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Semantic activation abnormalities in disorganized schizotypy.

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Semantic processing abnormalities in disorganized schizotypy

by

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ABSTRACT

To better understand the relationship between disorganized schizotypy and loose associations, we calculated semantic distances between successive responses on the Category Fluency Test (CFT), using WINDSORS (Windsor Improved Norms of Distance and Similarity of Representations of Semantics; Durda & Buchanan, 2008). We expected that disorganized schizotypy and cognitive slippage would be associated with looser associations. Eighty-six healthy undergraduate students completed the animal CFT and several schizotypy questionnaires. Disorganized schizotypy and cognitive slippage was associated with looser associations from the initial response. Cognitive slippage was also associated with closer associations between successively generated responses. These results support the hypothesis that semantic processing abnormalities are associated with certain aspects of disorganized schizotypy, but may be even more relevant to cognitive slippage, which appears to be a related but independent aspect of schizophrenic liability.

Dedication

To my family.

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List of Abbreviations

CFT	Category Fluency Test
CDI	Communication Disorders Index
CogDis	Cognitive Disorganization
CSS	Cognitive Slippage Scale
DIS	Disorganized Schizotypy Factor on the SPQ
DSM-III-R	Diagnostic and Statistical Manual 3rd Edition, Revised
HAL	Hyperspace Analogue to Language
ImpNon	Impulsive Non-Conformity
IntAn	Introvertive Anhedonia
LFT	Letter Fluency Test
NAART	North American Adult Reading Test
NEG	Negative Schizotypy Factor on the SPQ
O-LIFE	Oxford-Liverpool Inventory of Feelings and Experiences
PANAS-X	Positive and Negative Affect Schedule-Expanded
PANAS-NA	Negative Affectivity on the PANAS-X
PANAS- PA	Positive Affectivity on the PANAS-X
POS	Positive Schizotypy Factor on the SPQ
PPVT	Peabody Picture Vocabulary Test
SPQ	Schizotypal Personality Questionnaire
UnEx	Unusual Experiences
WAIS-R	Wechsler Adult Intelligence Scales, Revised
WINDSORS	Windsor Improved Norms of Distance and Similarity of Representations of Semantics

Semantic processing abnormalities in disorganized schizotypy

Thought disorder, a fundamental clinical symptom of schizophrenia, refers to abnormalities in thought form with preserved thought content. It is characterized by inappropriate use of semantic and associative aspects of language and manifests as disorganized speech, evident in loose associations or derailments, irrelevant and tangential responses, circumstantiality or loss of goal, and intrinsic illogicalities. In its most severe form, speech can be incoherent. It has long been suggested that many schizophrenic speech symptoms result from what Bleuler (1911/1950) referred to as a break down in "associative processes", believed to result from disturbances in how words and concepts are activated in semantic memory (Aloia, Gourovitch, Weinberger, & Goldberg, 1996; McCarley et al., 1999; Nestor et al., 1997; Spitzer, 1997). This is especially evident in the speech of thought disordered schizophrenia patients and often experienced as disorganized and loosely associated (Goldberg et al., 1998). Efforts to understand the nature of these "loose associations" have lead to research using various cognitive and neuropsychological paradigms to examine a wide range of schizophrenic speech processes (e.g. Levine, Schild, Kimhi, & Schreiber, 1996; Reilly, Harrow, Tucker, Quinlan, & Siegal, 1975; Sommer, Dewar, Osmond, & Hask, 1960).

Atypical semantic associations have also been used to partially explain the positive symptoms of schizophrenia, including hallucinations and delusions. For example, Hoffman, Rapaport, Mazure and Quinlan (1999) used neural network simulations to demonstrate that excessive synaptic pruning in areas normally responsible for language processing can result in exaggerated and inappropriate associations similar to hallucinations. David (1994) and Kerns et al. (1999) additionally suggested that over-

activation of associated lexical knowledge could give rise to hallucinations. Inner speech models of hallucinations have suggested that a breakdown in normal semantic networks could give rise to most loosely associated inner speech judged as foreign and external (see Laroi & Woodward, 2007, and Allen, Aleman & McGuire, 2007, for a reviews). In general, abnormal associations refer more to meanings of external or internal stimuli rather than that of language.

Despite the value of patient studies with respect to understanding semantic processing abnormalities in schizophrenia, studies using patient samples are potentially confounded by effects of anti-psychotic medications, or of environmental impoverishment caused by chronic mental illness. A corresponding line of research that avoids such confounds uses non-clinical samples that score high on measures of schizotypy, or schizotypal personality. These "schizotypes" demonstrate language abnormalities that are similar, albeit milder, to that found in thought disordered schizophrenia patients.

Schizotypy

Schizotypy refers to personality traits in the normal population that are qualitatively similar to, but quantitatively milder than, schizophrenia symptoms. Individuals with high levels of schizotypy are considered at risk for developing schizophrenia and/or psychosis[1]. Similar to the heterogeneous nature of schizophrenia, schizotypy is a multidimensional construct, usually conceptualized as consisting of three distinct factors, or subtypes, comprising positive, negative and disorganized schizotypy.

[1] In general, the terms "schizotypy" and "psychosis proneness" are used synonymously, although, as pointed out by Raine and Lencz (1995), some psychosis proneness scales such as Psychoticism, Physical Anhedonia, Social Anhedonia, and Schizoidia are not direct reflections of schizotypal features of

Positive schizotypy, as a personality trait, refer to tendencies toward unusual perceptual experiences, and magical and paranormal beliefs. This subtype corresponds to positive symptoms in schizophrenia typically found in schizophrenia patients, such as hallucinations and delusions. Negative schizotypy refers to tendencies toward social withdrawal and lack of pleasure and/or interest in social interactions. This subtype corresponds to negative symptoms in schizophrenia, such as anhedonia, affective flattening, and avolition. Finally, disorganized schizotypy refers to tendencies toward odd or disorganized speech and confused thinking, sometimes referred to as cognitive slippage (Miers & Raulin, 1985), and eccentric behavior. This subtype corresponds to symptoms of thought disorder typically found in disorganized schizophrenia patients, inappropriate affect, and bizarre behavior.

As a personality trait, the degree to which schizotypy is expressed in the normal population varies on a continuum much like other personality traits like extraversion or neuroticism. Hypothesized to be at the most extreme and "severe" end of the schizotypy personality trait continuum is frank psychosis (Kendler et al., 1991). This approach may offer insight into the schizophrenic disease process, as there is evidence of similar neuropsychological and cognitive abnormalities in schizotypy as those found in schizophrenia such as deficits in attention, eye-tracking, and most importantly, in semantic memory and language processing (Della Casa, Hofer, Weiner, & Feldon, 1999; Ettinger et al., 2005; Kiang & Kutas, 2005; Kimble et al., 2000; Lubow & De la Casa, 2002; Raine, Lencz & Mednick, 1995).

Models of Semantic Memory

As disorganized speech appears to reflect abnormalities in maintaining appropriate associations between semantic concepts, researchers have hypothesized that these symptoms arise from disturbances in semantic memory (McCarley et al., 1999; Moritz et al., 1999; Nestor et al., 1997; Niznikiewicz et al., 2002; Spitzer, 1997). Semantic memory refers to our knowledge of facts, including word meanings and associations, and consists of basic units of factual knowledge without personal connotations[2] that exist within an interconnected network of knowledge (Tulving, 1972; 1973).

One general model explaining how concepts are activated in the semantic store conceptualizes semantic memory as a neural network in which concepts are represented by individual nodes connected to other nodes by their meaningful relationship (Anderson & Pirolli, 1984; Collins & Loftus, 1975). Related concepts include: objects and their features (e.g., *DOG-FUR; DOG-PAWS)* or actions (*DOG-BARK; DOG-DIG);* categories and their exemplars (*ANIMAL-DOG; ANIMAL-CAT),* semantically similar concepts (*DOG-WOLF; DOG-PUPPY),* frequently associated concepts (*DOG-CAT; DOG-FLEAS),* or indirectly related concepts related by a mediating concept (*DOG-MOUSE*, mediated by *CAT*). In healthy individuals, semantically similar concepts are processed more efficiently than associated concepts, followed by indirectly related concepts (Beeman & Chiarello, 1998).

One model of how concepts are organized in semantic memory is the feature-based model of semantics (McRae, Cree, Seidenberg & McNorgan, 2005; McRae, de Sa

[2] An exception to this is *personal semantic memory*, a subcomponent of semantic memory that refers to knowledge about oneself that includes items of personal semantic information such as one's own name, where one lived at different times throughout one's life, or even what food one likes to eat.

& Seidenberg, 1997). Based on this model, concepts that share many perceptual features (i.e. are more semantically similar) or similar category membership will have greater semantic relatedness. For example, the concepts *DOG* and *CAT* are thought to occur in close proximity in an individual's semantic networks because they share numerous features (e.g., four legs, tail, fur, etc.) or belong to the same category (e.g. domestic pets). Furthermore they are highly associated concepts. Semantic relatedness facilitates the generation of related words (Chan et al., 1993), for example, because *DOG* and *CAT* are considered close semantic neighbors, activation of one almost always primes the activation of the other. The degree to which activation of one concept activates a semantic neighbor (i.e. as features for *DOG* become activated, several features of its neighbor *CAT* also become activated) reflects the number of overlapping features between the two concepts, and the more connections that exist, the greater the likelihood of activation.

The organization of semantic memory has also been explained in terms of the co-occurrence of words in the English language, referred to as a lexical co-occurrence, or language-based model of semantics (Buchanan, Westbury & Burgess, 2001). Unlike feature-based models, which describe semantic relatedness in terms of the degree of overlapping features, language-based models determine semantic relatedness is based on the frequencies with which words co-occur in spoken or written language (e.g. Landauer & Dumais, 1997; Lund & Burgess, 1996; Lund, Burgess & Audet, 1996; Nelson, McEvoy & Schreiber, 1998). For example, *DOG* and *CAT* are closely related because they frequently appear together in similar contexts. Furthermore, concepts that do not share perceptual features (e.g. *DOG* and *HOUSE*) can still be semantic neighbors on the basis of an individual's experience with these concepts appearing in similar contexts (Locker, Simpson, & Yates, 2003). As noted by Buchanan et al. (2001), it is likely that

both feature- and language-based relationships contribute significantly to the structure and activation of semantic knowledge, although the extent and exact nature of these contributions are yet to be fully understood.

Models of Thought Disorder

Increased spreading activation hypothesis.

