

AUTOBIOGRAPHICAL MEMORY AND THEORY OF MIND IN SCHIZOTYPY

by

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ABSTRACT

Individuals with schizophrenia exhibit marked impairments on tasks assessing theory of mind (ToM) and autobiographical memory (AM) qualities, and preliminary research has indicated a positive link between these abilities. This study is the first to systematically explore this relationship in the related personality trait of schizotypy. In a study of 47 undergraduate students (23 males) reporting a wide continuous range of schizotypy, we found that females, but not males, exhibited a negative correlation between ToM and schizotypy, and an unexpected positive correlation between AM qualities and schizotypy. Factor score analysis within females indicated that disorganized schizotypy was the strongest correlate of both ToM (i.e., affective ToM; ability to infer emotions), and AM qualities (i.e., mental imagery vividness). Finally, independent of schizotypy and sex, ToM was negatively correlated with AM qualities. This negative association between ToM and AM as well as the positive relationship between schizotypy and AM (in females) distinguish findings in schizotypy from those in schizophrenia. Although, the qualities of AM in schizotypy are relatively unexplored in schizotypy, overlapping and AM-related constructs (e.g., mental image vividness, creativity) are enhanced in schizotypy. This phenomenon is theorized to occur due to a reduced latent inhibition process, which also reveals distinct patterns of sexual dimorphism in schizotypy. In sum, the current study found sex to be a critical variable in each hypothesis, demonstrating a unique pattern in females, but not males. It could be that distinct underlying mechanisms account for sex differences on ToM and AM tasks in schizophrenia-related disorders.

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES.....	v
INTRODUCTION	1
METHOD	5
Participants.....	5
Measures	7
Procedure	9
RESULTS	11
Theory of Mind: Relationships with Schizotypy and Sex	11
Autobiographical Memory: Relationships with Schizotypy and Sex	12
Autobiographical Memory: Relationships with Theory of Mind, Schizotypy, and Sex	12
DISCUSSION.....	14
APPENDIX A: TABLES AND FIGURES	22
APPENDIX B: IRB APPROVAL LETTER	28
LIST OF REFERENCES.....	32

LIST OF TABLES AND FIGURES

Table 1: Descriptive Statistics and Comparison of Mean Scores	23
Table 2: Correlation Matrix of SPQ, TASIT–SI, and AMQ Scores, by Sex (With Males Located Below the Diagonal)	24
Table 3: Results of Two Multiple Linear Regression Analyses Predicting AMQ Total Score	25
Figure 1: Scatterplot of the SPQ Disorganized Factor and the Social Inference–Enriched (SI–E) Scores in Males	26
Figure 2: Scatterplot of the SPQ Disorganized Factor and the Social Inference–Enriched (SI–E) Scores in Females	26
Figure 3: Scatterplot of the SPQ Disorganized Factor and the Autobiographical Memory Questionnaire (AMQ) Scores in Males.....	27
Figure 4: Scatterplot of the SPQ Disorganized Factor and the Autobiographical Memory Questionnaire (AMQ) Scores in Females	27

INTRODUCTION

Broad cognitive impairments have become hallmark features of schizophrenia (Green, Kern, & Heaton, 2004; Green & Horan, 2010; Harrington, Siegert, & McClure, 2005). In particular, the constructs of theory of mind (ToM) and autobiographical memory (AM) have received considerable attention over the past two decades.

ToM, a social cognitive construct, was initially defined as the ability to correctly assess one's own and others' mental states (Premack & Woodruff, 1978). Current conceptualizations have broadened the scope of ToM to include accurate identification of the social subtleties of both verbal (e.g., sarcasm, irony, deception) and non-verbal (e.g., tone of voice, facial gestures) forms of social communication. Furthermore, studies examining ToM performance in individuals with schizophrenia have consistently demonstrated impairments, which typically yield a large effect size and predict functional outcome, over and above current symptomatology (for meta-analyses see Bora, Yucel, & Pantelis, 2009; Sprong, Schothorst, Vox, Hox, & Engeland, 2007).

AM, a subsystem of episodic memory, refers to the active process of mentally reliving or recollecting personally-experienced events relevant to the self (Reese, 2002). Tulving (1985) proposed that the defining aspect of AM is the capacity to mentally travel back in time to re-experience past events, distinguishing AM from episodic memory. Individuals with schizophrenia also exhibit impaired AM functioning, characterized by an overly general style (e.g., Kaney, Bowen-Jones, & Bentall, 1999; Warren & Haslem, 2007), in which they were found to generate fewer distinct memories (Elevåg, Kerbs, Malley, Seeley, & Goldberg, 2003; Wood, Brewin, & McLeod, 2006) and fewer personal (cf. public) events (Cuervo-Lombard et al.,

2007; Danion et al., 2005; Ruitort et al., 2003; Wood et al., 2006). These impairments remained significant even after controlling for executive functioning (Cuervo-Lombard et al., 2007) and intelligence (Lawrence, Doughty, Al-Mousawi, Clegg, & Done, 2007). It has been argued that without an intact AM, one would have no way of knowing oneself, the world, or others (Bruhn, 1990). Thus, theories have proposed AM impairments may have a negative downstream effect on ToM ability in nonpsychiatric adults (Naito, 2003; Perner, 2000; Perner, Kloo, & Gornik, 2007; Welch-Ross, 1997), and individuals with schizophrenia (Corcoran, 2000). Consistent with this idea, preliminary research suggest that ToM and AM are positively associated in schizophrenia samples (Corcoran & Frith, 2003; Mehl, Rief, Mink, Lullman, & Lincoln, 2011).

It is generally acknowledged that schizophrenia falls on a spectrum of related disorders, with a multifaceted etiology and susceptibility genes interacting with environmental anomalies to produce various phenotypes of schizophrenia (Claridge, 1985; Siever & Davis, 2004). At the lowest level of severity on the schizophrenia continuum is the latent personality construct of schizotypy, which refers to the traits and behaviors exhibited in schizotypal personality disorder and schizophrenia, but at a subclinical level with minimal functional impairment (Lenzenweger, 2010; Raballo & Parnas, 2011). Studies indicate that schizotypy appears to share genetic liability with schizophrenia, as schizotypy is more prevalent in first-degree relatives of schizophrenia patients than in those without a family history of schizophrenia (Appels, Sitskoorn, Vollema, & Kahn, 2004; Asarnow et al., 2001). Therefore, investigating neurocognitive deficits in individuals with schizotypy can provide a window into the neuropathology of schizophrenia without the accompanying confounds (e.g., chronic antipsychotic medication and severe active symptomatology).

