, the control group performance on false alarms (M = 0.004, SD = 0.006) was significantly different from the SPD individual's higher false alarm rate of 0.01, $t(25) = 4.57$, $p < .01$ (Cohen's $d = 1.67$; large effect size). For commission errors, the difference between the control sample (M = 1.46, SD = 1.39) and greater number of commission errors (2) by the individual with SPD approached statistical significance, $t(25) = 1.97$, $p = .06$ (Cohen's $d = .39$; small effect size). The reaction time of the individual with SPD (341.30 ms) was faster than the mean reaction time of our control sample (M = 437.31, SD = 53.39). A one sample t-test revealed a statistically significant difference, $t(25) = 9.17$, $p < .01$, resulting in a large effect size (Cohen's $d = 1.80$).

Performance on the B-SIT for our sample of controls (M = 10.42, SD = 1.14) was better than the performance of the individual with SPD (10 correct identifications), which approached statistical significance, $t(25) = 1.90$, $p = .07$ ($d = 0.37$; small effect size).

When comparing the individual with SPD to our SPF group, the difference between the omission errors for our SPF group (M = 2.56, SD = 2.66) and the larger number of omission errors (4) in the individual with SPD was statistically significant, $t(25) = 2.70$, $p = .01$ (Cohen's d

= 0.54; medium effect size). Although the SPD individual made a greater number of commission errors (2) than the SPF sample (M = 1.52, SD = 1.58), this difference did not approach statistical significance, $t(25) = 1.52$, $p = .14$. The reaction time of the individual with SPD was faster than the mean reaction time of our SPF sample (M = 403.05, SD = 64.02). This resulted in a statistically significant difference, $t(25) = 4.82$, $p < .01$ (Cohen's $d = 0.96$; large effect size). The SPD individual's higher false alarm rate was significantly difference from the SPF sample (M = 0.004, SD = 0.006), $t(25) = 4.80$, $p < .01$ (Cohen's $d = 1.00$; large effect size). The individual with SPD performed slightly worse on the B-SIT than our SPF sample (M = 10.12, SD = 1.42). However, this result did not approach statistical significance, $t(25) = 0.42$, $p = .68$.

As only one individual met diagnostic criteria for SPD, secondary analyses were conducted to explore the linear relationship (across both groups combined) between CPT and B-SIT performance indices and a SPD dimension score, as well as SPQ-B factor scores. The SPD dimension score was derived by summing each quantitative rating from the SPD items on the Structured Clinical Interview for DSM IV Axis II Personality Disorders (SCID-II). Scores were entered as follows: a score of 1 for absent or unreported symptoms, a score of 2 for subthreshold symptoms, or a score of 3 for symptoms reported to be above threshold. Thus, the SPD dimension score could range from 9 (absence of all SPD symptoms) to 27 (presence of all SPD symptoms).

The SPD dimension score showed a statistically significant positive correlation with the SPQ-B, $r(52) = .30$, $p = .03$, $R^2 = .09$. Notably, 91% of the variance was not shared between the measures. The SPQ-B subscales approached statistically significant positive correlations with the SPD dimension score, with the strongest correlation found with the Disorganization subscale,

$r(52) = .31$, $p = .03$, followed by the Interpersonal subscale, $r(52) = .29$, $p = .04$, while the Cognitive-Perceptual Deficits subscale did not approach statistical significance, $r(52) = .18$, $p = .19$ (see Table 3a).

The SPD dimension score showed a statistically significant positive correlation with several performance indices of the CPT, including omission errors $r_s(52) = .51$, $p < .001$ (see Figure 4), commission errors $r_s(52) = .38$, $p < .005$, and false alarms $r_s(52) = .44$, $p < .001$. In contrast, the SPQ-B had a statistically significant inverse relationship with reaction time from the CPT, $r_s(52) = -.34$, $p = .01$. The remaining correlations between the SPQ-B and CPT performance indices did not approach statistical significance (see Table 3b).

When combining genders, B-SIT scores were not significantly correlated with the SPD dimension score, $r_s(52) = -.11$, $p = .43$. After analyzing genders separately, the B-SIT scores were not correlated with the SPD dimension score for males ($r_s(20) = -.25$, $p = .29$, see Figure 5) or females ($r_s(31) = -.10$, $p = .60$). These findings did not change after controlling for days from the start of the menstrual cycle, $r(31) = -.17$, $p = .36$, or for the phase of the menstrual cycle (e.g. first 10 days vs. last 20 days of the menstrual cycle), $r(31) = .007$, $p = .92$ (see Figure 6). In addition, the SPQ-B did not show significant correlations with the B-SIT for males ($r_s(20) = -.20$, $p = .41$) or females ($r_s(31) = -.12$, $p = .54$). After controlling for days from the start of the menstrual cycle, the relationship with the SPQ-B did not change, $r(31) = -.12$, $p = .54$. Similarly, when accounting for the phase of the menstrual cycle, the relationship with the SPQ-B did not approach statistical significance, $r(31) = -.10$, $p = .59$ (See Table 3c).

CHAPTER FIVE: DISCUSSION

The present study appears to be the first to compare CPT and B-SIT performance in a group of young adults with psychometrically-defined schizotypal personality features (SPF). Contrary to our hypothesis, individuals with SPF (as defined by the SPQ-B) did not perform significantly worse than controls on any performance indices of the CPT. This is surprising as the CPT was included as a "gold-standard" endophenotype for comparison to the B-SIT. While the SPF group did make more omission errors than controls when combining genders, the small effect size (Cohen's d = 0.08) did not result in a statistically significant difference with our modest sample size (N = 26 in each group). This finding is not consistent with previous research that found group differences with a medium effect size in CPT-AX omission errors between individuals with psychometrically-defined SPF and healthy controls recruited from the same population as the current study (Bedwell et al., 2006). Conversely, the present study found that individuals with SPF showed a faster reaction time than healthy controls, with a medium effect size. This is consistent with the study by Bedwell and colleagues (2006), who also found a faster reaction time in the SPF group, although the small effect size (d = 0.29) found in that study did not reach statistical significance. In the current study, the faster reaction time did not create a consistent difference in accuracy, suggesting more efficient performance in some individuals in the SPF group. In contrast, Lenzenweger (2001) found that individuals with psychometrically-defined schizotypy, as measured by the Perceptual Aberration Scale (PAS), had a slowed reaction time on the CPT, although accuracy differences were not found.