Although the exact mechanisms that give rise to abnormalities in how concepts become associated are unknown, a popular hypothesis explains thought disorder in terms of increased spreading activation (Maher,1983). This "spreading activation theory" suggested that if the associative process (i.e. spreading activation) in schizophrenia was larger in magnitude and/or persisted to a greater extent than normal, the result could be an over activation of irrelevant associations that may intrude into speech caused by concepts remaining activated (e.g. Frith, 1979; Maher, 1983). Specifically, there would be increased spreading activation whereby activation of a word or concept causes a greater than normal spread of activation in the semantic network such that both strong and weak associates are activated (Spitzer, 1997). Such abnormalities could lead to the production of speech concepts that are loosely related and therefore seem disorganized.

Evidence for this model comes from studies finding enhanced semantic priming in schizophrenic and schizotypic individuals. Semantic priming is a phenomenon whereby exposure to a word facilitates the speed at which related words that are subsequently encountered as recognized. Studies have found that thought disordered schizophrenia patients demonstrate enhanced priming for indirectly related word pairs (e.g. *DOG-MOUSE)* whereas directly related word pairs (e.g. *DOG-CAT)* failed to demonstrate this effect (Moritz et al., 2001; Moritz, Woodward, Kuppers, Lausen, & Schickel, 2002; Spitzer, Braun, Hermle, & Maier, 1993). As indirectly related word pairs are considered

more distant and weaker associates, these findings are consistent with spread of activation that is greater than normal. In other words, activation has spread to a greater extent to more distant associates, thus priming their activation. Similarly, researchers have also found evidence of increased spreading activation in schizotypy using semantic priming (e.g. Moritz et al., 1999; Pizzagalli et al., 2001).

Of particular importance is that these studies have found evidence of increased spreading activation in schizophrenia patients only when the stimulus-onset asynchrony (SOA), or the time lag between the presentations of the word pairs was 300 ms or less. As priming at short SOAs (500 ms or less) is thought to represent "automatic" spread of activation, the authors concluded that their findings reflect abnormal automatic spread of activation through the semantic network rather than more controlled processes that may also give rise to priming like expectancy and semantic matching (Moritz et al, 2003; Spitzer et al, 1993).

Results from schizotypy studies are generally consistent with increased activation of distant associates. However, the majority of existing studies have focused on positive schizotypy, as much focus has been on theories that over-activation of distant associates lead to undue meaning being invested in coincidental events. For example, researchers found individuals scoring high on paranormal beliefs, an aspect of magical ideation, demonstrated greater priming of indirect associates (Pizzagalli, Lehmann, & Brugger, 2001). High scorers on magical ideation have also been found to judge unrelated word pairs as more meaningfully related than healthy controls (Mohr, Graves, Gianotti, Pizzagalli, & Brugger, 2001). Increased indirect semantic priming has also been found to correlated with scores on the Cognitive Disorganization (CogDis) subscale of the Oxford-

Liverpool Inventory of Feelings and Experiences (O-LIFE; Mason, Claridge, & Jackson, 1995) (Johnstone, Rossell, & Gleeson, 2008).

Semantic disorganization hypothesis.

Another popular hypothesis suggests that abnormal associations arise from structural disorganization in the semantic network (Goldberg et al., 1998; Goldberg & Weinberger, 2000). This "semantic disorganization theory" explains thought disorder in terms of semantic information being organized in an idiosyncratic, ineffective, or indirect way. According to this model, there is a presence of abnormal associations rather than over activation of distant associations that give rise to disorganized speech. In this sense, it is not a problem of distant associates becoming activated to an extent that is greater than normal, but a compromise in the structure and organization of semantic knowledge. Researchers have suggested that semantic boundaries may be looser than normal in thought disordered patients, as patients tend to categorize concepts inaccurately, with increased difficulty for items at the boundaries of two concepts. This has been demonstrated in a variety of paradigms, including morphing images tasks (Elvevåg et al., 2002; Zaslow, 1950), object sorting tasks (Chapman & Taylor, 1957), and word categorization tasks (Chan et al., 1994; Elvevåg et al., 2002), or when asked to determine important attributes of categories (Moran, 1953; Epstein, 1953).

Evidence for semantic disorganization also comes from multidimensional scaling procedures, in which statistically derived semantic clusters are graphically displayed by plotting points on a two- or three-dimensional map, where distances between points are though to reflect the psychological proximity between items in an interconnected network (Chen et al., 1993). In these studies, healthy individuals produce words along meaningful dimensions based on shared semantic attributes, such as domesticity and size, when asked

to list as many animals as quickly as they can. Thought disordered patients, on the other hand fail to produce words that fall along similar dimensions (e.g. Paulsen, et al., 1996; Sumiyoshi et al., 2001). These findings were reported as evidence of a breakdown in the structure of semantic knowledge in schizophrenia.

Another line of research uses semantic categorization tasks to assess the manner in which patients judge how concepts are meaningfully related by sorting words into different categories. Chen, Wilkins, and McKenna (1994) found that patients process words that are outside target semantic categories but related to them as if they were borderline members of these categories. Furthermore, patients include more borderline and outside category words as definite members of given categories compared to healthy controls. A similar pattern of results have been found using object-sorting tasks in which thought disordered patients use more conceptually loose criteria for sorting objects (McConaghy & Clancy, 1968). These findings appear to reflect that semantic boundaries are looser in schizophrenia patients, particularly those with prominent thought disorder.

Morgan, Bedford, O'Regan and Rossell (2009) administered a word categorization test to high scorers on the Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE, Mason & Claridge), a popular self-report measure of schizotypy. The authors found that high scorers on Cognitive Disorganization, the disorganized schizotypy subscale, performed more poorly on word categorization compared to high scorers on the positive and negative schizotypy subscales as well as controls. The authors concluded that disorganized schizotypy may be associated with atypical organization of semantic information, such that semantic processing is less efficient than normal. These findings parallel those in patient populations.

It should be noted that semantic disorganization is not necessarily mutually exclusive with increased spreading activation, as increased activation of distant or indirect associates through increased spreading activation may lead to architectural changes in the semantic network over time (Maher, 1983).

Dysexecutive hypothesis.

Although the role of semantic memory has been studied extensively in thought disordered schizophrenia patients, a separate camp of researchers (e.g. Anand & Wales, 1994, Barch & Berenbaum, 1996; Chaika, 1995; Crider, 1997; Docherty et al., 1996; Frith, 1992; Harrow & Prosen, 1978; Harvey & Sharma, 2002; Liddle, 1987; Maher, 1996) propose that thought disorder results from an impairment in executive functioning. This "dysexecutive theory" of thought disorder posits that impairments in different aspects of executive function could give rise to elements recognized in thought disorder. For example, it could result in impairing the monitoring, organization, and planning of speech (Kerns & Berenbaum, 2002), leading to difficulties focusing on a topic, filtering out irrelevant associations, and even taking into account the listener's perspective (McGrath, 1991). In this sense, executive dysfunction could lead to deficits in inhibiting inappropriate associations (Liddle & Morris, 1991) and in suppressing inappropriate mental activity (Baxter & Liddle, 1998), leading to distractibility and poor inhibition of automatic responses (Torres, O'Leary & Andreasen, 2004).

These theories are strengthened by evidence from numerous studies that have found disorganized schizophrenia patients to be significantly impaired in a wide range of neuropsychological tests (e.g. Liddle & Morris, 1991; McGrath et al., 1997; Nestor et al., 1998; Persons & Baron, 1985). Similarly, researchers have found subtle prefrontal deficits associated with psychometric schizotypy, although the role of executive

dysfunction in relation to disorganized symptoms in schizotypy has not been thoroughly investigated in this sample.

Although semantic priming and categorization tasks offer insight into how subjects process semantic stimuli with various degrees of associative relatedness, these tasks use stimuli with predetermined associative strengths and are less informative as to the natural associations formed by the subjects. To examine the degree of 'natural' associative looseness, researchers use word association tasks, in which individuals are presented with a single word and asked to come up with their own association, the first word that comes to mind. Word association tasks are informative into the qualitative nature of semantic associations produced by schizophrenia patients and schizotypic individuals, and can be examined in terms of their typicality and appropriateness for the given semantic category.

Researchers have gradually compiled large databases with normative information on the most common frequently produced words on word association tasks (e.g. Nelson, McEvoy, & Schreiber, 1998). In general, common words generate similar associations in different people despite the influence of personally relevant meaning. For example, in a sample of 300 individuals, approximately half associated 'white' with 'black', and one-third associated 'chair' with 'table' (Russell, 1970). This shows that commonly associated concepts are evident in the production of word associations. Furthermore, the frequency of "common" associations indicate that even single word associations are sensitive to the production in "atypical" associations.

Studies have found that individuals scoring high on perceptual aberration and magical ideation produce more idiosyncratic and uncommon words relative to high scorers on physical anhedonia (Miller & Chapman, 1983) or social anhedonia (Ward,

McConaghy, & Catts, 1991). Greater prevalence of idiosyncratic and uncommon responses have also been found in individuals who scored high on psychoticism, but not those who scored high on extraversion or neuroticism (Merten, 1993). This pattern of findings parallels those of word-association studies with schizophrenia patients, in which patients produce a greater number of rare responses, compared to normal controls (Merten, 1992).

In summary, different lines of research have found that schizotypy, like schizophrenia, is associated with abnormalities in how meaningful relationships between semantic concepts are processed, judged, and determined. Although the exact mechanisms contributing to atypical semantic associations are not fully understood, researchers have postulated that this phenomenon results from abnormalities in semantic and/or executive processes. Specifically, the spreading activation theory implicates abnormalities in spreading activation that activates both strong and weak associates to the same extent, whereas the semantic disorganization model focuses on abnormalities in the functional organization of the semantic store resulting in abnormal connections between weak associates. The dysexecutive theory, however, suggests that abnormalities in executive functions that govern the appropriate use of language, give rise to atypical semantic associations. Whatever the reason, it is important to examine how these individuals spontaneously produce words that have meaningful relationships already established in their semantic memory by assessing their performance on standardized neuropsychological paradigms, such as verbal fluency tasks that are thought to reflect semantic activation patterns, and by extension, semantic associations.

Verbal Fluency Tasks

One way in which semantic networks have been studied is by analyzing the pattern of responses on verbal-fluency tasks (e.g., Chan et al., 1993; Schwartz & Baldo, 2001). Semantic activation patterns have been investigated in schizotypal individuals by analyzing responses from the Category Fluency Test (CFT; Spreen & Strauss, 1998), a commonly used neuropsychological test. In this task, individuals are instructed to verbally generate exemplars that belong to a specific semantic category. For example, in a typical CFT, participants will be asked to generate as many examples of animals as possible within one minute. The most frequently used categories are animals, fruits, vegetables, and articles of clothing. Unlike word-association tasks, which determine the degree of meaningful relationship of single word responses to a predetermined word list, verbal fluency tasks can be used to the same effect with unique word lists generated by each participant.