As previously mentioned, individuals with schizophrenia demonstrate significant impairments across a variety of ToM tasks. Although inconclusive, ToM deficits have been observed in adults with schizotypy as well (e.g., Chung, Kang, Shin, Yoo, & Kwon, 2008; Gooding & Pflum, 2011; Langdon & Coltheart, 1999). Phenomenological aspects of AM, on the other hand, have yet to be systematically explored in schizotypy. Although individuals with schizophrenia have reported lower ratings on phenomenological aspects of AM (Cuervo et al., 2007; Danion et al., 2005), preliminary evidence suggests that those with schizotypy experience more vivid *involuntary* AM, than those with low schizotypy for trauma-related (Holmes & Steel, 2004; Marzillier & Steel, 2007) and non-trauma-related events (Jones & Steel, 2012). In addition, those with schizotypy appear to have an enhanced *mental time travel* ability, or the cognitive capacity of projecting oneself into the past to relive, and forward to pre-live, AM events (Winfield & Kamboj, 2010). Moreover, substantial evidence indicates that mental imagery vividness is independent of the severity of current psychopathology and may be an endophenotype for schizophrenia (Aleman, Böcker, Hijman, de Haan, & Kahn, 2003; Mintz & Alpert, 1972; Sack, van de Ven, Etschenberg, Schatz, & Linden, 2005). Further support for this relationship is derived from studies examining relatives of patients with schizophrenia (Oertel et al., 2009) and those high in schizotypy (Aleman, Böcker, & de Haan, 1999; Oertel et al., 2009; van de Ven & Merckelbach, 2003),

Furthermore, evidence reveals a moderating effect of sex on a wide variety of related cognitive tasks in schizotypy (Bedwell, Hernandez, & Ranieri, 2011; Krabbendam, Myin-Germeys, Hanssen, & van Os, 2005; Lubow & De la Casa, 2002; Thakkar, Brugger, & Park, 2009). In fact, one study reported a significant negative association between ToM and schizotypy in males, but not females (Langdon & Coltheart, 1999), while another found that both males and

females exhibited negative but distinct interactions with schizotypy factors and self-reported affective and cognitive empathy (Thakkar & Park, 2010). Sex differences are also commonly reported on memory tasks in the general population, which typically find females to outperform males (e.g., Davis 1999; Fujita et al., 1991). In schizophrenia, female patients were found to outperform male patients on tasks of verbal memory and learning, beyond sex differences found typically found in the normal population (Abbs et al., 2011).

Therefore, the first goal of this study is to explore the relationship between AM and ToM in schizotypy. We hypothesized that there would be a negative relationship between schizotypy scores and both AM and ToM, separately. Next, we hypothesized that a positive relationship would exist between AM and ToM across the sample, and that this relationship would be stronger in those with schizotypy. Our second goal was to explore the effect of sex in each of the previously mentioned hypotheses. Specifically, it was hypothesized that males would exhibit a negative relationship between schizotypy and ToM score; and to our knowledge, the potential moderating effect of sex on AM in schizotypy has yet to be reported. Based on previously cited literature, it was anticipated that females with schizotypy would report higher ratings on phenomenological aspects of AM as compared to female controls. However, we do not expect to observe this difference across the male participants.

METHOD

Participants

This study examined undergraduate students enrolled in classes offered by the psychology department of a large southeastern U.S. university. After providing informed consent, participants completed an online screening questionnaire which consisted of a fixed-random order of the following scales: (1) the Schizotypal Personality Questionnaire (SPQ; Raine, 1991), a 74-item self-report measure of schizotypy traits, which yields a total score and three factor scores akin to the subtypes of schizophrenia, the Cognitive-Perceptual, the Interpersonal, and the Disorganized factor scores; (2) the Abbreviated Marlowe-Crowne Social Desirability Scale (MCDS-A; Reynolds, 1982), a 13-item validity scale that assesses the over-endorsement of socially appropriate responses; (3) the Abbreviated Infrequency Scale derived from the Personality Research Form (IFS-A; Jackson, 1984; Calkins, Curtis, Grove, & Iacono, 2004), an 8-item validity scale that measures the frequency of highly-improbable responses; and (4) the Beck Depression Inventory-II (BDI-II; Beck, Steer, & Brown, 1996), a 21-item measure for the clinical screening of current depressive symptomatology with strong psychometric properties. Participants received academic credit in return for taking the online screening questionnaire.

Inclusion and exclusion cut-off scores for further laboratory participation were derived from the data of the first 200 participants to complete the questionnaire in its entirety. Students were excluded from further participation if they, (a) scored greater than two standard deviations above the mean on the MCSD-A, (b) endorsed more than one item in the wrong direction on the

IFS-A, (c) did not complete the questionnaire in its entirety, or (d) reported moderate to severe levels of depression (BDI-II score ≥ 18), since periods of affective disturbance have been consistently found to impair AM (Kuyken & Dalglish, 2011; McCleery et al., 2012; Mohanty et al., 2008; Williams & Broadbent, 1986).

Out of a total of 2,363 students that completed the online questionnaire, a total of 1,623 (69%) students met all initial screening criteria. Students scoring within the top 20th ($N = 410$) or bottom 20th percentile ($N = 382$) on the SPQ total score were recruited to participate in the lab-based portion of the study for additional academic credit. A total of 48 participants completed the lab-based phase of the study; however, one participant was identified as a statistical outlier and removed from all further analysis (see Results section below). Thus, the final sample consisted of 47 participants (48.9% male) with a mean age of 19.94 years ($SD = 4.32$; range = 18 to 47). Thirty-seven participants characterized their race as ‘Caucasian’ (78.7%), 5 as ‘African American’ (10.6%), 4 as ‘Hispanic’ (8.5%), and 1 identified as ‘Biracial or of Mixed Descent’ (2.1%). (see Table 1 for SPQ descriptive statistics).

The SPQ was re-administered on the date of testing and despite recruiting for relatively high and low groups from the online SPQ, the lab-based SPQ scores did not reveal ‘high’ or ‘low’ groups, but a continuous range of scores. Therefore, we decided to analyze schizotypy as a continuous dimension, which aligns more closely with the dimensional model of schizotypy (Tsuang, Stone, Tarbox, & Faraone, 2002; Appels et al., 2004). To further characterize the sample, specific sections of the Structured Clinical Interview for the DSM-IV Axis II Disorders (SCID-II; First, Gibbon, Spitzer, Williams & Benjamin, 1997), assessing avoidant personality disorder (APD), paranoid personality disorder (PPD), and schizotypal personality disorder (SPD) were administered by a graduate student in a doctoral clinical psychology program (A.D.). One

participant met diagnostic criteria for APD (2.1%), 6 for PPD (12.5%), and 8 for SPD (16.7%). All participants denied a previous diagnosis of autism or Asperger's disorder, a past or present neurological condition, and a family history of schizophrenia or schizoaffective disorder.