The study by Bedwell et al. (2006) defined the SPF group as individuals scoring a total raw score of 17 or higher on the SPQ-B, which represented the top 6% of their sample. The current study recruited from the top 10% of the sample; however, further analysis excluding SPF

participants scoring below 17 did not alter our findings. Raine & Benishay (1995) reported that approximately 59% of university students scoring within the top 10% of the sample on the full SPQ met diagnostic criteria for SPD. However, in the current study, only 4% of our SPF sample (1 of 26) met diagnostic criteria for SPD. Similarly, 54% of the SPF participants in our sample did not endorse any threshold or subthreshold symptoms of SPD in a clinical interview. This suggests participants recruited in the current study may not represent a group of individuals with true features of SPD.

Given that hypothesized differences in performance on the CPT were not supported using the SPQ-B, further analysis was conducted to examine if symptoms reported during a clinical interview of SPD would result in statistically significant correlations with the CPT-AX. We initially hypothesized that individuals meeting full diagnostic criteria for SPD would perform worse than SPF individuals that did not meet diagnostic criteria for SPD on performance indices of the CPT. While only one individual met criteria for SPD, the results of the one-sample t-test analysis supported this original hypothesis across CPT-AX omission errors, false alarms, and reaction time. This finding is consistent with research conducted by Moriarty and colleagues (2003) who used a similar clinical interview (SCID-II) to diagnose individuals with SPD. They reported that individuals with SPD made significantly more omission errors than controls on a dual-task version of the CPT (d = 0.88, large effect size). This suggests that the medium effect size for omission errors found in the current study for the individual with SPD could become more robust with a larger group of individuals meeting diagnostic criteria for SPD.

As the current study had one person with SPD, the relationship between endorsement of SPD criteria and performance on the CPT-AX was further assessed using quantitative rating totals from the SPD section of the SCID-II. Interestingly, the quantitative ratings total from a

clinician-administered interview of schizotypal personality disorder (SPD dimension score) showed a statistically significant correlation with CPT omission errors (R^2 = .26; large effect size), commission errors (R^2 = .15), and false alarms (R^2 = .19). In contrast, the self-report scale (SPQ-B) showed a statistically significant correlation with only reaction time (R^2 = .12; medium effect size) on the CPT, and did not approach statistical significance on any other CPT performance index. One explanation for this finding may be attributed to the relationship between the SPD dimension score and the factors of the SPQ-B. The SPD dimension score exhibited a statistically significant correlation with the Disorganized (R^2 = .10) and Interpersonal (R^2 = .08) factors of SPQ-B. However, the present study did not find a relationship between the SPD score and the Cognitive-Perceptual factor (R^2 = .03), a scale that addresses odd beliefs, magical thinking, and unusual perceptual experiences. One interpretation of this finding is that the SPQ-B does not allow the respondent the opportunity to explain or report the nature of their cognitive and perceptual experiences. During a clinician-administered interview, the examiner has the opportunity to clarify the nature of the beliefs and query regarding the degree and duration to which the beliefs are experienced resulting in a more valid score based on clinical judgement rather than self-report.

Studies comparing self-reported measures of schizotypy to clinician-administered interviews have reported mixed findings. Kendler, Thacker, & Walsh (1996) assessed first-degree relatives of four groups of patients diagnosed with DSM-III-R criteria, including schizophrenia, nonaffective psychoses, affective psychosis, and affective nonpsychosis, and first-degree relatives of the general population. Within these large group samples ($n \geq 158$), self-reported measures of pychoticism, magical ideation and social anhedonia (different measures than the one used in the current study) were directly compared to clinician-administered assessed

interviews. The authors reported that administration of a clinical interview better detected first-degree schizophrenia relatives than self-report measures. Kendler and colleagues (1996) also noted that schizotypal signs may be more accurately measured by trained examiners in contrast to an individual with schizotypy who may have poor insight of their own personality, particularly in relationship to other individuals. Another study reported similar findings and noted that interview assessments have greater diagnostic accuracy than questionnaire-based methods for schizotypy (Catts, Fox, Ward, & McConaghy, 2000).

Other studies have reported that questionnaire-based methods can detect schizotypy in some individuals (Calkins et al., 2004; Katsanis, Iacono, & Beiser, 1990). Calkins and colleagues (2004) used the SPQ and validity scales to assess first-degree relatives of schizophrenia patients. They found that relatives self-reported a higher degree of schizotypal traits than controls. It is important to note that the above authors did not use a clinical interview to compare the percentage of relatives meeting diagnostic criteria for SPD. Katsanis and colleagues (1990) compared self-report physical and social anhedonia scales to a structured clinical interview and found that the scales were able to differentiate patients with schizophrenia from relatives and relatives from control participants. While one study showed that 59% of university students scoring in the top 10% of the full SPQ met diagnostic criteria for SPD, a striking 41% did not (Raine & Benishay, 1995).

Thus, it appears that schizotypal traits may be more adequately assessed through an interview by trained clinicians who use clinical judgement to determine the presence of phenotypic aspects of SPD, rather than relying on self-report measures (e.g., SPQ). This may explain the inconsistent findings of CPT deficits when relying on self-report measures of schizotypal features.

Our hypothesis that B-SIT performance would result in a larger effect size than the CPT measures was partially supported. Group differences between olfactory identification scores did not approach statistical significance when the groups were defined by the SPQ-B. While the SPF males and females made more errors on the B-SIT than controls, the effect sizes were small (d = 0.16 to 0.34). However, consistent with our hypothesis, these effect sizes exceeded the CPT error measures (d = 0.05 to 0.08) when using the SPQ-B to define groups. Contrary to our hypothesis, the results for the females did not become statistically significant after accounting for the effect of the menstrual cycle. We found that B-SIT performance did approach statistical significance when comparing the individual with SPD to our control group (d = 0. 37; small effect size), with the individual with SPD making fewer correct responses (10) than the controls (M = 10.42). However, similar to when the groups were defined by the SPQ-B, the relationship between the SPD dimension score (for all participants) and B-SIT performance did not approach statistical significance. Using the SPD dimension score, the effect size for B-SIT performance was notably weaker than CPT performance indices.