In addition, although schizotypy is associated with greater production of unusual responses on single word association tasks, a single association limits our ability to understand the progression of associations and how concepts are activated over time. As such, it is important to examine multiple, successively generated responses over time using verbal fluency tests as they offer a window into the functional organization of semantic memory, which can be compared between high- and low-scorers on schizotypy.

Successful performance on the CFT requires a systematic search through one's knowledge of word meanings and their associations and relies heavily on the activation of concepts in semantic memory (Tulving, 1986). The individual is required to understand the attributes of a word, or concept, to determine whether it qualifies as a category exemplar. The use of semantic cues engages the frontal and temporoparietal regions (Newcombe, 1969). This is in contrast to the letter fluency test (LFT), where exemplars

must start with specific letters (i.e. *"F"*, *"A"*, *"S"*), drawing from phonemic or orthographic cues and greater dependence on left prefrontal and left inferior parietal cortex functioning (Benton, 1986; Milner, 1964). Furthermore, generating words based on orthographic criteria is more abstract and less well practiced than assessing words based on their meaning (Perret, 1974). For this reason, the CFT appears to provide useful information about the functional organization of the semantic network (Aloia et al., 1996; Rossell, Rabe-Hesketh, Shapleske, & David, 1999; Sumiyoshi et al., 2001; Troyer, Moscovitch, Winocur, Leach, & Freedman, 1998) and is appropriate for assessing the production of distant semantic associations in schizotypy.

The total number of responses generated, or total fluency score, on the CFT has been found to be lower in schizophrenia patients than in controls (Allen & Frith, 1983; Allen, Liddle, & Frith, 1993; Aloia et al., 1996; Elvevåg, Fisher, Gurd, & Goldberg, 2002; Giovannetti, Goldstein, Schullery, Barr, & Bilder, 2003; Paulsen et al., 1996; Rossell et al., 1999; Sumiyoshi et al., 2001). In contrast, verbal fluency studies generally fail to find significant differences total fluency between high and low scorers on overall schizotypy or schizotypy subtypes (Dinn, Harris, Aycicegi, Greene, & Andover, 2002; Duchêne, Graves, & Brugger, 1996; Hori et al, 2008; Hori, Ozeki, Terada, & Kunugi, 2008, Kiang & Kutas, 2006).

There appear to be only two studies that have found significant differences in total fluency. Méary, Ferchiou, Trandafir, Leboyer and Schürhoff (2009) found that disorganized schizotypy was associated with increased total fluency on animals CFT. The authors concluded that disorganized schizotypy might be associated with excessive spreading activation. It should be noted that disorganized schizotypy was measured using the Odd Speech subscale on the SPQ (Odd Eccentric Behavior was excluded), suggesting

that aspects of disorganized schizotypy associated with atypical speech processes may be especially related to semantic activation abnormalities. In contrast, Tsakanikos and Claridge (2005) found that extremely high scorers on positive and negative schizotypy demonstrated increased and decreased letter fluency, respectively. Disorganized schizotypy failed to differ significantly on the LFT task. It should be noted that disorganized schizotypy was assessed with the O-LIFE CogDis subscale which measures aspects of disorganized schizotypy associated with difficulties in attention and concentration, as well as moodiness and social anxiety. Some researchers have expressed concerns that CogDis may not correspond with clinical descriptions of schizophrenic disorganization (Cochrane, Petch & Pickering, 2010; Mason et al., 1997).

As total fluency score may not accurately capture subtle abnormalities in semantic activation, researchers have also examined the typicality of responses produced by category fluency tasks. Kiang and Kutas (2006) examined response typicality on a CFT in a sample of 60 undergraduate students by calculating a "typicality index" for each response. Schizotypy was measured using the Schizotypal Personality Questionnaire (SPQ, Raine, 1991), and "fruits" category CFT was used, although a subset of 34 participants also completed a "four-footed animals", "articles of clothing", and "vehicles" category CFT. In addition, baseline verbal ability was measured with the Peabody Picture Vocabulary Test (PPVT) (Dunn & Dunn, 1997). In addition to calculating the typicality for each response, the authors also calculated the typicality of the order in which words were produced. For example, it is much more typical for individuals to start with *APPLE* than *COCONUT*.

Once again, total fluency score was no different between schizotypy and controls. However, when looking at the Typicality Index, high scorers on the SPQ not only

produced a greater number of atypical exemplars, even the order in which they produced responses was more atypical than low scorers. This finding was most prominent in the disorganized subtype. These findings support the view that unusual semantic associations may be activated in schizotypal populations, thus resulting in an increased prevalence of atypical and unusual category exemplars being generated on category fluency tests. These results demonstrate that on the "fruits" CFT, both individual words and the order in which words are produced are more atypical in all three subtypes of schizotypy compared to controls.

Minor, Cohen, Weber, and Brown (2010) followed the methodology used by Kiang and Kutas (2006) and calculated the typicality index of responses on the "fruits" and "vegetables" CFT in 83 prescreened undergraduate students. Schizotypy was measured with the SPQ, although the Social Anxiety and Suspiciousness subscales were omitted from the calculation of the Interpersonal factor, the negative schizotypy subscale. Given the relevance of odd and disorganized speech and associative loosening, the authors used an additional observational measure, the Communication Disorders Index (CDI; Docherty, 1996), to assess odd speech on a natural language task. They found that individuals scoring high on the SPQ total score, a composite score of "general" schizotypy did not differ from controls on either total fluency score or response typicality. However, in the high schizotypy group, greater response atypicality was significantly associated with increased odd speech when a stress was induced. In terms of subtype, however, the authors found scores on disorganized schizotypy was positively correlated with response atypicality, whereas scores on negative schizotypy was negatively correlated with response atypicality. Positive schizotypy was not significantly related to response typicality.

This pattern of results is generally consistent with findings in schizophrenia patients in which production of peculiar responses is associated with the severity of thought disorder (Baskak, Ozel, Atbasoglu, & Baskak, 2008). Brébion, Bressan, Ohlsen, Pilowsky, and David (2010), however, failed to reproduce these findings, although they noted the small number of thought disordered schizophrenia patients limited their study sample. In fact, severity of certain negative symptoms was associated with lower typicality scores, in which more typical responses were produced.

Troyer, Moscovitch, and Winocur (1997) proposed that two additional aspects of verbal fluency performance may be clinically useful: clustering (production of words that fall into the same semantic category) and switching (ability to shift between semantic clusters once one has been exhausted). This can be observed during verbal fluency tasks when responses tend to be produced in "spurts", or temporal clusters, with longer pauses between clusters (e.g. Bousfield & Sedgewick, 1944). On category fluency tasks, words within a cluster tend to be semantically related (Gruenewald & Lockhead, 1980; Rosen & Engle, 1995). These response patterns are thought to correspond to semantic activation of closely related words, comprising a cluster, which when exhausted requires a search for another semantic cluster, signaling a switch. Typical performance indexes include calculation of a total cluster size (the number of words belonging to clusters), average cluster size, and switch rate (number of switches between clusters including single words) (Troyer et al., 1997). Furthermore, Troyer et al, proposed that production within a cluster of successive semantically related words relies on temporal-lobe mediated access to semantic memory, whereas switches between clusters depend more on frontal brain regions and executive processes. Therefore an examination of clustering and switching patterns in non-clinical schizotypy could provide valuable information into the role of

semantic vs. executive processes that may contribute to atypical semantic activation. This is especially important given the competing "Dysexecutive model" of thought disorder, which is of particular relevance to disorganized schizotypy, given the different emphases on the Disorganization factor of the SPQ and the CogDis subscale of the O-LIFE.

Only one study to date has examined clustering and switching in schizotypy. Szöke et al. (2009) found that as the severity of disorganized schizotypy (measured by the Odd Speech subscale on the SPQ) increased, so did the number of words belonging to clusters (total cluster size). Furthermore, as the severity of negative schizotypy increased, the number of switches decreased. It should be noted that the Suspiciousness subscale on the SPQ was excluded from the calculation of both negative and positive factor scores. Based on these findings, there is evidence that disorganized schizotypy, particularly aspects related to speech abnormalities, may be especially detectable in category fluency variables tapping semantic processes.

It should be noted that although semantic dysfunction is typically associated with disorganized schizophrenia, some studies have found greater CFT impairment in association with positive symptoms rather than disorganized symptoms. For example, Kerns et al. (1999) reported increased semantic associations produced by patients with hallucinations on a modified letter fluency task compared to those with thought disorder. In addition, DeFreitas, Dunaway and Torres (2009) found greater impairment in semantic fluency among patients with predominantly positive symptoms after "controlling" for the influence of general word production ability by taking the difference score between CFT and LFT performance. These findings have been explained in terms of impaired semantic memory rather than deficits in spreading activation.

In addition to disorganized schizotypy, researchers have also found evidence of abnormal spreading activation in healthy individuals who score high on non-clinical measures of thought and language disturbances similar to those found in thought disordered schizophrenia patients. Moritz and colleagues (1999) compared performance on an indirect semantic priming task between high and low scorers on a 10-item self-report measure based on frequent verbal complaints given by schizophrenia patients. They found increased priming for indirect associates among high scorers, suggesting increased semantic priming of indirectly associated word pairs (*LEMON-SWEET*) among healthy individuals reporting language disturbances similar to those found in thought disordered schizophrenia patients. Their findings suggest that outside of the disorganized schizotypy construct, similar semantic processing abnormalities are found in both clinical and non-clinical individuals reporting similar forms of thought and language disturbances, confirming the need to thoroughly examine this phenomenon in non-clinical samples.

According to Meehl (1962), a primary feature of both schizotypy and schizophrenia is cognitive slippage, which is a loosely defined construct encompassing associative disturbances, confused thinking, and speech difficulties. Meehl suggested that a large percentage of any high-risk sample are schizotypes who should display signs of cognitive slippage. Because loose associations are a predominant feature of formal thought disorder and the diagnostic hallmark of Disorganized Schizophrenia, it was important to ensure the study captured the full range of disorganized type schizotypy. For this reason, cognitive slippage was also assessed in the current study using the Cognitive Slippage Scale (CSS; Miers & Raulin, 1987). As no previous research has examined

category fluency performance in association with the CSS the results may offer unique insight into semantic processing in this particular aspect of schizotypy.