Measures

Autobiographical Memory Questionnaire (AMQ)

The AMQ (Rubin, Schrauf, & Greenberg, 2003) is a 16-item self-report questionnaire that assesses various *phenomenological aspects* of AM. Fifteen AMs were elicited by employing 15 *cue words* (each located on the top, front page of each AMQ), each prompting the first AM that comes to mind. The cue words are derived from the reliability study, conducted by the developers (Rubin, 1980; Rubin, Schrauf, & Greenberg, 2004), and include: *city, dress, horse, lake, love, mother, party, plant, poetry, kiss, mountain, ocean, sickness, fire, and wine*. Following verbal recitation of each memory, participants completed an questionnaire (AMQ) for each memory. The first 15 items are rated on a 7-point Likert scale and averaged within participants to form three AMQ factor score: (1) the *Recollection/Belief* (AMQ-R/B) factor score, which assesses the subjective feeling of reliving or re-experiencing the past event, as well as the feeling of *remembering*, rather than knowing that an event occurred, (2) the *Component Processes* (AMQ-CP) factor score, which mainly assesses visual and auditory imagery associated with the event, and (3) the *Reported Properties of Event* (AMQ-RP) factor score, which assesses the feeling of personal importance, accompanying the event (i.e., a self-defining memory), as well as an estimate of event rehearsal frequency, or how many times this event was previously elicited (mentally or verbally). The final item assesses AM *specificity* and asks participants to categorize

the recalled event into one of three event categories: (a) a *single event*, an event that included reference to a particular time and place, (b) a *merging event*, a summary of similar events that occurred on different occasions, or (c) an *extended event*, an event that spanned multiple days. A total AM specificity score was calculated by adding the number of single events recalled. The AMQ has exhibited strong test-retest reliability over a one or two week interval (with Cronbach's α values ranging from .84 to .96).

The Awareness of Social Inference Test (TASIT) – Social Inference–Minimal (SI-M) & and Social Inference–Enriched (SI-E) tasks

TASIT-SI (McDonald, Flanagan, & Rollins, 2002) is comprised of 31 short videotaped-vignettes divided into two parts, the *SI-M* and *SI-E* tasks, depicting professional actors engaging in real-world social interactions, developed to assess ToM ability in adults with traumatic brain injuries. The *SI-M* task displays 15 vignettes, five of which depict scenes of sincerity (actual dialogue and context are consistent), while the remaining 10 vignettes display scenes of sarcasm (meaning is opposite from the actual dialogue). The *SI-E* task includes 16 vignettes and depicts actors as either lying (dialogue is contrary to actual beliefs), or expressing sarcasm (dialogue is contrary to the message intends to display). The *SI-E* task is considered to be more difficult, as it requires the accurate appraisal of context, as the speech for both scripts are identical in verbal content but differ only in the subtle, non-verbal characteristics of speech (e.g., body language, tone of voice, facial gestures). To perhaps compensate for this difference in level of difficulty, the developers included a contextually-relevant visual cue in the sarcasm vignettes, which reveals the true nature of the scene (McDonald et al, 2002). Following each vignette, participants were asked to judge four three-option forced-choice prompts regarding the target actor's (1)

beliefs or knowledge ('thinking'), (2) meaning by what he or she said ('saying'), (3) intentions ('doing'), and (4) actual feelings ('feeling'). Scores were calculated separately for both tasks by adding the number of correct responses for each judgment, across probe items.

TASIT-SI has demonstrated adequate reliability, reporting moderate to high test-retest reliability across both the SI-M and SI-E scores over a period of 5-26 weeks (ranging from .83 to .88, respectively; Schrauf et al., 2004). Previous investigations of construct validity have also revealed significant correlations between TASIT-SI scores and well-established measures of social perception (e.g., labeling and matching photographs of faces; Ekman and Freisen, 1976) and ToM (e.g., first-order ToM stories, second-order ToM stories, and physical/control stories; McDonald et al., 2006).

Procedure

All participants were assessed on separate occasions, provided informed consent, and completed the tasks listed above. Additionally, participants are administered a paper-and-pencil version of the SPQ, in addition to specific clinical interviews to examine the reliability of schizotypy scores, on the date of testing.

During the AMQ administration, the experimenter reads the directions aloud to participants (verbatim from the AMQ cover page), instructing each to focus on the cue word until a specific AM comes to mind. After processing the AM, participants are asked to verbally recite each memory into a digital audiorecorder, in as much detail to sufficiently "tell a story." Participants were encouraged to take as much time as necessary, as a memory may not just "pop into your head." On average, participants completed the AMQ in approximately 35 to 40 minutes (range: 10 to 75 minutes). It should be noted that the present study departs from the published

AMQ procedure in that we opted for participants to complete the AMQ in private to reduce potential confounds related to the presence of an experimenter in the room and to allow the subject to fully *relive* a personally-experienced event.

During TASIT–SI tasks, participants viewed the videotaped vignettes on a 26” monitor. The videotape was paused following each vignette, giving the participant time to answer the four probe items related to that scene. This procedure was completed until all vignettes were viewed, with an average completion time of approximately 25-to-30 minutes.

RESULTS

We conducted a series of multiple linear regression analyses to assess each hypothesis. One outlier was identified in the SI-M score analysis (Studentized residual score = -4.42, Cook's distance score = 0.27) and removed from all further analyses. Sample demographic information and descriptive statistics for the SPQ and all cognitive measures are shown in Table 1.

Theory of Mind: Relationships with Schizotypy and Sex

Two female participants failed to complete both TASIT-SI tasks; thus, all analyses examining TASIT-SI tasks included 45 participants (51.1% male). TASIT-SI scores were analyzed in separate regression analyses, each containing the main effects of sex, SPQ total score, and the higher-order sex by SPQ interaction.

Our data revealed that the SI-M score exhibited a trend-level relationship with sex, $\beta = 0.44$, $t(41) = 1.89$, $p = .07$, with females performing better, while the SPQ total score failed to exhibit a significant relationship, $\beta = 0.59$, $t(41) = 1.26$, $p = .21$. The sex by SPQ interaction also failed to reach statistical significance, $\beta = -0.67$, $t(41) = 1.42$, $p = .16$. On the other hand, the SI-E score was significantly related to the main effect of sex, $\beta = .58$, $t(41) = 2.59$, $p = .01$ with females performing better, and SPQ total score, $\beta = 0.92$, $t(41) = 2.06$, $p = .05$. The sex by SPQ interaction was also found to associate with the SI-E score, $\beta = -1.08$, $t(41) = 2.40$, $p = .02$. Further analysis revealed that the SPQ total score was negatively associated with the SI-E score in females, $\beta = -0.48$, $t(20) = 2.46$, $p = .02$, but was not related to the SI-E score in males, $\beta = 0.22$, $t(21) = 1.04$, $p = .31$. Within female participants, the SPQ Disorganized, $r(20) = -.53$, $p =$

.01 (see Figures 1 and 2), and SPQ Cognitive-Perceptual, $r(20) = -.42, p = .05$, factor scores exhibited the strongest relationships with the SI-E ‘feeling’ probe items, $r(20) = -.58, p = .005$. Trends were found for both the ‘doing’ probe items, $r(20) = -.41, p = .06$, and the ‘thinking’ probe items, $r(20) = -.36, p = .10$, within females.