One explanation for this finding is that olfactory identification deficits may not represent a robust endophenotype previously found in samples with schizophrenia or schizophrenia-spectrum disorders. This explanation does not appear to be supported by Park and Schoppe (1997) who first examined olfactory identification ability in psychometrically-defined schizotypes (using the longer SPQ). The results of their study revealed large effect sizes (Cohen's d = 1.12 for males and Cohen's d = 0.74 for females) for olfactory identification performance as measured by the UPSIT with high schizotypes performing worse on the UPSIT task. Based on the above study and Cohen's (1992) recommendations, we conducted power analyses prior to our study in order to estimate the sample size of males and females needed to

achieve a power level of .80. Though we had the necessary power to detect effect sizes similar to those reported by Park & Schoppe (1997), their findings were not replicated in the current study.

It is important to note two main differences between our study and the above study. Park and Schoppe (1997) used the longer version of the SPQ-B, to define high and low schizotypes. In addition, they used the UPSIT, a longer version of the B-SIT, to assess olfactory identification ability. Thus, three main issues may have limited the detection of olfactory deficits in individuals with SPF in the current study. First, the UPSIT may be more sensitive to differences in olfactory identification performance between controls and individuals with schizotypy. However, correlations between the B-SIT and the UPSIT range from 0.83 to 0.89 (Doty, 2001; Doty et al., 1996) suggesting that the B-SIT is generally as effective as the UPSIT in measuring olfactory dysfunction. Similarly, previous research has demonstrated the B-SIT's ability to detect differences between deficit and non-deficit schizophrenia (Goudsmit et al., 2003). However, the UPSIT showed a larger effect size (Cohen's $d = 1.09$) between non-deficit and deficit schizophrenia than the B-SIT (Cohen's $d = 0.86$). Seckinger and colleagues (2004) also used to the UPSIT to differentiate between deficit and non-deficit schizophrenia and similarly reported a larger effect ($d = 1.34$) than the previous study found with the B-SIT. The B-SIT has 12-items compared to the 40-item UPSIT. In the current study, the mean B-SIT score of all participants (N = 52) was 10.27 (SD = 1.27, range: 6 to 12). The B-SIT's relatively restricted range of items may have limited our ability to detect a relationship between olfactory identification performance and schizotypal features.

Second, Park & Schoppe's (1997) use of the full SPQ may have more adequately tapped into schizotypal personality traits that better distinguished the high schizotypes from the

comparison group. As the current study was not able to replicate previous findings using the full SPQ with both the BSIT and CPT indices, this could be one possibility. However this seems unlikely as intercorrelations between the SPQ-B and the full factor SPQ have reportedly ranged from .89 to .94 and the authors of the scale note that the SPQ-B can be used as both a screening measure and for dimensional analyses (Raine & Benishay, 1995).

Finally, the combined use of SPQ-B and the BSIT in the present study may have compounded this problem resulting in a lack of findings for olfactory identification in individuals with psychometrically-defined SPF. Since only one published study has addressed the relationship between olfactory identification and psychometrically-defined schizotypy (using full SPQ and longer UPSIT), the potential interaction from using the abbreviated versions of both of these measures remains unclear.

Several limitations were inherent in the present study. First, the sample used in this study consisted of undergraduate students. Research in community-samples would further our understanding of schizotypy and its relationship to performance deficits on the CPT and B-SIT to a more representative population. Second, the use of self-report of menstrual cycle as a measure of estrogen level is a gross estimate at best. A more accurate measure of the estrogen level (e.g., biological analysis) would more adequately assess the relationship between estrogen levels and performance on an olfactory identification task in females with psychometrically-defined schizotypy. This measure is an integral part of determining what role estrogen plays in the differences in olfactory identification performance between males and females with schizophrenia (Kopala, Good, & Honer, 1995).

The clinical utility of using olfactory identification with schizophrenia patients is currently being researched but findings thus far have been promising. One study reported that

individuals at "ultra-high risk" for developing psychosis who later developed schizophrenia made significantly more errors on the UPSIT than individuals who later developed a different psychotic disorder (Brewer et al., 2003). The authors note that this finding lends further support to olfactory identification deficits as a "premorbid marker of transition to schizophrenia." Another study reported olfactory identification impairment identifies individuals with schizophrenia who are prone to unremitting negative and disorganized symptoms (Good, Whitehorn, Rui, Milliken, & Kopala, 2006). Thus far, research on olfaction in schizophrenia has been more extensive than with other schizophrenia-spectrum disorders, suggesting a need for more research on olfaction in schizophrenia-spectrum disorders. This would help clarify the utility of olfactory identification as a genetic endophenotype.

Our data tentatively indicate that the SPQ-B may be less successful at identifying schizotypal personality traits than schizotypy assessed by a clinical interview. Future studies might compare the use of other structured interviews of schizotypy (e.g., the Schedule for Schizotypal Personalities (SSP): Baron, Asnis, & Gruen, 1981; or the Structured Interview for Schizotypy (SIS): Kendler, Lieberman, & Walsh, 1989) to the SPQ-B and other self-report schizotypy questionnaires. We found a relationship between performance indices of the CPT-AX and clinically-assessed SPD dimension scores. These data are consistent with a growing body of research indicating that the CPT is a useful endophenotype for schizophrenia-spectrum disorder. In regards to B-SIT performance, our preliminary and inconsistent findings suggest that further investigation is needed to adequately assess the relationship between schizotypy and olfactory identification performance. While the B-SIT did show slightly larger effect sizes than the CPT using the SPQ-B to define groups, none of the measures were statistically significant, clouding clear interpretation of this effect size difference. Notably, when a clinical interview

was used to define schizotypy, the CPT was clearly more sensitive to these traits than the B-SIT. Studies addressing olfactory identification performance in individuals meeting full criteria for schizotypal personality disorder would greatly increase our understanding of this relationship. Research is also needed to compare the ability of the B-SIT to the longer UPSIT in the ability to detect subtle differences in olfactory identification performance in individuals with subclinical symptoms along the schizophrenia spectrum.