Taken together, it appears that neuropsychological abnormalities found in non-clinical schizotypy are not severe enough to produce detectable differences in fluency scores compared to controls. Furthermore, studies using different conceptualizations of disorganized schizotypy appear to produce conflicting results. For this reason, it is important to assess the full spectrum of disorganized schizotypy traits in association with a comprehensive evaluation of fluency performance to better understand the nature of semantic processing associated with this subtype.

The Present Study

The purpose of the present study was to examine the quality of responses produced on a category fluency task as a function of schizotypy in a non-clinical sample. Because it is difficult to compare results when different schizotypy measures are used, we also aimed to improve upon the methodology of existing research by administering both the O-LIFE and SPQ. Not only will this increase the generalizability of our results but also the ability to capture the full range of schizotypic manifestations, especially disorganized schizotypy, which is the most inconsistently replicated factor.

Semantic relatedness between animal category exemplars was measured using WINDSORS (Windsor Improved Norms of Distance and Similarity of Representations of Semantics; Durda & Buchanan, 2008), a recently developed vector-based representation of semantic memory in a high-dimensional space. WINDSORS was produced based on a lexical co-occurrence model of semantics, and determines semantic distance between two words based on the number of times they occur together in a large corpus of written text. Specifically, WINDSORS- derived semantic distances are considered reflections of

similarity in meaning. Durda and Buchanan (2008) demonstrated that WINDSORS-derived distances capture both semantic and associative relationships between words by computing distances between word pairs used in semantic priming tasks. Therefore, our WINDSORS-derived semantic distances captured, 1) frequency of co-occurrence in similar contexts in the English language, 2) semantic similarity, 3) associative strength, and/or 4) simultaneously semantically similar and associatively related relationships. The main advantage of WINDSORS is that unlike earlier computational models, such as the hyperspace analogue to language (HAL; Burgess, 2000, 2001; Burgess & Livesay, 1998; Burgess & Lund, 2000; Lund & Burgess, 1996), WINDSORS derived semantic distances are not affected by word frequency. That is, WINDSORS takes into account the fact that high frequency words inherently co-occur to a greater extent with all other words.

The total and average semantic distance between each word on each individual's CFT list was calculated as a measure of average semantic relatedness between successively generated words. Greater distance would suggest that, on average, concepts tend to activate more distantly related concepts. Smaller distance would suggest that, on average, concepts tend to activate more closely related concepts. In addition, the total and average semantic distance between the initial response and all other words produced on each individual's CFT list was calculated as a measure of average semantic relatedness between initial response and its associates. Greater distance would suggest that, on average, the initially activated concept tends to activate more distant associates. Smaller distance would suggest that, on average, the initially activated concept tends to activate more closely related associates. In both cases, higher values are thought to reflect greater activation of distantly associated concepts, and by extension, more atypical semantic activation.

Our primary aim was to examine the semantic relatedness between CFT responses in relation to disorganized schizotypy. It was expected that individuals with higher disorganized schizotypy would produce more distantly associated responses, quantified as greater semantic distances between successively produced words, as well as between the initially produced response and all other responses. This would reflect greater proclivity towards activation of distantly associated concepts in disorganized schizotypy.

It was also expected that individuals with higher cognitive slippage would produce more distantly associated responses due to the conceptual overlap between cognitive slippage and disorganized schizotypy symptoms. This outcome would be consistent with Meehl's theory that cognitive slippage reflects a breakdown in associative processes, and would provide additional evidence of the validity of the CSS as an independent measure of language and thought abnormalities associated with schizotypy in the normal population.

A secondary aim was to examine clustering and switching on the CFT in relation to overall schizotypy and schizotypy subtype. Specifically, total cluster size, average cluster size, and switch rate were computed and analyzed as a function of schizotypy. If differential impairment in clustering reflects deficits in semantic processing in clinical populations, then in a non-clinical sample we might also expect individuals with high scores on disorganized schizotypy and/or cognitive slippage to exhibit differential impairment in clustering but have intact switching. That is, it was expected that individuals high on disorganized schizotypy, as well as individuals high on cognitive slippage would produce fluency lists with fewer words belonging to semantic clusters (lower total cluster size), and fewer words per cluster (lower average cluster size), but

show no difference in the number of switches made between clusters, compared to low scorers on disorganized schizotypy and low scorers on cognitive slippage.

Method

Participants

Eighty-six undergraduate students (66 female, 20 male, mean age = 21.37, *SD* = 3.75 years, Caucasian = 52, Mixed = 10, South Asian = 9, African American = 7, Middle Eastern = 5, Asian = 3) from the University of Windsor participated in this study for course credit for their involvement. All participants elected to participate in the current study through the University of Windsor Research Participant Pool. The Research Participant Pool is a large group of undergraduate students allowed to register for academic research studies due to their enrollment in an eligible psychology course. Students were recruited using an online advertisement describing the study. Participants were asked only to sign up if they are fluent in English. Data was also excluded from participants who endorsed past or current psychiatric, neurological, language, or learning disorder. Data from seven participants who met these criteria were excluded from data analysis. Specifically, four participants were excluded for a psychiatric history, two were excluded for learning disability diagnosis, and one participant withdrew prematurely. The remaining 79 participants (58 females, 19 males) had a mean age of 21.05 years (*SD*= 3.06 years). Data for SPQ and CSS were missing for one participant who withdrew prematurely. Ethics approval was obtained through the University of Windsor Research Ethics Board and written informed consent was obtained from all participants prior to the study. A copy of the consent form is provided in Appendix A.

Measures

Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE). The O-LIFE (Mason, Claridge & Jackson, 1995) contains 153 statements in a dichotomous "yes/no" response format, 49 of which are filler questions. Four dimension scores are derived 'Unusual Experiences' (UnEx) assesses tendencies towards experiencing perceptual disturbances, hallucinatory experiences, and magical thinking). 'Cognitive Disorganization' (CogDis) assesses deficits in attention, concentration, and decision-making, and tendencies towards social anxiety, moodiness, and purposelessness. 'Introvertive Anhedonia' (IntAn) assesses social anhedonia and physical/emotional anhedonia. These three dimensions correspond generally to positive, negative, and disorganized schizotypy, respectively. The fourth dimension, 'Impulsive Non-conformity' is based on the Psychoticism scale (Eysenck & Eysenck, 1976) and excluded from our analyses. It assesses impulsivity, recklessness, and self-destructive behaviors. A composite schizotypy score was calculating by taking the total score excluding the 49 filler items. Higher scores indicate more severe symptoms.

The O-LIFE is a reliable and valid measure of non-clinical schizotypy. All three subscales of interest have high internal consistency reliability, with α=.77 to .89 (Mason & Claridge, 2006; Rawlings & Freeman, 1997); test-retest reliability greater than r=.70 (Burch et al., 1988). It has adequate construct validity in factorial validity, with all factor loadings >.25, and goodness of fit of the four factor solution in the absence of any other acceptable models (Mason, 1995). The O-LIFE has been used in a variety of research domains, and has demonstrated predictable effects in relation to neuropsychological function (Avons et al., 2003; Rawlings & Goldberg, 2001) and differences in hemispheric function for language task performance (Kravetz et al., 1998; Nunn & Peters, 2001). Studies have also found evidence of heritability of O-LIFE scales along the lines

predicted for schizotypal traits (Linney et al., 2003). It should be noted that the original authors of the O-LIFE cautioned against the theoretical soundness of computing composite scores by summing scores from two or more scales to produce a single measure and did not provide psychometric properties for a composite O-LIFE score. A copy of the O-LIFE is provided in Appendix B.

The Schizotypal Personality Questionnaire (SPQ). The SPQ (Raine, 1991) contains 74 statements in a dichotomous "yes/no" response format and includes nine subscales corresponding to the nine diagnostic criteria in the DSM-III-R for Schizotypal Personality Disorder (American Psychological Association, 1987), that form three factor scores. The 'Cognitive-Perceptual' factor (POS) includes the subscales Ideas of Reference, Magical Thinking, Unusual Perceptual Experiences, and Paranoid Ideation. The 'Interpersonal' factor (NEG) includes Social Anxiety, No Close Friends, Constricted Affect, and Paranoid Ideation. The 'Disorganization' factor (DIS) includes Odd Speech, and Odd Eccentric Behavior. These three factor scores correspond to the positive, negative, and disorganized schizotypy, respectively. The SPQ also produces an overall composite score. Higher scores indicate more severe symptoms.

The SPQ is a reliable and valid measure of non-clinical schizotypy. It has strong internal consistency reliability, with α=.90 to .91 for the total scale score, and α=.71 to .78 for individual subscales; two-month test-retest reliability of .82. It has good convergent validity with other schizotypy measures (r=.81 with the Schizotypal Personality Scale and r=.59 to .65 with the Schizophrenism Scale); good discriminant validity with low correlations with psychosis-proneness scales not included in the DSM-III-R (APA, 1987) (r=.18 to .19 with Anhedonia, and r=.27 to .37 with Psychoticism), and adequate criterion validity in that 55% of the top 10% of the normative sample have a DSM-III-R clinical

diagnosis of Schizotypal Personality Disorder as assessed by structured clinical interviews (Raine, 1991). The SPQ has been used in a variety of research domains, and has demonstrated predictable effects in relation to neuropsychological function (Daneluzzo et al., 1998; Park & McTigue, 1997). A copy of the SPQ is provided in Appendix C.

Cognitive Slippage Scale (CSS). The CSS (Miers & Raulin, 1985) contains 35 statements in a dichotomous "yes/no" response format and was developed to measure cognitive slippage, that is hypothesized as a fundamental characteristic of thought disorder in schizophrenia and schizotypy and indicative of a genetic predisposition to schizophrenia. Although cognitive slippage can be manifested in hallucinations, delusions, speech deficits, confused thinking, and disturbances in attention (which are nicely sampled by the O-LIFE and SPQ), items on the CSS focus on speech deficits and confused thinking; for example, "My thoughts are orderly most of the time"(F) and "I hardly ever find myself saying the opposite of what I meant to say"(F).

The CSS is a reliable and valid measures of non-clinical cognitive slippage. It has strong internal consistency reliability, with α=.87 for males and α=.90 for females; good concurrent validity with other schizotypy scales (e.g., perceptual aberration, intense ambivalence, social anxiety, magical ideation, somatic symptoms, and distrust); fair construct validity in accurately predicting scores on several MMPI scales (Fischer & Corcoran, 2007). It should be noted that, for the CSS, no test-retest correlations are available and there is a slight correlation with a social desirability response bias, although the latter cannot be completely ruled out in any self-report measure. A copy of the CSS is included in Appendix D.