Autobiographical Memory: Relationships with Schizotypy and Sex

Next, the AMQ total score was predicted from the same set of variables as listed above. The results revealed a trend for the SPQ total score to negatively predict the AMQ total score, $\beta = -0.80, t(43) = 1.87, p = .07$, while no main effect was revealed for sex, $\beta = -0.03, t(43) = 0.13, p = .90$. The sex by SPQ interaction also positively associated with the AMQ total score, $\beta = 0.96, t(43) = 2.24, p = .03$. Further correlations were conducted to explore this interaction, and a trend was observed for the SPQ total score to positively predict the AMQ total score in females, $\beta = 0.38, t(22) = 1.95, p = .06$, but not in males, $\beta = -0.23, t(21) = 1.09, p = .29$. Moreover, only the SPQ Disorganized factor score significantly correlated with the AMQ total score, $r(22) = .51, p = .01$, the AMQ-CP subscale, $r(22) = .50, p = .01$, and the AMQ-RB subscale, $r(22) = .45, p = .03$. (see Table 2, and Figures 3 and 4).

Next, we examined the frequency of single events recalled by each participant on the AMQ. Neither the SPQ total score, $\beta = -0.43, t(43) = 0.96, p = .34$, nor sex, $\beta = 0.17, t(43) = 0.75, p = .46$, was associated with the frequency of single events. The sex by SPQ interaction also failed to reach significance, $\beta = 0.40, t(43) = 0.88, p = .38$.

Autobiographical Memory: Relationships with Theory of Mind, Schizotypy, and Sex

Finally, we conducted two sequential linear regression analyses to predict the AMQ total score from each TASIT–SI score, along with SPQ total score, and sex. Each model included all

main effects in the first block, with all higher-order interactions entered in the second block. As shown in Table 3, there were no significant effects (other than sex) for the model including the SI-M score. However, the model examining the SI-E score found that the SI-E score was negatively related to the AMQ total score across the sample. No interaction was revealed between the SPQ total score and either TASIT score in predicting the AMQ total score.

DISCUSSION

The aim of the present study was twofold. Our primary aim was to examine the relationships between AM and ToM in schizotypy. Secondarily, we aimed to clarify the potential interaction between sex and schizotypy in these relationships, as previous research has demonstrated sex interactions on both ToM and AM tasks in schizophrenia-spectrum disorders (e.g., Thakkar & Park, 2010; Goldstein et al., 1998).

First, we hypothesized that ToM performance would exhibit a negative relationship with total schizotypy score. However, our data failed to exhibit a significant relationship between total schizotypy score and ToM performance. Although contrary to our hypothesis, the finding of the present study is consistent with that of the only published study to date, assessing TASIT–SI performance in schizotypy (Jahshan & Sergi, 2007). Specifically, the authors failed to find a significant association between TASIT–SI performance and the abbreviated SPQ. In contrast to the present study, however, Jahshan and Sergi did not report on the sex by schizotypy interaction, which limits comparisons to the present findings. On the other hand, two studies have examined TASIT–SI performance in patients with schizophrenia (Kerns et al., 2008; Sparks et al., 2010), both finding that the patients performed significantly poorer on vignettes depicting counterfactual information (e.g., SI-E task, and SI-M lie vignettes), but comparable to controls on vignettes depicting sincerity (SI-M sincerity vignettes).

Secondarily, we sought to explore the sex interaction on this relationship. Based on previous literature, we hypothesized that males, but not females, with schizotypy would exhibit a negative relationship between ToM and schizotypy (Langdon & Coltheart, 1999; Thakkar &

Park, 2010). Contrary to our hypothesis, we found that females, but not males, demonstrated a negative relationship between the total schizotypy score and the SI-E score, but not the SI-M score.

Collectively, these results suggest that ToM performance may not be globally affected in schizophrenia but specifically confined to tasks of decoding counterfactual social information (Kern et al., 2008), and may be a better endophenotype of schizophrenia than other social cognitive abilities (Montag et al., 2012). Thus, inconsistencies in the literature examining ToM functioning in individuals with schizophrenia-spectrum disorder may be partially explained by the unwieldy scope of ToM and the lack of any consensus on the methodological approach that would yield the most valid results in this population (Badgaiyan, 2009).

More specifically, we found that females reporting higher disorganized and positive schizotypy traits exhibited the strongest association with the SI-E ‘feeling’ probe items. The ‘feeling’ probe items assessed the ability to detect subtle and complex emotions (i.e., disapproval, sympathy), and can only be derived from the situational *context* (e.g., tone of voice, prosody), as comprehending the *content* (e.g., interpersonal dialogue) of these vignettes was not sufficient for accurate appraisal of vignettes. This probe is related to the concept of *affective ToM*, or the ability to infer the feelings and emotions of others. Previous research has demonstrated that in females, a negative relationship exists between schizotypy scores (particularly interpersonal traits) and *affective ToM*, while males exhibited a negative association between positive schizotypy and self-reported levels of *affective empathy* (i.e., immediate and automatic response to the emotions of others; Thakkar & Park, 2010). However, when analyzed concurrently, only the SPQ Disorganized factor score remained significant. Furthermore, contrary to the findings of the present study, previous research has found males, but not females,

with schizotypy tend to exhibit a negative relationship with first- and second-order ToM (Langdon & Coltheart, 1999). It could be that ToM processing activates sexually dimorphic patterns of neural activation that are distinctive to females with schizotypy. For example, imaging research has indicated that on a task of comprehension of counterfactual information (Rapp et al., 2010), females with schizotypy demonstrated a distinct pattern of neural activation that corresponded more with language areas (e.g., middle temporal gyrus) than with areas consistently activated under other second-order ToM tasks (e.g., medial prefrontal cortex; Raichle et al., 2001). Further research is needed to clarify whether these relationships are stronger in males or females.

The results of studies examining the relationship between schizotypy factor scores and ToM performance are currently inconclusive. For example, ToM performance has been associated with positive schizotypy (Barragan et al., 2011; Gooding & Plfum, 2011; Karcher & Shean, 2012; Langdon & Colheart, 1999; Pickup, 2006), disorganized schizotypy (Thakkar, Brugger, & Park; 2009; Sarfati et al., 1997), as well as negative schizotypy (Henry, Bailey, & Rendell, 2008). Still others have failed to find a significant association between ToM and total schizotypy (Ferryhough, Jones, Whittle, Waterhouse, & Bentall, 2008; Fyfe, Williams, Mason, & Pickup, 2007; Jahshan & Sergi, 1997). Overall, our results (in females) are mostly consistent with previous literature across the schizophrenia-spectrum, in that positive (and disorganized) schizotypy traits typically demonstrate a strong relation with ToM performance (Bora et al., 2009). Although, this sex interaction should be considered tentative until further replication, it could be that the lack of a consistent pattern between ToM and schizotypy may be partially accounted for by the interaction between schizotypy factor score and sex.