Table 1:
Demographic information for Phase 2 participants

Cognitive Measure	**SPF (N = 26) Mean ± SD**	**Controls (N = 26) Mean ± SD**
SPQ-B score	18.08 ± 1.62	6.27 ± 1.93
Age	19.64 ± 1.10	19.75 ± 1.55
Gender		
Female	62%	62%
Male	38%	38%
Race		
Caucasian	65 %	73%
African-American	23 %	19%
Hispanic	8 %	8%
Visual Acuity		
20/15	57.7 %	46.2 %
20/20	26.9 %	38.5 %
20/30	11.5 %	11.5 %
20/40	0.04 %	0.04 %

Table 2:
CPT and B-SIT performance by group

Cognitive Measure	**SPF (N = 26) Mean ± SD**	**Controls (N = 26) Mean ± SD**	**Mann-Whitney *U***	***p***	***Cohen's d***
CPT Omission Errors	2.62 ± 2.62	2.42 ± 2.56	331.0	.90	0.08
CPT Commission Errors	1.54 ± 1.55	1.46 ± 1.39	329.5	.87	0.05
CPT False Alarms	0.005 ± 0.006	0.004 ± 0.006	318.5	.68	0.07
CPT Reaction Time (ms)	400.7 ± 63.89	437.31 ± 53.59	196.5	.01	0.62
B-SIT Females Score	10.38 ± 1.26	10.56 ± 0.96	300.5	.77	0.16
B-SIT Males Score	9.70 ± 1.57	10.20 ± 1.40	38.0	.34	0.34

Table 3:
Correlations of Factor Indices and Cognitive Performance Indices

(a) Correlations of SPQ Factor scores with SPD scores

	SPD2	SPQ-B	SPQd	SPQi	SPQc
SPD2	--	.30*	.31*	.29*	.18
SPQ-B		--	.87**	.90**	.87**
SPQd			--	.67**	.65**
SPQi				--	.68**
SPQc					--

Values are Pearson correlations; significance is two-tailed; * Statistically significant $p < .05$, **Statistically significant $p < .01$; SPD2 = Dimensional score from the Schizotypal Personality Disorder Section of the Structured Clinical Interview for DSM-IV Axis II Personality Disorders; SPQ-B = Abbreviated Schizotypal Personality Questionnaire; SPQd = Disorganized Scale of the SPQ-B; SPQi = Interpersonal Scale of the SPQ-B; SPQc = Cognitive Perceptual Scale of the SPQ-B

(b) Correlations of CPT & B-SIT Performance Indices with SPQ & SPD scores

	CPTo	CPTc	CPTfa	CPTrt	B-SIT
SPD2	.51**	.38**	.44**	-.01	-.11
SPQ-B	-.06	.08	.10	-.34*	-.14
SPQd	-.01	.04	.08	-.32*	-.04
SPQi	-.02	.02	.03	-.32*	-.15
SPQc	-.02	.12	.15	-.34*	-.16
CPTo	--	.42**	.37**	.20	-.05
CPTc		--	.89**	.04	.01
CPTfa			--	-.04	.01
CPTrt				--	.10
BSIT					--

Values are Spearman correlations; significance is two-tailed; CPTo = Continuous Performance Test (CPT) omission errors; CPTc = CPT commission errors; CPTfa = CPT false alarms; CPTrt = CPT reaction time; B-SIT = Brief Smell Identification Test

(c) Correlations of Male and Female B-SIT Performance Indices with SPQ & SPD scores

	B-SIT Performance		Female B-SIT Performance Controlling for Menstrual Cycle	
	Males	Females	Menstrual Days	Menstrual Phase
SPD2	-.25	-.15	-.17	-.16
SPQ-B	-.20	-.12	-.12	-.10
SPQd	-.24	. 06	.004	.007
SPQi	-.31	-.06	-.10	-.07
SPQc	-.10	-.19	-.21	-.22

Values are Spearman correlations; significance is two-tailed; Menstrual Days = Days from the start of the menstrual cycle; Menstrual Phase = Phase of the menstrual cycle during the time of the study (First 10 days vs. Last 20 days)