The North American Adult Reading Test (NAART). The NAART (Blair & Spreen, 1989; Spreen & Strauss, 1998) is a list-reading task consisting of 61 irregularly pronounced English words scored for accuracy according to American and Canadian pronunciation rules. The NAART is a reliable and valid measure of verbal intelligence, comparable in psychometric properties to the Wechsler Adult Intelligence Scale-Revised (WAIS-R) Vocabulary test and is equally reliable and valid for young, middle-aged, and older adults (Uttl, 2002). It has high internal consistency reliability, α=.94; high inter-rater reliability (*r*=.99) (Blair & Spreen, 1989). It has good concurrent validity with the WAIS-R Verbal IQ (*r* = .83), and Full Scale IQ (*r* = .75) (Lezak, Howieson, Loring, Hannay, & Fischer, 2004). A copy of the NAART is included in Appendix E.

Positive and Negative Affect Schedule- Expanded Form (PANAS-X). Recent findings suggest that the strength of spreading activation may be state-dependent and modulated by mood (Hanze & Hesse, 1993). The PANAS-X (Watson & Clark, 1999; Watson, Clark, & Tellegen, 1988) was administered to control for potential confounds attributed to mood states. It requires participants to rate to what extent they generally experience 60 different affects (e.g. cheerful, disgusted, attentive, bashful, and daring) on a 5-point Likert scale from 1 ("very slightly or not at all") to 5 ("extremely"). It produces a 'Positive Affectivity' (PA) score, referring to tendencies towards positive affects, and a 'Negative Affectivity' (NA) score, referring to tendencies towards negative affects.

The PANAS-X scales are reliable and valid measures of general positive and negative affectivity. Both scales have sufficient internal consistency reliability, with *α*=.83 to.93 (Watson & Clark, 1997); reasonably well test-retest reliability for 2-month and 7-year intervals. It has good construct validity in high convergent validity, with *r*=.89 to .95 within the two scales, and good discriminant validity, *r*= -.05 to-.35 between the

two scales, and high convergence with other personality measures (Bagozzi, 1993; Watson & Clark, 1999). A copy of the PANAS-X is included in Appendix F.

Demographics Questionnaire. The demographics questionnaire consisted of questions about age, gender, and years of education, handedness and information regarding exclusionary criteria. A copy of the Demographics Questionnaire is included in Appendix G.

Procedure

Participants completed a demographics questionnaire measuring age, gender, and years of education, handedness and information regarding exclusionary criteria prior to administration of the fluency test. Because verbal fluency performance is related to education, age, and verbal knowledge (Auriacombe et al., 2001; Phillips, 1999; desRosiers & Kavanagh, 1987), participants were given the NAART and PANAS-X to control for or assess the influence of such factors on verbal fluency performance. After this, participants were seated comfortably in a quiet room and received instructions for the category fluency test. For this task, participants were asked to generate as many types of animals as possible, excluding proper names, or variations of the same subgroup.

Responses were recorded verbatim in the order they are produced on paper and subsequently reviewed. A trained research assistant, as well as the researcher, scored each participant's responses and came to consensus in determining cluster memberships. Participants were given one minute to complete the category fluency test (animals). If the participant stopped before the end of the minute, they were encouraged to think of more words as previously stated with the instructions. All participants completed questionnaires in the following order: PANAS-X, O-LIFE, SPQ, and CSS.

Scoring of the CFT.

The total number of responses was be recorded as the total category fluency score. Following the standard instructions for the animals CFT, names of extinct, imaginary, or magic animals were allowed, but given names for animals like “Fido” and “Morris” were not. Standard inadmissible words (e.g. proper names, wrong words, variations, repetitions) are not scored as correct, however, they were included in the final analyses. Scoring for clustering and switching will be based on guidelines provided by Troyer et al. (1997). Fluency lists will be scored for switching tendency by counting the number of transitions between animal categories, including single words. Categories were determined based on semantic attributes, for example, animals that share a common habitat (e.g. North American, African, water-dwelling), species (e.g. insects, amphibians, mammals), type of usage by humans (e.g. pets, farm animals), etc. In cases where two categories overlapped, with some responses belonging to both categories, some words belonging exclusively to the first category, and some words belonging exclusively to the second category, the overlapping items are assigned to both categories. For example, for *dog, cat, tiger, lion,* the first two words are scored as pets, and the last three items are scored as feline. Cat was included in both the pet category and feline category. In cases where smaller clusters are embedded within larger clusters, or two categories overlapped, but all items can correctly be assigned membership to a single category, only the larger, more common category is to be used. A copy of scoring rules and animal categories are included in Appendix H.

Cluster size was determined by counting the number of responses within a semantic cluster, starting from the second response in the cluster. For example, in a sequence of responses such as *dog-cat-cow-chicken-sheep*, there are two clusters and one switch. Dog and cat belong to the “Pets” category, and cow, chicken, and sheep belong to

the "farm animals" category. Cluster sizes were summed and averaged over the total number of clusters, producing a total and average cluster size, respectively. A switch is present at the junction of cat and cow. The cluster size for the first cluster (Pets) is 2-1 = 1, and the cluster size for the second cluster (farm animals) is 3-1 = 2. Cluster sizes will be summed and averaged over the total number of clusters, producing a mean cluster size.

The number of switches depends, to an extent, on total verbal fluency. Thus a weighted measure of switches (i.e. switch rate) will be calculated by averaging the number of switches over total verbal fluency when assess a participants' switching tendency (see Epker, Lacritz, & Cullum, 1999).

For each response, as a measure of semantic activation, the "distance" was obtained from the next response. Distances could not be derived from five words that were not available from WINDSORS at the time of the study: *earwig, goby fish, meerkat, lamprey,* and *sea lamprey.* Each word only appeared only once within the sample in the word lists of four participants. Analyses were performed with this data missing pairwise. Generally, few words across lists were omitted due to missing semantic distance variables. For consistency, all responses were converted to singular form prior to determining semantic distance variables. Four dependent variables were calculated for each participant's word list: the total semantic distance between each word and the next (sum distance), the average semantic distance between each word and the next (average distance), the total semantic distance between first word on the list and all other words (sum distance from initial response), and the average semantic distance between first word on the list and all other words (average distance from initial response). Greater semantic distances indicate more distantly associated words. Table 1 shows examples of the four semantic distance variables for two sample word lists.

Table 1.
Sample WINDSORS Semantic Distances for Two CFT Response Lists

	Between Words	From Initial Response		Between Words	From Initial Response
List 1			List 2		
DOG			DOG		
CAT	0.32	0.32	ELEPHANT	0.72	0.72
MOUSE	0.48	0.70	HORSE	0.82	0.50
GERBIL	1.00	1.00	TIGER	0.76	0.71
HORSE	1.01	0.50	CAT	0.54	0.32
COW	0.75	0.71	RAT	0.58	0.78
SHEEP	0.48	0.68	PARROT	0.69	1.04
PIG	0.50	0.62	SHARK	0.82	0.82
BEAR	0.77	0.53	GOAT	0.90	0.80
DEER	0.70	0.82	SPIDER	0.86	0.91
Total	6.00	5.90		6.69	6.62
Average	0.67	0.66		0.74	0.74

Note. Between Words= WINDSORS-derived sematic distances for each word from the response preceding it. From Initial Response= WINDSORS-derived semantic distances for each from the initially produced response. List 1 exemplifies a word list with more closely associated responses, whereas, List 2 exemplifies a word list with more distantly associated concepts, as reflected in greater Total and Average semantic distances for the latter.

Statistical Analyses

We were primarily interested in the average degree of semantic relatedness between responses. Calculating averages also reduces any confounding effects of list length because the number of responses produced on a list (i.e. list length) would likely influence semantic relatedness. For this reason, average semantic distances were calculated in two ways. First, total semantic distances were calculated for each participant by computing the sum of semantic distances between each response, and the effects of list length controlled statistically during statistical analysis (i.e. entered as covariates or controlled using regression analysis). Second, average semantic distances were calculated for each participant prior to statistical analysis (i.e. dividing summed semantic distance by number of responses produced). Therefore, both the total and average semantic distance

between successively produced words, and from the initially produced response were calculated and used in our statistical analyses.

To examine group differences between high and low schizotypy as measured by O-LIFE and SPQ, and high- and low-cognitive slippage as measured by the CSS, the sample was split at the median into high and low scoring groups for all three psychometric measures. A series of one-way ANCOVAs were conducted, with total list length (total list length) entered as a covariate where appropriate as suggested by Elvevåg and colleagues (2002). For all dependent variables, z-scores ± 2.5 were excluded from analyses. To examine differences in schizotypy subtype, within high- and low- schizotypy groups as measured by the O-LIFE and SPQ, Pearson's r were computed for all dependent variables, if both variables passed the Kolmogorov-Smirnov test for normality (α=.05). For subscales that were significantly non-normal, Spearman's ρ was computed with two-tailed significance levels. In addition, because individuals can be high on more than one schizotypy subscale, multiple regression analyses were conducted.

Results

Overall Assessment Scores

Table 2 shows descriptive statistics for assessment scores for the study sample. Neither verbal ability as measured by the NAART, or the PANAS-X scores were correlated with the dependent variables. For this reason, they were not included as covariates. Spearman's rho indicates that age is significantly correlated with total fluency, total cluster size, average cluster size, sum distance from initial response and average distance from initial response. Regressions were run to see how much the age-total fluency correlation contributes to these other correlations.

Table 2.

Descriptive Statistics for Assessment Scores

	M	*SD*	Range
Gender [a]	58 (19)		
Handedness [b]	71 (6)		
Age	21.05	3.06	18-36
NAART verbal score	97.41	12.16	30.66-127.81
PANAS-NA	19.7	5.86	10-35
PANAS-PA	33.18	5.31	19-49
O-LIFE total [c]	33.62	11.82	12-61
Unusual Experiences	7.86	4.47	0-22
Cognitive Disorganization	11.04	5.44	1-15
Introvertive Anhedonia	5.84	3.62	1-23
SPQ total [d]	22.44	13.17	1-52
Cognitive-Perceptual Factor	9.33	5.73	0-25
Disorganization Factor	5.21	4.13	0-16
Interpersonal Factor	10.88	7.48	1-29
CSS [d]	8.6	7.05	0-29

Note. [a] Gender: F(M), [b] Handedness: R(L), [c] n=77, [d] n=76

To create high- and low- schizotypy groups, the study sample was split at the median O-LIFE total score (*mdn* = 32). Two cases exactly on the median on the O-LIFE were excluded from the analysis. Mean O-LIFE score for the high-schizotypy group was 43.26 (*SD* = 7.99) and for the low-schizotypy group was 23.82 (*SD* = 5.68). The high-schizotypy group did not differ from the low-schizotypy group on gender, $\chi^2(1) = .11$, $p = .74$, handedness, $\chi^2(1) = .001$, $p = .97$, NAART score, $F(1,75) = 2.06$, $p = .16$, or PANAS-PA (positive affectivity) score, $F(1,75) = 2.37$, $p = .13$. However, PANAS-NA (negative affectivity) scores were significantly higher in the high-schizotypy group, $F(1,75) = 25.19$, $p = .001$, and age was marginally higher in the low-schizotypy group, $F(1,72) = 3.65$, $p = .06$ (see Table 3 for means). As expected, the high-schizotypy group scored significantly higher on all O-LIFE subscale scores relative to the low scoring group (all $p < .05$). Furthermore, the high-schizotypy group scored significantly higher on CSS compared to the low-schizotypy group ($p < .05$).