Next, we posited a negative association between phenomenological aspects of AM and schizotypy. Our data do not support this hypothesis, as we failed to find a significant negative association between total schizotypy score and phenomenological ratings of AMs, across the sample. Instead, females exhibited a positive trend between the total schizotypy score and phenomenological AM score, while no relationship was found for males. Specifically, this relationship was only significant between disorganized schizotypy and the phenomenological aspects of mentally reliving past experiences (AMQ-RB), and mental imagery vividness (AMQ-CP), in females. These findings contradict those found in schizophrenia, as patients generally perform worse on tasks of AM. Since research has yet to systematically examine the phenomenological aspects of deliberately retrieved autobiographical memories in schizotypy, this hypothesis was derived from the schizophrenia literature, (e.g., Cuervo-Lombard et al., 2007; Danion et al., 2005). However, in recent years, a number of studies have examined related constructs with similar results to the current study. For example, mental imagery vividness across four groups, (schizophrenia patients, relatives of the patients, a high schizotypy group, and a low schizotypy group), and found that all three schizophrenia-spectrum disorder groups experienced significantly enhanced mental imagery vividness than those in the low schizotypy group (Oertel et al., 2009).

Furthermore, *mental time travel* (Suddendorf & Corballis, 2007), a construct related to AM defined as or the ability to mentally project oneself backward in time to relive, or forward in time to pre-live personal events, was examined in schizotypy (Winfield & Kamboj, 2010). Consistent with our findings, the authors reported that subjective feelings of reliving AM, as well as envisioning future autobiographical events, were significantly and positively related to schizotypy. Furthermore, the authors reported that those with high schizotypy were assessed to

have more creativity than those with low schizotypy. Interestingly, creativity was found to attenuate the relationship between schizotypy and mental time travel, when concurrently analyzed, but only in past, but not future, AMs. These results indicate that the association between subjectively experienced creativity and schizotypy may be partially explained by enhanced creativity in schizotypy.

Finke (1989) defined mental imagery as a perceptual experience that occurs in the absence of a stimulus (e.g., a memory or hallucination), and while enhanced mental imagery may provide some cognitive advantages (i.e., creativity), increased mental imagery vividness has been associated with the development of hallucinations. Furthermore, mental imagery vividness and hallucinations were found to be independent predictors of schizophrenia, with potentially distinct underlying mechanisms, which may attribute to the etiology of schizophrenia (McGuire et al., 1996; Mintz & Alpert, 1972).

While the relationship between psychopathology and creativity has been extensively studied (e.g., Becker 2001; Schuldberg, French, Stone, & Heberle, 1988), few have examined the relationship between phenomenological experiences of creativity and psychopathology. One study found that higher schizotypy scores were associated with higher phenomenological ratings of creativity among a sample of artists (Nelson & Rowe, 2010). The authors have attributed this enhanced experience of creativity in schizotypy to a reduced latent inhibition process, which may result in the failure to cognitively filter events or other stimuli based on prior events (Peterson, Smith, & Carson, 2002). This was hypothesized to enrich the subjective immediate experience of the immediate event, and our findings indicate that this may also be true for later recollections of the event.

We further hypothesized that the frequency of single events would negatively correlate with schizotypy. Contrary to our hypothesis, no association was found between the frequency of recalled single event types. This hypothesis, however, was also derived from the schizophrenia literature, (e.g., Danion et al., 2005; Ruitort et al., 2003). It should be noted, however, that our study focused on the distinction between different event *types* of AMs (i.e., single, extended, and merged events) and not the level of detail included, which may explain these contradictory findings.

Our final hypothesis posited a positive relationship between ToM and AM that would be differentially affected by schizotypy. We found no evidence to suggest that schizotypy directly related to AM, when controlling for ToM and sex (see Table 4). However, a significant main effect of sex was found in both models, and, contrary to our hypothesis the SI-E score was found to negatively associate with AM. Although these findings are contradictory to our hypothesis and preexisting literature in schizophrenia (Corcoran & Frith, 2003), a recent study assessed cognitive and affective components of ToM in patients with schizophrenia, and found that the ToM ability of infer *intentions*, but not *emotions*, was positively related to AM in schizophrenia (Mehl et al., 2010). Thus, it appears that specific aspects of ToM and sex may be stronger predictors of AM functioning than psychopathological symptoms.

The results presented in the current study may have implications to improve future psychosocial or cognitive treatments for schizophrenia. Since social functioning impairments in are among the more treatment refractory aspects of schizophrenia-spectrum disorders, treatments that address key predictors of social functioning must be targeted (Horan, Kern, Green & Penn, 2008). Indeed, preliminary empirical evidence suggests that both ToM training (Choi & Kwon, 2006; Penn et al., 2005) and AM event-specificity training (Ricarte, Hernández, Latorre, & Ross,

2011) have demonstrated promise as potential treatment components. Our findings further indicate that female patients with schizophrenia-spectrum disorders may benefit more from such treatments than male patients.

There are limitations in our findings that deserve mention. First, we observed the interaction between schizotypy and sex to be a recurring theme throughout the present study. Since few studies have examined sex interactions on cognition in schizophrenia-spectrum disorders, the conclusions drawn from the current study should be considered tentative. However, this pattern of results is consistent with the conclusions of Johnston et al. (2008), who strongly suggested that sex effects should be included in research designs assessing cognition in schizotypy, as schizotypy and various cognitive processes both demonstrated sex interactions. Secondly, relatively poor test-retest reliability of SPQ scores was revealed between the initial web-based administration, used to screen for participants and the lab-based administration, used in the statistical analysis. Specifically, while recruiting for two distinct groups (i.e., high and low schizotypy), the lab-based SPQ revealed a continuous range of SPQ scores. However, due to a lack of experimental control associated with the web-based administration (e.g., students completed online-based SPQ at their own leisure), the lab-based scores were believed to be a more valid indicator of schizotypy. Thirdly, these findings may not be generalizable to the population at large, as we recruited a sample of undergraduate students. Lastly, assessing subjective experiences of imagined events, particularly in schizotypy, has been subject to criticism, due to participant item over-endorsement (Merckelbach & Van de Ven, 2001). A more objective analysis of the content of autobiographical memories may yield more valid results.

In conclusion, our study adds to the schizotypy literature on a number of accounts. We found that performance on measures of ToM and AM were both related to schizotypy, but only

in females. Specifically, ToM performance was negatively related to schizotypy, while AM performance was positively related to schizotypy, in females. However, we found no evidence to suggest that ToM or AM were related to schizotypy in males. Since relatively few studies have examined the moderating effect of sex on cognition in schizotypy, these findings may partially explain some of the inconsistencies in the literature. More generally, these findings provide preliminary evidence to suggest that males and females with schizophrenia-related disorders may exhibit sexually dimorphic profiles in the relationships between ToM and AM.