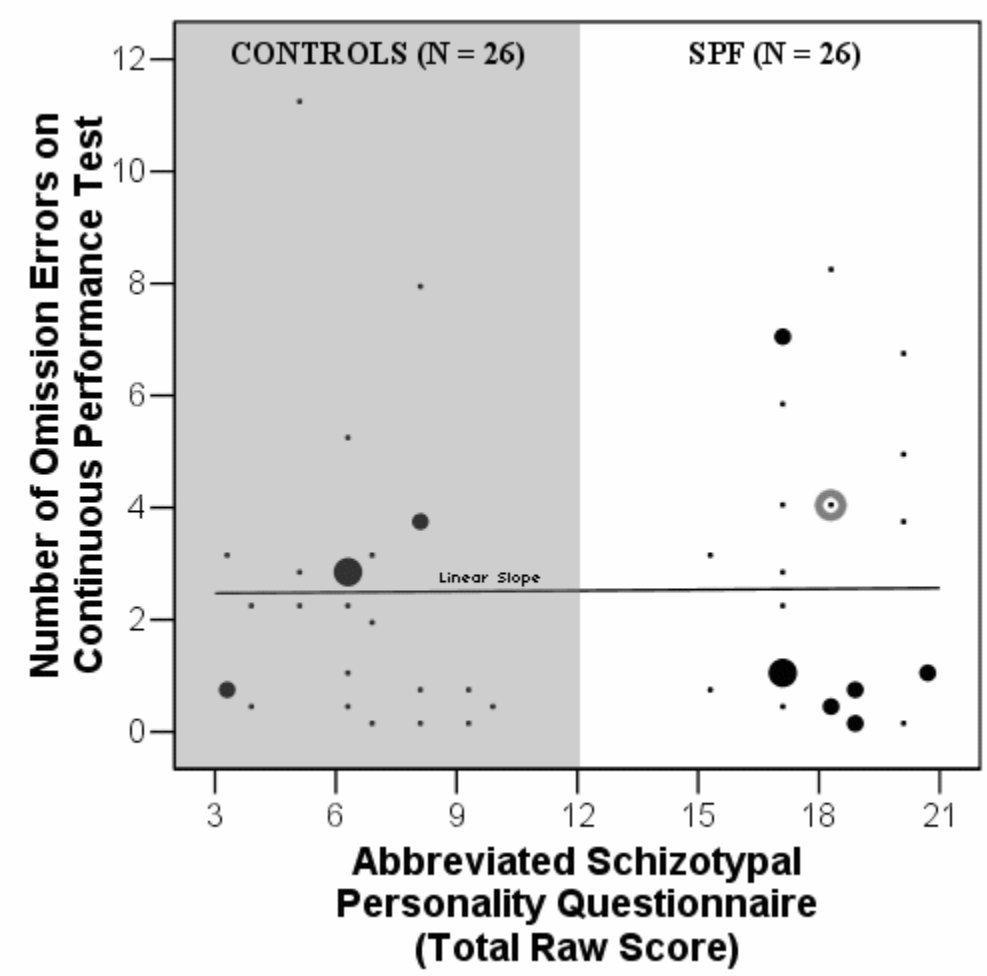


Figure 1: Distribution of omission errors on the CPT by SPQ-B total scores.
Note: Larger circles represent a large number of data points falling at that coordinate; SPF = Schizotypal Personality Features; the individual meeting diagnostic criteria for Schizotypal Personality Disorder is denoted with a circular band around the data point.

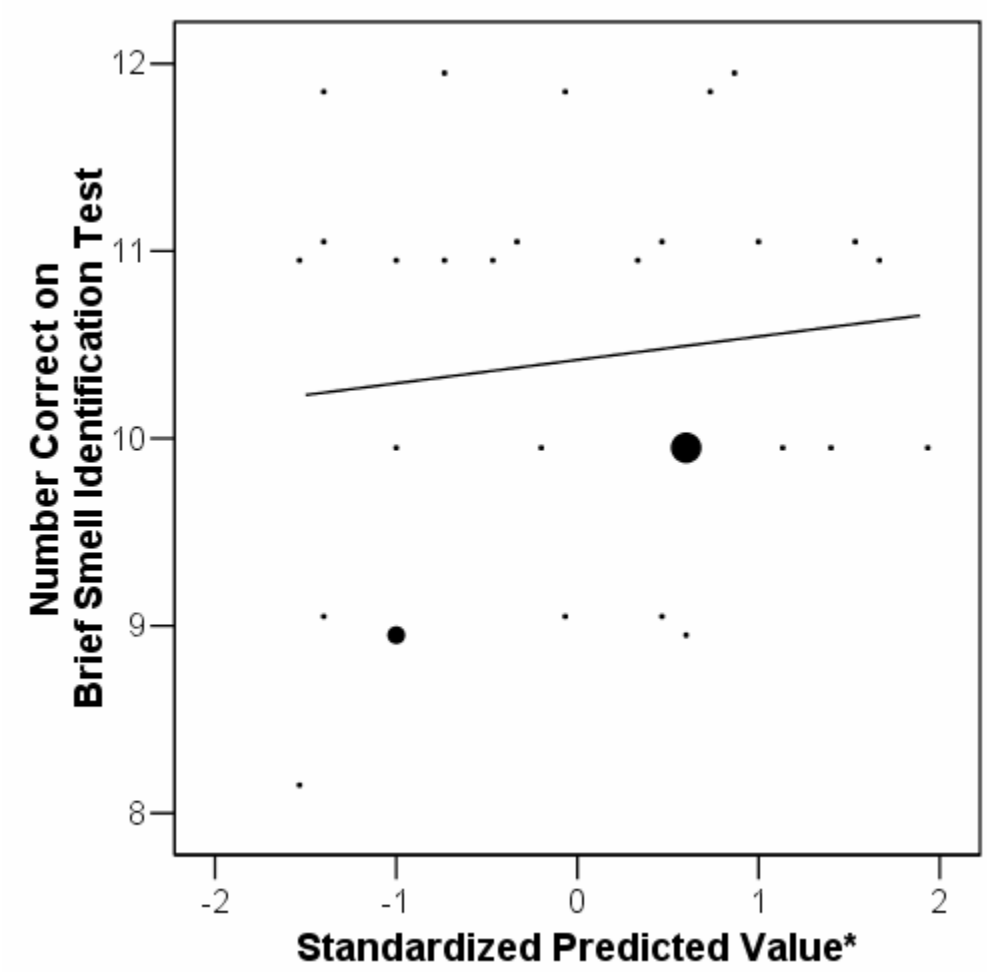


Figure 2: Distribution of female BSIT scores by SPQ-B score after covarying for menstrual phase

* Represents z score of SPQ-B score after covarying for menstrual cycle (First 10 days vs. Last 20 days); Larger circles represent a large number of data points falling at that coordinate.