Table 3.

Descriptives for High- and Low- Scorers on the O-LIFE (N = 77)

	Low (n = 38)		High (n = 39)	
Measure	*M*	*SD*	*M*	*SD*
Gender [a]	28 (10)		30 (9)	
Handedness [b]	35 (3)		36 (3)	
Age	21.75+	3.64	20.42+	2.21
NAART Verbal Score	99.59	9.05	95.60	14.62
PANAS-X NA	16.68***	4.05	22.49***	5.90
PANAS-X PA	34.13	5.52	32.28	5.03
O-LIFE				
Unusual Experience	4.87*	2.63	10.85*	3.94
Cognitive Disorganization	7.11*	3.59	14.72*	4.27
Introvertive Anhedonia	4.58*	2.83	7.23*	3.86
CSS	4.89*	4.08	12.10*	7.67

Note: [a] Gender: F(M), [b] Handedness: R(L)
+ $p < .10$. * $p < .05$. *** $p < .001$

In addition to creating high- and low-schizotypy groups based on the O-LIFE total score, the study sample was split by median SPQ total score (*mdn* = 20.5). Mean SPQ score for the high-schizotypy group was 33.54 (*SD* = 8.62) and for the low-schizotypy group was 11.33 (*SD* = 4.93). The high-schizotypy group did not differ from the low-schizotypy group on gender, $\chi^2(1) = .01$, $p = .95$, handedness, $\chi^2(1) = .13$, $p = .72$, age, $F(1,73) = 1.89$, $p = .174$, or NAART score, $F(1,75) = 1.41$, $p = .24$. However, both PANAS-NA, $F(1,75) = 12.33$, $p = .001$, and PANAS-PA, $F(1,75) = 10.24$, $p = .002$, scores were significantly different between groups. As expected, all SPQ subscale scores and CSS score was significantly higher in the high-schizotypy group compared to the low-schizotypy group (all $p < .05$). See Table 4 for means.

Table 4.

Descriptives for High- and Low-Scorers on the SPQ (N =76)

	Low	High

	(n = 37)		(n = 39)	
Measure	*M*	*SD*	*M*	*SD*
Gender [a]	27 (10)		31 (8)	
Handedness [b]	33 (4)		37 (2)	
Age	21.5	3.67	20.54	2.168
NAART Verbal Score	98.96	8.83	95.64	15.02
PANAS-NA	17.67***	4.96	22.05***	5.968
PANAS-PA	34.97**	4.84	31.29**	5.26
SPQ				
Cognitive-Perceptual	5.23*	3.12	13.44*	4.71
Disorganized	2.69*	2.35	7.72*	4.27
Interpersonal	4.90*	2.99	16.87*	5.54
CSS	5.84*	4.95	11.33*	7.82

Note. [a] Gender: F(M), [b] Handedness: R(L)
* $p < .05$. ** $p < .01$. *** $p < .001$.

In addition, high- and low- cognitive slippage groups were created by splitting the sample at the median CSS score (*mdn* = 7). Five cases that fell exactly on the median were excluded from the analyses. For the high-cognitive slippage group, mean CSS score was 11.69 (*SD* = 7.24) and for the low-cognitive slippage group was 5.97 (*SD* = 6.24). Normality tests revealed that CSS score was significantly non-normal for the low-CSS group, $D(38) = .26$, $p = .000$. The two groups did not differ on gender, $\chi^2(1) = .35$, $p = .55$, age, $F(1,69) = .00$, $p = .95$, NAART score, $F(1,71) = .11$, $p = .74$, PANAS-NA score, $F(1,71) = 2.42$, $p = .12$, or PANAS-PA score, $F(1,71) = 1.16$, $p = .29$. However, there were marginally more left handed individuals in the high-cognitive slippage group, $\chi^2(1) = 3.28$, $p = .07$ (see Table 5 for means). To better understand the relationship between schizotypy and cognitive slippage, both composite and subscale scores on the O-LIFE and SPQ were compared between high and low cognitive slippage groups. Surprisingly, the two groups only differed on Cognitive Disorganization, $F(1,71) = 6.82$, $p = .01$, and the Cognitive-Perceptual Factor on the SPQ, $F(1,71) = 4.12$, $p = .05$, although there was a marginal difference on O-LIFE total score, $F(1,71) = 3.34$, $p = .07$, and the Interpersonal

Factor on the SPQ, $F(1,71) = 3.29$, $p = .07$. No other schizotypy subscales were significantly different between groups.

Table 5.
Descriptives for High- and Low-Scorers on the CSS (N = 76)

	Low (n = 39)		High (n = 37)	
Measure	*M*	*SD*	*M*	*SD*
Gender [a]	29 (10)		29 (8)	
Handedness [b]	38 (1)+		32 (5)+	
Age	20.89	3.92	20.94	1.48
NAART Verbal Score	97.12	15.63	98.11	8.40
PANAS-NA	18.34	5.35	20.43	6.10
PANAS-PA	33.74	5.31	32.37	5.53
O-LIFE total score	31.63+	11.23	36.66+	12.56
Unusual Experiences	7.53	4.08	8.66	4.83
Cognitive Disorganization	9.50**	5.30	12.71**	5.20
Introvertive Anhedonia	5.66	3.55	6.37	3.87
SPQ total score	20.39	12.44	25.31	13.62
Cognitive-Perceptual	8.13*	5.63	10.83*	5.64
Disorganized	9.47	6.85	12.60	7.88
Interpersonal	5.32+	4.05	5.34+	4.28

Note. a Gender: F(M), b Handedness: R(L)
+ $p < .10$. * $p < .05$. ** $p < .01$

Category Fluency Variables

Total list length.

The total number of responses produced by each participant was calculated as an overall category fluency score, or total list length. There was a main effect of cognitive slippage as measured by the CSS, $F(1,70) = 6.74$, $p = .01$, such that high scorers on the CSS produced significantly fewer words ($M = 18.30$, $SE = .60$) compared to low scorers ($M = 20.51$, $SE = .61$). This effect remained significant even after age was entered as a covariate, $F(1,67) = 5.92$, $p = .02$. There was no main effect of schizotypy as measured by the O-LIFE, Welch's $F(1,74) = 1.16$, $p = .29$, such that total list length was not

significantly different between the high-schizotypy group (M = 19.83, SE = .58) compared to the low-schizotypy group (M = 19.35, SE = .62). Similarly, there was no main effect of SPQ, $F(1, 72) = 0.51$, $p = .48$, such that total list length was not significantly different between high- schizotypy group (M = 19.21, SE = .60) and the low-schizotypy group (M = 19.82, SE = .61).

Total Cluster Size.

The total number of words that belonged to a semantic cluster was calculated for each participant's response list. Preliminary analyses indicated total cluster size to be significantly correlated with total list length, $r_s = .67$, $p < .001$, and age, $r_s = -.28$, $p < .05$. Due to the significant correlation between the two covariates, $r_s = -.29$, $p < .05$, multiple regression analyses were conducted to determine which variable was most predictive of total cluster size. Results revealed both total list length and age significantly predicted total cluster size ($B = .58$, $\beta = .70$, $p < .001$ for total list length, and $B = -.20$, $\beta = -.19$, $p < .05$ for age), therefore both were entered as covariates.

There was no main effect of schizotypy as measured by the O-LIFE, $F(1,68) = 2.47$, $p = .12$, such that total cluster size were not significantly different between the high-schizotypy group (M = 10.40, SE = .36) and the low-schizotypy group (M = 11.23, SE = .38). Similarly, there was no main effect of schizotypy as measured by the SPQ, $F(1,68) = .001$, $p = .97$, such that total cluster size was not significantly different between the high-schizotypy group (M = 10.59, SE = .36) and the low-schizotypy group (M = 10.57, SE = .38). Finally, there was no main effect of cognitive slippage as measured by the CSS, $F(1,64) = 1.70$, $p = .20$, such that total cluster size was not significantly lower in the high-cognitive slippage group (M = 10.30, SE = .39) relative to the low-cognitive slippage

group (M = 11.03, SE = .38). Both total list length and age were significant covariates for all three analyses (all $p < .05$).

Average Cluster Size.

The average cluster size was calculated for each participant's word lists. Preliminary analyses indicated that average cluster size was significantly correlated with total cluster size, $r_s = .65$, $p < .001$, and switch rate, $r_s = -.46$, $p < .001$. As total list length is significantly correlated with both total cluster size, $r_s = -.28$, $p < .001$, and switch rate, $r_s = .51$, $p < .001$, a multiple regression analysis was conducted to determine which variable was most predictive of average cluster size. Results revealed that only switch rate was a significantly predicted average cluster size, ($B = -.22$, $\beta = -.67$, $p < .05$ for switch rate, $B = .03$, $\beta = .10$, $p > .05$ for total cluster size, and $B = .10$, $\beta = .44$, $p > .05$ for total list length), therefore only switch rate was entered as a covariate.

There was a main effect of cognitive slippage as measured by the CSS, $F(1,67) = 5.00$, $p = .03$, such that average cluster size was significantly smaller in the high-cognitive slippage group (M = 1.88, SE = .11) relative to the low-cognitive slippage group (M = 2.21, SE = .10). It should be noted that homogeneity of variances was marginally violated, $F(1,68) = 3.68$, $p = .06$, however the effect remained significant with Welch's correction, $F(1,65.07) = 4.22$, $p = .04$. There was no main effect for schizotypy as measured by the O-LIFE, $F(1,71) = 0.50$, $p = .48$, such that average cluster sizes were not significantly different between the high-schizotypy group (M = 1.99, SE = .11) and the low-schizotypy group (M = 2.09, SE = .11). Similarly, there was no main effect for schizotypy as measured by the SPQ, $F(1,72) = 0.27$, $p = .59$, such that average cluster size was not significantly different between the high-schizotypy group (M = 2.09, SE = .11) and the low-schizotypy group (M = 2.01, SE = .11).