APPENDIX A: TABLES AND FIGURES

Table 1: Descriptive Statistics and Comparison of Mean Scores

Variables	Total sample (<i>N</i> = 47)					Males (<i>n</i> = 23)		Females (<i>n</i> = 24)		<i>t</i>
	M	(<i>SD</i>)	Skew	Actual range	Potential range	M	(<i>SD</i>)	M	(<i>SD</i>)	
	SPQ total score	16.53	(14.30)	0.75	0–48	0–74	19.22	(15.00)	13.96	
Cognitive-Perceptual	6.13	(6.88)	1.02	0–25	0–33	6.65	(7.48)	5.63	(6.38)	0.51
Interpersonal	6.34	(5.59)	0.94	0–22	0–33	7.83	(6.18)	4.92	(4.66)	1.82 [†]
Disorganized	5.02	(4.91)	0.75	0–16	0–16	5.61	(4.77)	4.46	(5.08)	0.80
TASIT ^a										
Social Inference – Minimal (SI-M)	53.42	(3.61)	0.95	47–59	0–60	52.74	(3.26)	54.14	(3.88)	1.31
‘Do’ items	13.24	(0.91)	0.25	12–15	0–15	26.96	(1.61)	27.64	(1.43)	1.50
‘Say’ items	13.38	(1.54)	1.45	17–31	0–15	25.87	(4.27)	27.59	(2.52)	1.64
‘Think’ items	13.13	(1.27)	0.05	19–29	0–15	24.30	(2.14)	24.91	(2.47)	0.88
‘Feel’ items	13.64	(1.11)	-0.38	22–31	0–15	27.22	(2.37)	27.73	(2.43)	0.71
Social inference – Enriched (SI-E)	55.22	(3.12)	0.95	46–59	0–64	54.64	(3.23)	55.82	(2.95)	1.26
‘Do’ items	14.04	(1.19)	1.12	10–16	0–16	13.83	(1.34)	14.27	(0.98)	1.27
‘Say’ items	13.33	(2.76)	1.04	6–16	0–16	12.70	(3.34)	14.00	(1.85)	1.61
‘Think’ items	11.47	(1.56)	0.09	8–16	0–16	11.39	(1.41)	11.55	(1.74)	0.33
‘Feel’ items	13.82	(1.90)	0.32	10–16	0–16	13.74	(1.84)	13.91	(2.00)	0.30
AMQ total	4.70	(0.81)	0.48	2.85–6.46	1–7	4.45	(0.65)	4.95	(0.87)	2.21*
Recollection/Belief	5.18	(0.86)	0.73	2.60–6.65	1–7	4.90	(0.77)	5.45	(0.87)	2.28*
Component Processes	4.61	(0.94)	0.05	2.57–6.63	1–7	4.45	(0.75)	4.76	(1.08)	1.12
Properties of Event	3.80	(1.03)	0.29	1.30–6.57	1–7	3.30	(0.82)	4.29	(0.98)	3.74**
AMQ Specific Events	10.36	(2.56)	0.08	6–15	0–15	9.52	(2.39)	11.17	(2.50)	2.31*

Note. SPQ = Schizotypal Personality Questionnaire. TASIT–SI = The Awareness of Social Inference Tests. AMQ = Autobiographical Memory gQuestionnaire. M = Mean. (*SD*) = Standard deviation.

^aTwo female participants failed to complete both TASIT–SI tasks (female *n* =22).

[†]*p* < .10. * *p* < .05. ***p* < .01

Table 2: Correlation Matrix of SPQ, TASIT–SI, and AMQ Scores, by Sex (With Males Located Below the Diagonal)

Variables	TASIT																		
	SPQ				AMQ					SI-M					SI-E				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1. SPQ	–	.93**	.88**	.91**	.38 [†]	.37 [†]	.36 [†]	.21	.08	-.25	-.03	-.15	-.43*	-.13	-.48*	-.48*	.06	-.18	-.40 [†]
2. Cognitive-Perceptual	.86**	–	.75**	.78**	.30	.30	.29	.12	.07	-.09	.14	.02	-.30	-.08	-.42*	-.48*	.13	-.06	-.25
3. Interpersonal factor	.88**	.57**	–	.69**	.22	.24	.17	.19	-.11	-.34	-.08	-.32	-.44*	-.22	-.38 [†]	-.45*	.09	-.03	-.24
4. Disorganized factor	.85**	.60**	.71**	–	.51*	.45*	.50*	.30	.20	-.29	-.15	-.20	-.44*	-.13	-.53*	-.41 [†]	-.07	-.36 [†]	-.58**
5. AMQ	-.23	.02	-.39 [†]	-.24	–	.88**	.97**	.64**	.27	-.30	-.12	-.35	-.33	-.13	-.44*	-.12	-.33	-.43*	-.39 [†]
6. Recollection/Belief	-.22	.06	-.45*	-.17	.89**	–	.78**	.46*	.24	-.19	-.10	-.27	-.18	-.07	-.40 [†]	-.23	-.22	-.38 [†]	-.44*
7. Component Processes	-.29	-.05	-.42*	-.29	.97**	.79**	–	.53*	.26	-.26	-.10	-.29	-.31	-.11	-.41 [†]	-.04	-.30	-.43*	-.34
8. Properties of the Event	.14	.15	.21	.00	.41*	.08	.35	–	.16	-.46*	-.17	-.54*	-.45*	-.29	-.35	-.17	-.38 [†]	-.15	-.19
9. Specific Events	-.19	-.05	-.25	-.28	-.08	-.07	.05	-.41*	–	-.01	-.28	.01	-.14	.30	-.01	.09	.00	-.20	-.18
10. TASIT SI-M^b	.18	.12	.18	.17	.12	-.05	.13	.34	.13	–	.67**	.92**	.84**	.80**	.52*	.40 [†]	.16	.11	.11
11. ‘Do’ items	.13	.00	.18	.14	-.25	-.33	-.18	-.07	.32	.65**	–	.60**	.40 [†]	.31	.13	.15	-.17	.17	.07
12. ‘Say’ items	.21	.19	.22	.13	.34	.14	.33	.50*	-.05	.82**	.40 [†]	–	.69**	.67**	.48*	.33	.29	.04	.06
13. ‘Think’ items	-.12	-.09	-.17	-.07	.08	.05	.07	.11	.02	.62**	.22	.31	–	.55**	.58**	.43*	.16	.28	.16
14. ‘Feel’ items	.22	.20	.19	.23	-.05	-.11	-.06	.18	.25	.45*	.19	.17	.04	–	.43*	.35	.16	-.13	.07
15. TASIT SI-E^b	.22	.20	.27	.03	-.24	-.19	-.30	.07	.06	.15	-.02	.15	.06	.13	–	.72**	.51*	.22	.55**
16. ‘Do’ items	.42*	.37 [†]	.45*	.24	.04	-.17	.10	.29	-.03	.17	-.02	.26	-.32	.50*	.28	–	.10	-.09	.35
17. ‘Say’ items	.02	-.10	.22	-.15	-.20	-.42*	-.07	.10	.40 [†]	.45*	.35 [†]	.33	.31	.15	.47*	.33	–	.00	.57**
18. ‘Think’ items	-.12	-.13	-.02	-.12	.15	.10	.23	-.09	.05	.14	.06	-.03	.34	.02	-.31	-.01	.17	–	.32
19. ‘Feel’ items	.32	.34	.33	.14	-.21	-.30	-.14	-.03	.26	.40 [†]	.29	.21	.20	.39 [†]	.08	.20	.30	.36 [†]	–

Notes. SPQ = Schizotypal Personality Questionnaire. AMQ = Autobiographical Memory Questionnaire. TASIT = The Awareness of Social Inference Test. SI-M = Social Inference–Minimal = SI-E. Social Inference–Enriched.