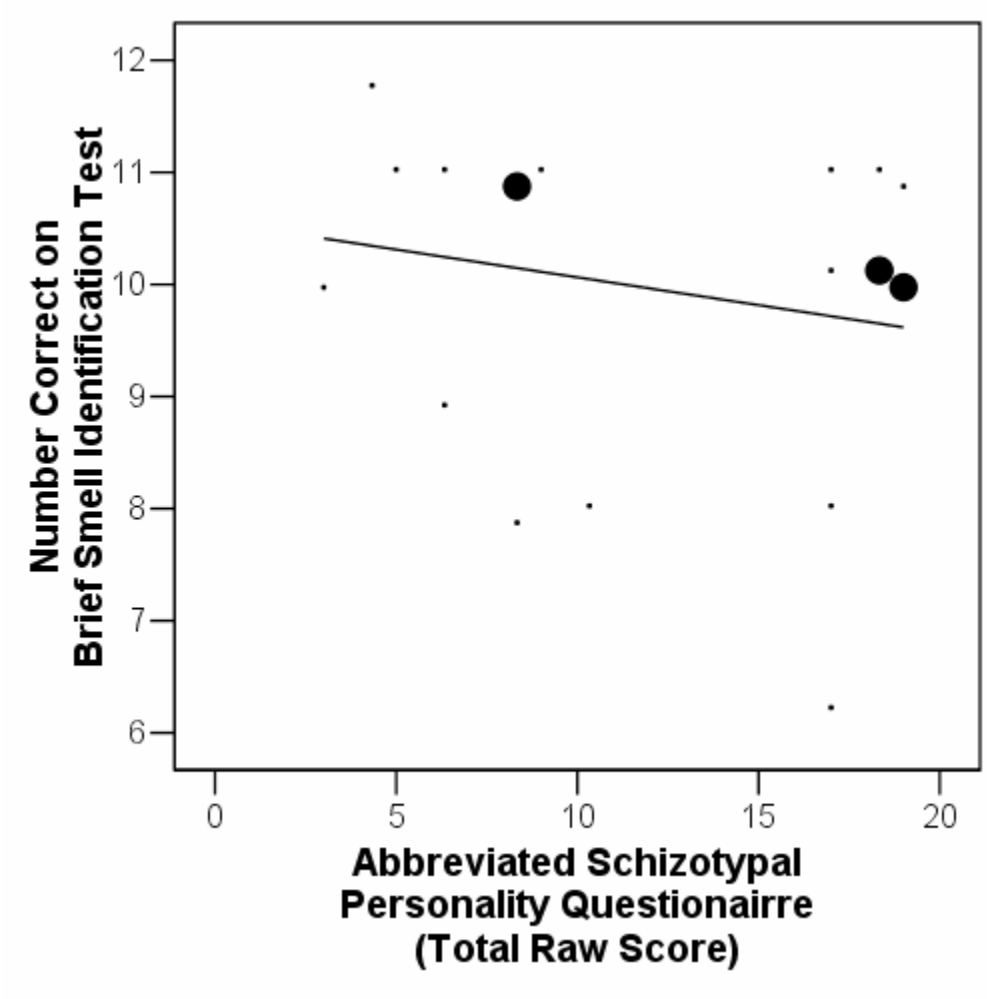


Figure 3: Distribution of male BSIT scores by SPQ-B total score.
Note: Larger circles represent a large number of data points falling at that coordinate; the individual meeting diagnostic criteria for Schizotypal Personality Disorder is denoted with a circular band around the data point.

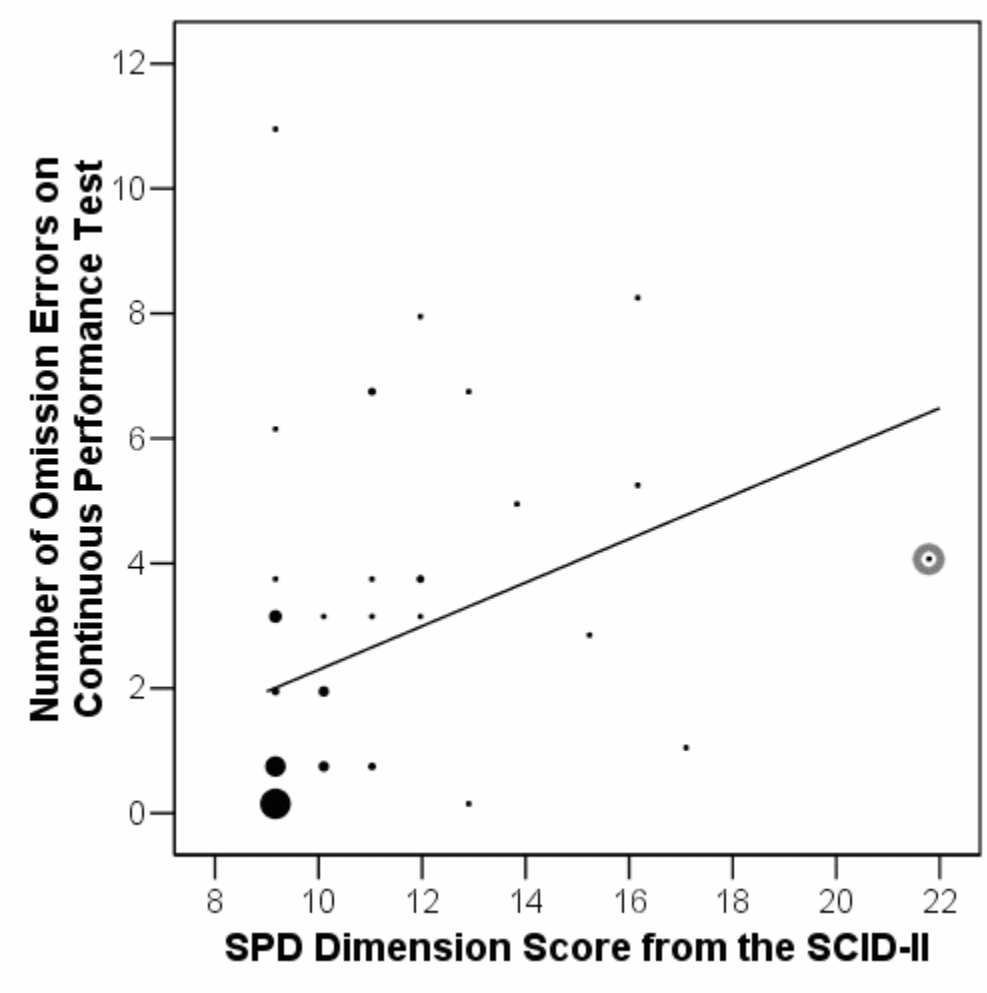


Figure 4: Distribution of omission errors on the CPT by SPD dimension scores.
SPD dimension score was derived by summing each quantitative rating from the SPD items on the Structured Clinical Interview for DSM IV Axis II Personality Disorders (SCID-II). Note: Larger circles represent a large number of data points falling at that coordinate; the individual meeting diagnostic criteria for Schizotypal Personality Disorder is denoted with a circular band around the data point.