Switch Rate.

The number of switches was calculated for all participants' word lists. Preliminary analyses indicated that switch rate was significantly correlated with total list length, r_s = .51, p < .001, and average cluster size, r_s = -.46, p <. 001. However, because switch rate is most likely influenced by the number of responses given, only total list length was entered as a covariate. There was no main effect of schizotypy as measured by the O-LIFE, $F(1,71) = 1.85$, p = .18, such that switch rates were not significantly different for the high-schizotypy group (M = 8.32, SE = .30) relative to the low- schizotypy group (M = 7.72, SE = .30). It should be noted that switch rate was significantly non-normal for low scorers on the O-LIFE, $D(36) = .15$, p = .04. Similarly, there was no main effect of schizotypy as measured by the SPQ, $F(1,72) = 0.03$, p = .86, such that switch rate was not significantly different between the high scoring group (M = 7.92, SE = .31) and the low scoring group (M = 8.00, SE = .32). Finally, no main effect of cognitive slippage as measured by the CSS was found, $F(1,67) = 0.60$, p = .44, such that the switch rate was not significantly different between the high-cognitive slippage group (M = 8.10, SE = .33) and the low-cognitive slippage group (M = 7.74, SE = .32).

Semantic Distance Variables

Total semantic distance between successive words.

The total semantic distance between successively generated word pairs on each individual's word list was calculated and compared between high- and low-scoring groups using one-way ANCOVAs. Preliminary analyses revealed that total distance was significantly correlated with total list length, r_s = .93, p < .001, age, r_s = -.23, p < .05, total cluster size, r_s = .58, p < .001, and switch rate, r_s = .55, p < .001. However, because the total semantic distance between words on a word list is most likely influenced by list

length, only total list length was entered as a covariate. There was no main effect of schizotypy as measured by the O-LIFE, $F(1,74) = .01$, $p = .93$, such that the total distance between words was not significantly different between the high-schizotypy group ($M = 13.22$, $SE = .15$) and the low-schizotypy group ($M = 13.24$, $SE = .15$). Similarly, there was no main effect of schizotypy as measured by the SPQ, $F(1,75) = .03$, $p = .95$, such that the total distance between words was not significantly different between the high-schizotypy group ($M = 13.22$, $SE = .15$) and the low-schizotypy group ($M = 13.21$, $SE = .15$). Finally, no main effect of cognitive slippage as measured by the CSS was found, $F(1,70) = 1.04$, $p = .31$, such that the total distance between words was not significantly different between the high-cognitive slippage group ($M = 13.08$, $SE = .16$) relative to the low-cognitive slippage group ($M = 13.31$, $SE = .16$).

Average semantic distance between successive words.

The average semantic distance between successively generated words on each participant's word list was calculated. Due to the potential confounding effect of total list length, total list length was entered as a covariate. A one-way ANCOVA with total list length as a covariate revealed a main effect of cognitive slippage as measured by the CSS, $F(1,69) = 6.66$, $p = .01$, such that the average distance between words was significantly lower in the high-cognitive slippage group ($M = .70$, $SE = .01$) than in the low-cognitive slippage group ($M = .73$, $SE = .01$). There was no main effect of schizotypy as measured by the O-LIFE, $F(1,73) = .03$, $p = .87$, such that the average distance between words was not significantly different between the high-schizotypy group ($M = .72$, $SE = .01$) and the low-schizotypy group ($M = .71$, $SE = .01$). Similarly, there was no main effect of schizotypy as measured by the SPQ, $F(1,72) = .14$, $p = .71$. It should be noted that homogeneity of variance was violated, $F(1,73) = 4.24$, $p = .04$, however the results

remained non-significant with Welch's correction for unequal variances, $F(1,68.59) = .17$, $p = .68$, such that the average distance between words was not different between the high-schizotypy group ($M = .71$ $SE = .05$) and the low-schizotypy group ($M = .72$, $SE = .04$). Total list length was not a significant covariate for any of the analyses (all $p > .05$).

Total semantic distance from initial response.

The total semantic distance between the first word and all other words generated on each participant's word list was calculated. Preliminary analyses indicated that total distance from the first response was significantly correlated with total list length, $r_s = 0.95$, $p < .001$, total cluster size, $r_s = 0.6$, $p < .001$, switch rate, $r_s = 0.51$, $p < .001$, and age, $r_s = -.20$, $p < .05$. However, because the total semantic distance between words on a word list is most likely influenced by total list length, only total list length was tested as a covariate. A one-way ANCOVA with total list length as a covariate revealed a main effect of cognitive slippage as measured by the CSS, $F(1,67) = 6.16$, $p = .02$, such that the total distance from the first word to all other words was significantly higher in the high-cognitive slippage group ($M = 14.89$, $SE = .14$) relative to the low-cognitive slippage group ($M = 14.39$, $SE = .14$). There was no main effect of schizotypy as measured by the O-LIFE, $F(1,71) = .37$, $p = .55$, such that that the total distance from the first word to all other words was not significantly different between the high-schizotypy group ($M = 14.75$, $SE = .14$) and the low-schizotypy group ($M = 14.63$, $SE = .14$). Similarly, there was no main effect of schizotypy as measured by the SPQ, $F(1,72) = .58$, $p = .45$, with the high-schizotypy group scoring no differently ($M = 14.72$, $SE = .13$) than the low-schizotypy group ($M = 14.58$, $SE = .14$).

Average Distance from Initial Response.

Due to the potential confounding effect of total list length, total list length was entered as a covariate. A one-way ANCOVA with total list length entered as a covariate revealed a main effect of cognitive slippage, $F(1,68) = 4.63$, $p = .04$, such that the average distance from the first word to all other words was significantly higher in the high-cognitive slippage group ($M = 0.81$, $SE = .01$) relative to the low-cognitive slippage group ($M = 0.78$, $SE = .01$). Total list length was a significant covariate, $F(1,68) = 4.20$, $p = .04$.

There was no main effect of schizotypy as measured by the O-LIFE, $F(1,73) = 2.56$, $p = .11$, such that the average distance from the first word to all other words was not significantly different between the high-schizotypy group ($M = 0.80$, $SE = .01$) and the low-schizotypy group ($M = 0.78$, $SE = .01$). Similarly, there was no main effect of schizotypy as measured by the SPQ, $F(1,74) = 0.70$, $p = .41$, such that the average distance from the first word to all other words was not significantly different between the high-schizotypy group ($M = 0.80$, $SE = .01$) and the low-schizotypy group ($M = 0.79$, $SE = .01$). Total list length was not a significant covariate for either of the analyses (both $p > .05$).

Schizotypy subtypes and dependent variables.

To determine whether any of the variables were significantly correlated with different subtypes of schizotypy as measured by the O-LIFE and SPQ, Pearson's correlations were calculated (see Table 6). Where any one of the variables were non-normal, Spearman's correlations were calculated. There was a positive correlation between the DIS and average distance from initial response, $r_s(77) = .25$, $p = .03$.

Table 6.
Correlations Between Schizotypy Subscales and Dependent Variables

	Total List Length	Total Cluster Size	Average Cluster Size	Switch Rate	Total Between Word	Average Between Word	Total From First	Average From First

O-LIFE								
UnEx	.09	.01	.09	.10	.08	-.04	.14	.12
CogDis	-.06	-.04	-.02	-.15	-.09	-.06	-.01	.04
IntAn	-.01	.00	.12	-.14	-.07	-.09	-.06	-.14
SPQ								
Positive	-.06	-.12	-.02	.00	-.08	-.09	-.03	.07
Disorganized	.14	.02	.10	-.00	.08	-.02	.18	.25*
Negative	-.03	-.05	.04	-.19	-.10	-.11	.01	.07

* $p < .05$

Supplemental Analyses

Due to lack of research using the Cognitive Slippage Scale and the exploratory use of WINDSORS in category fluency, supplemental analyses were conducted to better understand the nature of our findings. First, additional clustering variables were examined. First, a one-way ANCOVA with total list length as a covariate revealed that the total number of clusters was not significantly different, $F(2,68) = .08$, $p = .78$, between high scorers on cognitive slippage ($M = 5.37$, $SE = .20$) and low scorers ($M = 5.28$, $SE = .21$). Second, a one-way ANCOVA with total list length as a covariate revealed that the total number of unique clusters (not repeats to a cluster) was not significantly different, $F(2,68) = .06$, $p = .81$, between high scorers on cognitive slippage ($M = 4.39$, $SE = .20$) compared to low scorers ($M = 4.46$, $SE = .21$). Finally, a one-way ANCOVA with total list length as a covariate revealed that the number of responses that were not members of any cluster was not significantly different, $F(2,66) = .24$, $p = .62$, between high scorers ($M = 3.61$, $SE = .33$) and low scorers ($M = 3.37$, $SE = .35$). Total list length was not a significant covariate, $F(1, 66) = .62$, $p = .43$.

Due to the high correlation between CogDis, DIS, and CSS, stepwise regression analyses were conducted for all significant findings associated with high cognitive slippage, with covariates entered into step 1, and CogDis, DIS, and CSS entered in

together in step 2. When all three predictors were entered into the equation, only DIS remained significant predictor, $B = .25$, $\beta = .32$, $p = .04$, partial $r = .25$, semi partial $r = .26$, for average distance from initial response. For the average distance between successively generated words, regression analysis confirmed that only CSS significantly predicted average distance, $B = -.003$, $\beta = -.48$, $p = .01$, partial r = -33, semi partial $r = -.33$, even after controlling for the effects of total list length. Neither DIS nor CogDis predicted average distance (both $p > .05$). Results from multiple regression analysis revealed that CogDis marginally predicted total list length, $B = -.21$, $\beta = -.31$, $p = .08$. Age was not a significant covariate for any of the analyses (both $p > .05$). Despite the main effect of CSS, neither CSS, DIS, nor CogDis predicted average distance from initial response, average cluster size, and total cluster size.

To determine the degree of correlation between the Odd Speech and Odd Eccentric Behavior subscales of the DIS factor and O-LIFE CogDis and the CSS, partial correlations were calculated controlling for positive and negative schizotypy scores (see Table 7). The results revealed that although the two subscales making up the SPQ disorganization factor were highly correlated with each other, $r = .45$, $p < .001$, Odd Eccentric Behavior was only marginally correlated with the CSS, $r = .23$, $p = .06$, and uncorrelated with CogDis, $r = .16$, $p > .05$.