^aMales ($n = 23$) are shown below the diagonal, and females ($n = 24$) are shown above the diagonal.

^bTwo female participants failed to complete TASIT–SI tasks ($n = 22$).

[†] $p < .10$. * $p < .05$. ** $p < .01$.

Table 3: Results of Two Multiple Linear Regression Analyses Predicting AMQ Total Score

Predictors Entered ^a	TASIT											
	Social Inference-Minimal (SI-M) Model						Social Inference-Enriched (SI-E) Model					
	Block 1			Block 2			Block 1		Block 2			
	<i>B</i>	β	[95% CI of <i>B</i>]	<i>B</i>	β	[95% CI of <i>B</i>]	<i>B</i>	β	[95% CI of <i>B</i>]	<i>B</i>	β	[95% CI of <i>B</i>]
Block 1												
Sex	0.62	0.24*	[0.14, 1.11]	0.66	0.41**	[0.18, 1.13]	0.67	0.42**	[0.22, 1.13]	0.75	0.47**	[0.28, 1.26]
TASIT	-0.10	-0.12	[-0.46, 0.19]	0.39	0.49	[-0.41, 1.19]	-0.26	-0.32*	[-0.49, -0.03]	-0.03	-0.07	[-1.12, 0.36]
SPQ	0.06	0.12	[-0.18, 0.29]	0.08	0.09	[-0.16, 0.31]	0.04	0.07	[-0.19, 0.27]	0.06	0.07	[-0.20, 0.13]
Block 2												
Sex x SPQ int.				0.23	0.29	[.0.00, 0.47]				0.15	0.19	[-0.10, 0.40]
Sex x TASIT int.				-0.27	-0.55	[-0.76, 0.22]				-0.09	-0.17	[-0.62, 0.44]
SPQ x TASIT int.				-0.28	-0.36	[-1.01, 0.45]				-0.49	-0.55	[-1.34, 0.35]
Sex x TASIT x SPQ int.				0.26	0.53	[-0.20, 0.82]				0.43	0.67	[-0.18, 0.95]
R^2 (adj. R^2)		.14	(.08)		.28	(.14)		.23	(.17)		.31	(.18)
<i>F</i>		2.30 [†]			2.01 [†]			4.03*			2.39*	
ΔR^2					.13						.08	
ΔF					1.67						1.13	

Note. *N* = 45. CI = Confidence interval. AMQ = Autobiographical Memory Questionnaire. SPQ = Schizotypal Personality Questionnaire, TASIT-SI = The Awareness of Social Inference Test.

^aOutcome variable: AMQ total score.

[†]*p* < .10. **p* < .05. ***p* < .01.

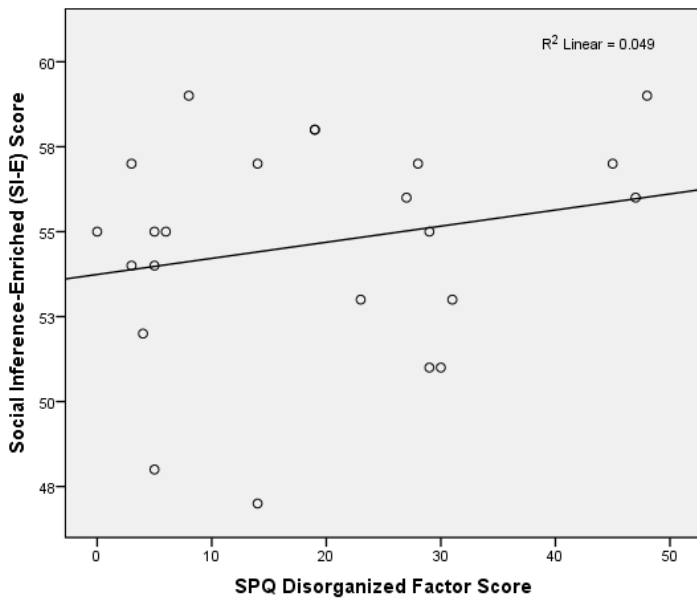


Figure 1: Scatterplot of the SPQ Disorganized Factor and the Social Inference-Enriched (SI-E) Scores in Males

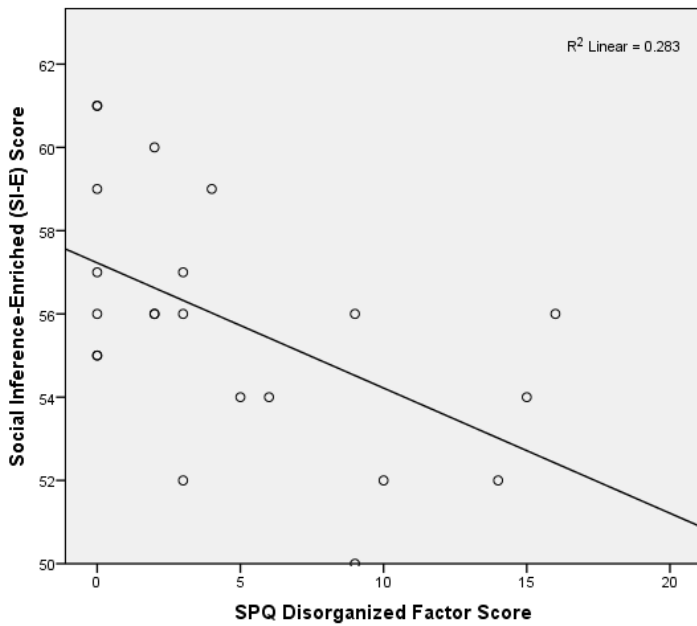


Figure 2: Scatterplot of the SPQ Disorganized Factor and the Social Inference-Enriched (SI-E) Scores in Females