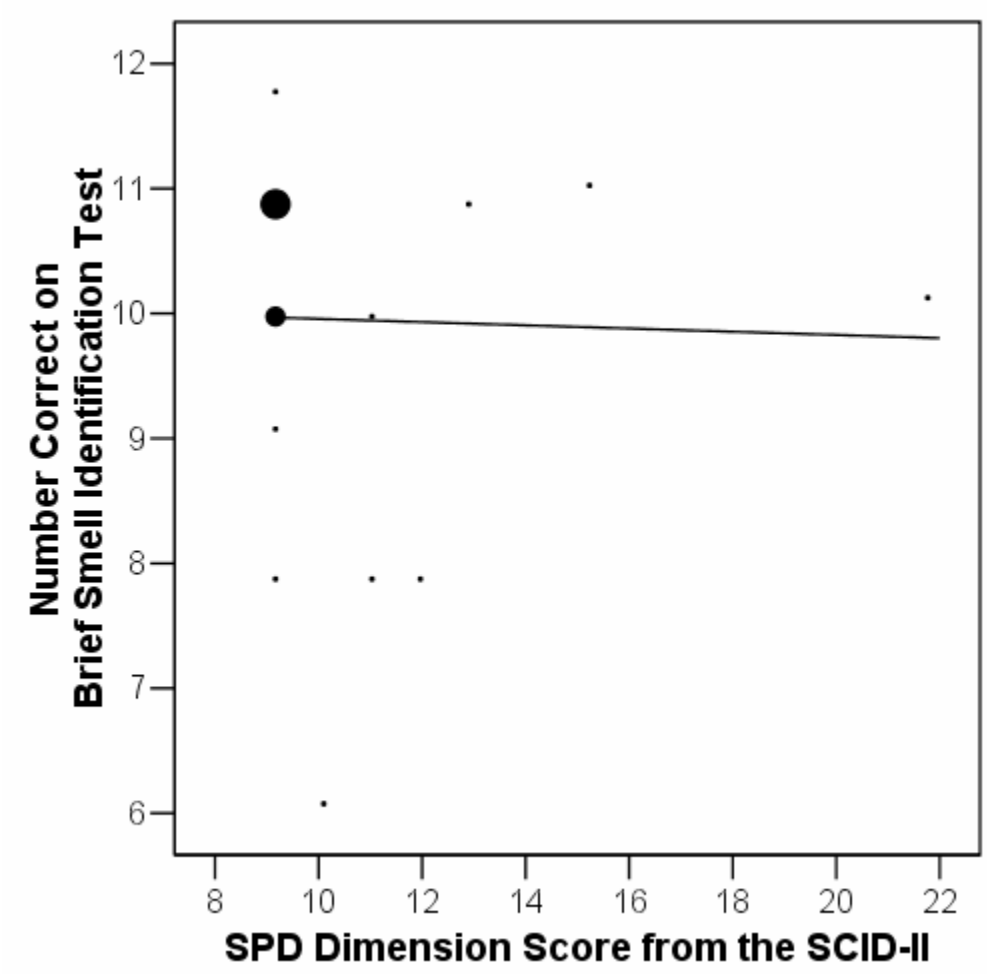


Figure 5: Distribution of male BSIT scores by SPD dimension score.
Note: Larger circles represent a large number of data points falling at that coordinate; the individual meeting diagnostic criteria for Schizotypal Personality Disorder is denoted with a circular band around the data point.

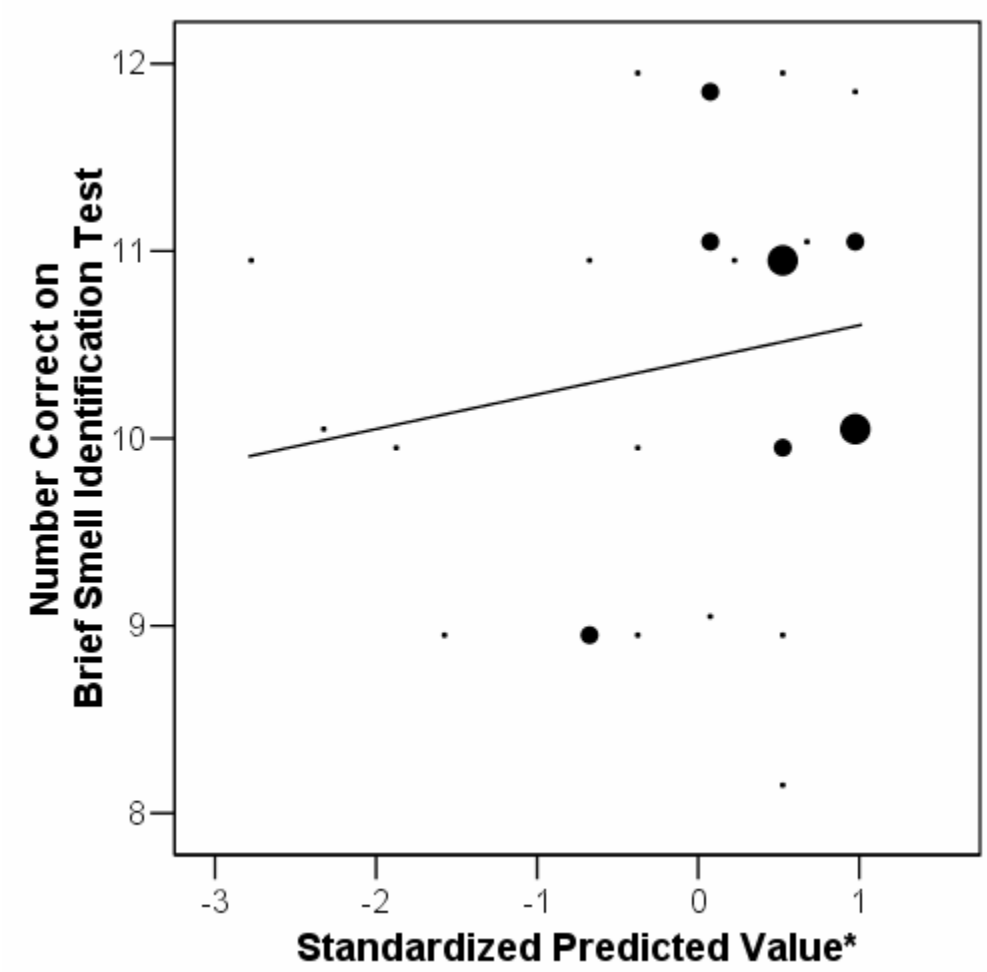


Figure 6: Distribution of female BSIT scores by SPD dimension score after covarying for menstrual phase.