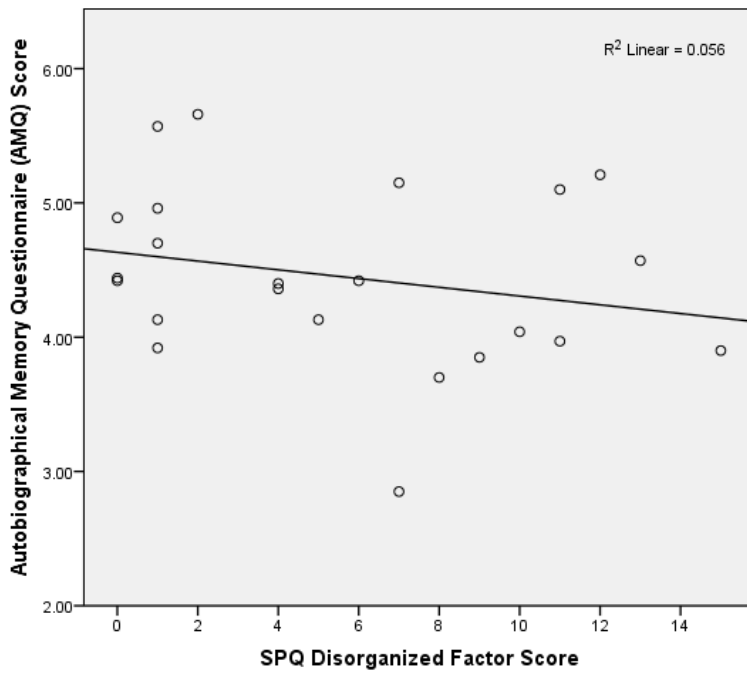


Figure 3: Scatterplot of the SPQ Disorganized Factor and the Autobiographical Memory Questionnaire (AMQ) Scores in Males

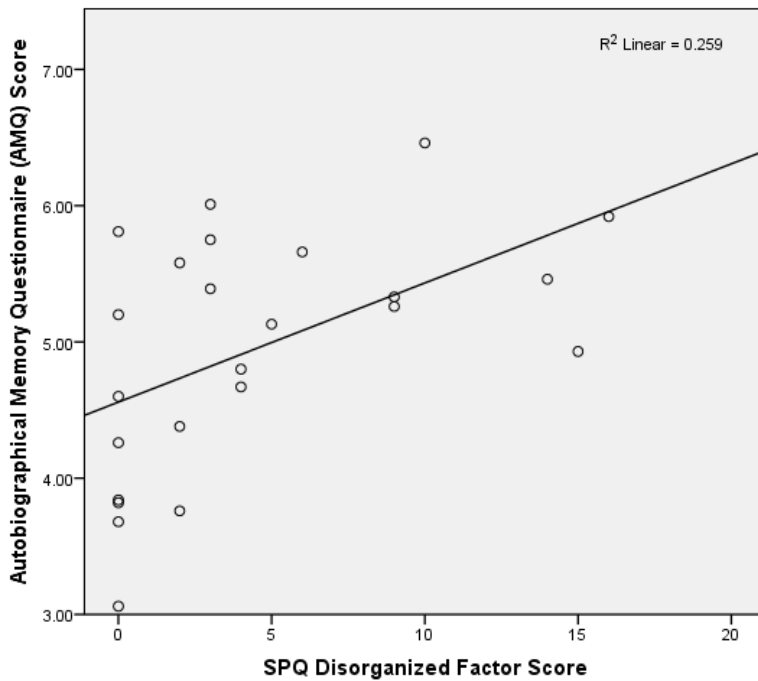


Figure 4: Scatterplot of the SPQ Disorganized Factor and the Autobiographical Memory Questionnaire (AMQ) Scores in Females

APPENDIX B: IRB APPROVAL LETTER



University of Central Florida Institutional Review Board
Office of Research & Commercialization
12201 Research Parkway, Suite 501
Orlando, Florida 32826-3246
Telephone: 407-823-2901 or 407-882-2276
www.research.ucf.edu/compliance/irb.html

Approval of Human Research

From: UCF Institutional Review Board #1
FWA00000351, IRB00001138

To: Andrew E. Deptula and Douglas M. Dykstra

Date: June 30, 2010

Dear Researcher:

On June 30, 2010, the IRB approved the following human participant research until 6/29/2011 inclusive:

Type of Review: UCF Initial Review Submission Form
Project Title: Working Memory, Autobiographical Memory, and Theory of Mind
Investigator: Andrew E. Deptula
IRB Number: SBE-10-06971
Funding Agency: N/A

The Continuing Review Application must be submitted 30 days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form cannot be used to extend the approval period of a study. All forms may be completed and submitted online at <https://iris.research.ucf.edu>.

If continuing review approval is not granted before the expiration date of 6/29/2011, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in iRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki, DVM, UCF IRB Chair, this letter is signed by:

Signature applied by Janice Turchin on 06/30/2010 01:43:20 PM EDT

IRB Coordinator

APPENDIX C: DEFENSE ANNOUNCEMENT

Announcing the Final Examination of Mr. Andrew E. Deptula for the degree of Master of Science

Date: November 30, 2012

Time: 12:00 p.m.

Room: PSY 301C

Thesis title: Autobiographical Memory and Theory of Mind in schizotypy

Individuals with schizophrenia exhibit marked impairments on tasks assessing theory of mind (ToM) and autobiographical memory (AM) qualities, and preliminary research has indicated a positive link between these abilities. This study is the first to systematically explore this relationship in the related personality trait of schizotypy. In a study of 47 undergraduate students (23 males) reporting a wide continuous range of schizotypy, we found that females, but not males, exhibited a negative correlation between ToM and schizotypy, and an unexpected positive correlation between AM qualities and schizotypy. Factor score analysis within females indicated that disorganized schizotypy was the strongest correlate of both ToM (i.e., affective ToM; ability to infer emotions), and AM qualities (i.e., mental imagery vividness). Finally, independent of schizotypy and sex, ToM was negatively correlated with AM qualities. This negative association between ToM and AM as well as the positive relationship between schizotypy and AM (in females) distinguish findings in schizotypy from those in schizophrenia. Although, the qualities of AM in schizotypy are relatively unexplored in schizotypy, overlapping and AM-related constructs (e.g., mental image vividness, creativity) are enhanced in schizotypy. This phenomenon is theorized to occur due to a reduced latent inhibition process, which also reveals distinct patterns of sexual dimorphism in schizotypy. In sum, the current study found sex to be a critical variable in each hypothesis, demonstrating a unique pattern in females, but not males. It could be that distinct underlying mechanisms account for sex differences on ToM and AM tasks in schizophrenia-related disorders.

Outline of Studies:

Major: Clinical Psychology

Educational Career:

B.A., 2006, Syracuse University

Committee in Charge:

Dr. Jeffrey S. Bedwell

Dr. Deborah C. Beidel

Dr. Valerie Sims

Approved for distribution by Jeffrey S. Bedwell, Committee Chair, on November 20.

The public is welcome to attend.

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