* Represents z score of SPD dimension score after covarying for menstrual cycle (First 10 days vs. Last 20 days); SPD dimension score was derived by summing each quantitative rating from the SPD items on the Structured Clinical Interview for DSM IV Axis II Personality Disorders (SCID-II); Larger circles represent a large number of data points falling at that coordinate.

APPENDIX A: ABBREVIATED SCHIZOTYPAL PERSONALITY QUESTIONAIRRE

Instructions: Please answer each item by clicking Y (Yes) or N (No). Answer **all** items even if unsure of your answer. When you have finished, check over each one to make sure you have answered them all.

Yes	No	1.	People sometimes find me aloof and distant.
Yes	No	2.	Have you ever had the sense that some person or force is around you, even though you cannot see anyone?
Yes	No	3.	People sometimes comment on my unusual mannerisms and habits
Yes	No	4.	Are you sometimes sure that other people can tell what you are thinking?
Yes	No	5.	Have you ever noticed a common event or object that seemed to be a special sign for you?
Yes	No	6.	Some people think that I am a very bizarre person.
Yes	No	7.	I feel I have to be on my guard even with friends.
Yes	No	8.	Some people find me a bit vague and elusive during a conversation.
Yes	No	9.	Do you often pick up hidden threats or put-downs from what people say or do?
Yes	No	10.	When shopping do you get the feeling that other people are taking notice of you?
Yes	No	11.	I feel very uncomfortable in social situations involving unfamiliar people.
Yes	No	12.	Have you had experiences with astrology, seeing the future, UFOs, ESP or a sixth sense?
Yes	No	13.	I sometimes use words in unusual ways.
Yes	No	14.	Have you found that it is best not to let other people know too much about you?
Yes	No	15.	I tend to keep in the background on social occasions.
Yes	No	16.	Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?
Yes	No	17.	Do you often have to keep an eye out to stop people from taking advantage of you?
Yes	No	18.	Do you feel that you are unable to get "close" to people?
Yes	No	19.	I am an odd, unusual person.
Yes	No	20.	I find it hard to communicate clearly what I want to say to people.
Yes	No	21.	I feel very uneasy talking to people I do not know well.
Yes	No	22.	I tend to keep my feelings to myself.

APPENDIX B: INFREQUENCY-PSYCHOPATHOLOGY SCALE

Instructions: If the statement is **true** or **mostly true**, as applied to you, click true (T). If a statement is **false** or **not usually true**, as applied to you, click false (F).

True	False	1.	It would be better if almost all laws were thrown away.
True	False	2.	Sometimes I am so strongly attracted by the personal articles of others such as shoes, gloves, etc., that I want to handle or steal them, though I have no use for them.
True	False	3.	Someone has been trying to poison me.
True	False	4.	In walking I am very careful to step over sidewalk cracks.
True	False	5.	Someone has been trying to rob me.
True	False	6.	There are persons who are trying to grab everything they can get in this world.
True	False	7.	Everything tastes the same.
True	False	8.	It does not bother me particularly to see animals suffer.
True	False	9.	I have been told that I walk during sleep.
True	False	10.	I have never been in love with anyone.
True	False	11.	My neck spots with red often.
True	False	12.	I am afraid of using a knife or anything very sharp or pointed.
True	False	13.	Sometimes I enjoy hurting persons I love.
True	False	14.	Someone has control over my mind.
True	False	15.	I have often wished I were a member of the opposite sex.
True	False	16.	I can express my true feelings only when I drink.
True	False	17.	I hate my whole family.
True	False	18.	I can't go into a dark room alone even in my own home.
True	False	19.	I do not read every editorial in the newspaper everyday.
True	False	20.	Once in a while I put off until tomorrow what I ought to do today.
True	False	21.	I love my father, or (if your father is dead) I loved my father.
True	False	22.	Sometimes when I am not feeling well I am irritable.
True	False	23.	I get angry sometimes.
True	False	24.	I believe in law enforcement.
True	False	25.	My mother is a good woman, or (if your mother is dead) my mother was a good woman.
True	False	26.	I love my mother, or (if your mother is dead) I loved my mother.
True	False	27.	Talking over problems and worries with someone is often more helpful than taking drugs or medicine.

APPENDIX C: ABBREVIATED MARLOWE-CROWN SOCIAL DESIRABILITY SCALE

Instructions: If the statement is **true** or **mostly true**, as applied to you, click true (T) If a statement is **false** or **not usually true**, as applied to you, click false (F).

True	False	1.	It is sometimes hard for me to go on with my work if I am not encouraged.
True	False	2.	I sometimes feel resentful when I don't get my way.
True	False	3.	On a few occasions, I have given up doing something because I thought too little of my ability.
True	False	4.	There have been times when I felt like rebelling against people in Authority even though I knew they were right.
True	False	5.	No matter who I'm talking to, I'm always a good listener.
True	False	6.	There have been occasions when I took advantage of someone.
True	False	7.	I'm always willing to admit it when I make a mistake.
True	False	8.	I sometimes try to get even rather than forgive or forget.
True	False	9.	I am always courteous, even to people who are disagreeable.
True	False	10.	I have never been irked when people expressed ideas very different from my own.
True	False	11.	There have been times when I was quite jealous of the good fortune of others.
True	False	12.	I am sometimes irritated by people who ask favors of me.
True	False	13.	I have never deliberately said something that hurt someone's feelings.

APPENDIX D: INFREQUENCY ITEMS

Instructions: If the statement is **true** or **mostly true**, as applied to you, click true (T). If a statement is **false** or **not usually true**, as applied to you, click false (F).

True	False	1.	There have been a number of occasions when people I know have said to hello to me.
True	False	2.	I cannot remember a single occasion when I have ridden on a bus.
True	False	3.	I find that I often walk with a limp which is the result of a skydiving accident.
True	False	4.	There have been times when I have dialed a telephone number only to find that the number was busy.
True	False	5.	I visited Easter Island last year.
True	False	6.	I go at least once every two years to visit either northern Scotland or some parts of Scandinavia.
True	False	7.	Sometimes I feel sleepy or tired.
True	False	8.	On some occasions I have noticed that some other people are better dressed than myself.

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