Table 7.
Correlations Between CSS and Disorganized Schizotypy Subscales

	Cognitive Slippage	Cognitive Disorganization	Odd Speech	Odd Eccentric Behaviour

Cognitive Slippage Scale	-	.50***	.28*	.23+
Cog. Disorganization		-	.26*	.16
Odd Speech			-	.43***
Odd Eccentric Behavior				-

Note. Odd Speech and Odd Eccentric Behavior compose the SPQ Disorganization Factor score.
+ p <.10, * p <.05, *** p <.001

As some dependent variables may be especially associated with a particular subscale making up the DIS Factor, correlations were calculated separately for the Odd Speech and Odd Eccentric Behavior subscales (see Table 8). Furthermore, as some researchers have omitted the Odd Eccentric Behavior subscale (e.g. Szöke et al., 2009), separate analyses will make it easier to place our findings in the context of existing knowledge. Our results indicated that the Odd and Eccentric Behavior subscale is significantly positively correlated with both measures of semantic distance from initial response (both p < . 05)

Table 8.
Correlations Between SPQ Disorganization Subscales and Dependent Variables

	Total List Length	Total Cluster Size	Average Cluster Size	Switch Rate	Total Between Word	Average Between Word	Total From First	Average From First
Odd Speech	0.12	0.12	0.03	-0.02	0.07	-0.13	-0.15	0.14
Odd Eccentric Behavior	0.20	0.05	0.20	0.09	0.19	0.09	0.27*	0.31**

* p < . 05. ** p < . 01.

To examine variability of initial responses, response frequencies were calculated for high and low CSS groups, as well as high and low DIS groups split at the median score of 4. Chi-Square analysis was conducted to determine whether significant differences existed between the frequency of "typical" responses between groups by comparing the frequency of responses being either *DOG* or *CAT,* compared to other exemplars. Results revealed that the number of individuals producing *DOG* or *CAT* was

not significantly different between CSS groups, $X^2(1) = .17$, $p = .68$. However, results for the high and low scorers on DIS approached significance, $X^2(1) = 3.363$, $p = .07$. The frequency table is provided below on Table 9.

Table 9.
Percentages of Different Initial Responses for High and Low Groups

CSS				SPQ Disorganization			
Low (n = 35)		High (n = 37)		Low (n = 39)		High (n = 37)	
Dog	34.3	Dog	43.2	Dog	46.2	Dog	29.7
Cat	31.4	Cat	16.2	Cat	25.6	Cat	21.6
Bird	5.7	Bird	5.4	Bird	5.1	Alligator	5.4
Monkey	5.7	Alligator	2.7	Giraffe	5.1	Anteater	5.4
Aardvark	2.9	Anteater	2.7	Antelope	2.6	Bird	5.4
Alligator	2.9	Antelope	2.7	Ape	2.6	Monkey	5.4
Anteater	2.9	Elephant	2.7	Deer	2.6	Aardvark	2.7
Ape	2.9	Giraffe	2.7	Elephant	2.6	Goldfish	2.7
Goldfish	2.9	Gorilla	2.7	Lion	2.6	Gorilla	2.7
Lion	2.9	Horse	2.7	Monkey	2.6	Horse	2.7
Monkey	2.9	Lion	2.7	Pig	2.6	Lion	2.7
Pig	2.9	Raccoon	2.7			Raccoon	2.7
		Rhinoceros	2.7			Rhinoceros	2.7
		Seal	2.7			Seal	2.7
		Snake	2.7			Snake	2.7
		Zebra	2.7			Zebra	2.7

Discussion

As expected, high scores on Schizotypal Personality Questionnaire's Disorganization Factor (DIS) and the Cognitive Slippage Scale (CSS) produced word lists in which the average semantic distance between the initial response and all subsequent responses was greater than word lists of low scorers. That is, the initial response produced by high scorers on DIS and/or CSS were less meaningfully related to the rest of the response list compared to low scorers. This is consistent with the increased spreading activation model of thought disorder, such that activation may be stronger, farther reaching, and/or persisting for a longer duration than normal. In this sense, increased

spreading activation could result in activation of weaker associates, or less meaningfully related animals.

Another explanation is that high scorers on DIS and CSS tended to produce less typical initial responses. Established category fluency norms indicate that *DOG* and *CAT* were the two most typical animal category exemplars and most frequently produced first responses (Yoon et al., 2004). In general, this finding was replicated by our study; however, there was a marginally smaller percentage of first responses, *DOG* and *CAT,* in the high scoring DIS group. Therefore, it is possible that the increased distance form first response observed in this subset of non-clinical schizotypic individuals is driven by atypical first responses and more typical subsequent responses. This explanation would be consistent with the findings of increased response atypicality of category fluency exemplars produced by high scorers on DIS in previous studies (Kiang & Kutas, 2006; Minor et al., 2010). However, as we did not calculate the typicality indexes (Yoon et al., 2004) for initial responses, it is difficult to come to definitive conclusions. Any hypotheses regarding underlying differences in the typicality of initial responses require statistical validation. In either case, the resulting response list is somehow less semantically related to the initial response. Future studies should examine whether response typicality plays a mediating or moderating role in differences in semantic distance from initial response and elucidate any differences that exist between symptoms of odd speech and eccentric behavior in relation to the time-course of responses becoming more atypical.

An interesting and unexpected finding is that when DIS is broken down into its constituent subscales, distance from initial response was only correlated with the Odd Eccentric Behavior subscale. The Odd Speech subscale, which is significantly correlated

with scores on the CSS and Oxford-Liverpool Inventory of Feelings and Experiences' Cognitive Disorganization Factor (CogDis), was unrelated to the distance from initial response. This finding seems counterintuitive given the theoretical overlap between loose associations and odd speech. One possibility is that eccentric behavior may be the behavioral reflection of odd thinking, and possibly greater production of atypical exemplars. The fact that Odd Eccentric Behavior does not correlate with CSS or CogDis but uniquely predicts semantic performance suggests that at least two separate processes are involved in schizotypic disorganization, both of which will contribute to abnormal semantic activation.

We also expected that loose associations produced by high scorers on disorganized schizotypy and cognitive slippage would be detectable between successively generated words. That is, the average semantic distance between words would be greater for high scorers compared to low scorers. Counter to our expectations, the average distance between successively generated words was no different between high scorers and low scorers. In contrast, we found that high scorers on cognitive slippage produced words that were more closely related compared to low scorers.

One possibility is that automatic spreading activation is impaired in individuals high on cognitive slippage. For example, activation of strong associates may persist to a greater than normal degree, or activation could fail to spread to weak associates. In schizophrenia patients, strong associates (e.g. *dog-cat, lion-tiger, horse-cow*) are retrieved easily, but retrieval of weak associates requires a notably greater amount of effortful search (Nelson et al., 1998; Paulsen et al., 1996), which is consistent with executive function problems.

Another important and unexpected finding is that, compared to low scorers, high scorers on cognitive slippage produced significantly fewer words overall (i.e. more impaired overall fluency) and exhibited differential impairment in clustering. Specifically, individuals high on cognitive slippage produced smaller clusters and fewer words that belonged to clusters, although switch rate and the number of unclustered words was no different than that of low scorers. The production of clusters is assumed to depend, in large part, on the relatively automatic activation of clustered words that have been activated in the semantic network. A more effortful searching is required if activation is less "automatic", thereby making initiation of searching relatively more difficult for high scorers. As previously discussed, it is possible that cognitive slippage, like schizophrenia, is associated with semantic processing abnormalities that extend to the automatic spreading activation of weak associates.

In keeping with the secondary purposes of the study, we also examined clustering and switching in schizotypy. We predicted that high scorers on disorganized schizotypy would produce smaller clusters with a higher switch rate than low scorers. In contrast, clustering and switching was no different between high and low scorers on disorganized schizotypy. Unlike Szöke et al. (2009), we failed to find differences even after the Odd Speech and Odd Eccentric Behavior subscales were analyzed separately. As our sample consisted of high functioning young adults, it is possible that abnormalities in our high schizotypy groups were not severe enough to cause impairments in clustering or switching. Future studies using a pre-selected sample based on severity of schizotypy and slippage traits should be examined for differences in clustering and switching.

The lack of findings associated with high scores on the CogDis suggests that aspects of disorganized schizotypy comprising difficulties in attention, concentration and

decision-making, social anxiety, moodiness, and a sense of purposeless are less associated with abnormalities semantic processing. This was not unexpected given the absence of items assessing speech difficulties. It should be noted that our study was limited by primarily female sample. Gender differences have been found in subscale elevations, such that females generally score higher on disorganized schizotypy (CogDis) whereas males generally score higher in negative schizotypy.

Furthermore, our focus on specific subtypes does not take interactions between specific types of traits that may have a comparable influence on semantic activation. For example, researchers have reported that individuals scoring high on both positive and negative schizotypy report the greater cognitive slippage than just those scoring high on just one subtype. The current study was designed to control for the effects of symptom combinations through regression analysis, which failed to produce significant findings with the exception of DIS predicting average distance from initial response. Future research should determine whether specific combinations of schizotypy are most associated with cognitive slippage, and whether different traits interact in ways that affect semantic processing.

Although Meehl (1962) described cognitive slippage as the defining vulnerability factor to schizophrenia, there has been surprisingly little empirical research into this construct. Most research has focused on two- and three-factor models of schizophrenia, in which cognitive slippage is not included as a classical description. Our findings support the construct validity of cognitive slippage and raises questions as to the nature of this phenomenon in relation to schizotypy and schizophrenia, and the role it plays in semantic and neuropsychological abnormalities prevalent in the schizophrenia disease process.

In addition, the different pattern of findings between CogDis, DIS, and CSS adds to the divergent validity of the O-LIFE and SPQ's metric of schizotypic disorganization. As such, our findings provide further support for the convergent validity of both DIS subscale and CSS as measures of speech abnormalities as indicated by atypical semantic processes, and add to the divergent validity of the O-LIFE and SPQ as frameworks for understanding schizotypic disorganization. Furthermore, it draws attention to the differentiation between the Odd Eccentric Behavior and Odd Speech subscales of the DIS.

In conclusion, although we found evidence that the initial response is less strongly related to subsequent responses in high disorganized schizotypy and high cognitive slippage, the contradicting finding of more strongly related individual responses in high slippage suggests that they are two distinct underlying processes. In fact, our overall pattern of results indicates non-clinical cognitive slippage (i.e. speech difficulties and confused thinking) is associated with detectable impairments in total fluency and automaticity of accessing subclusters of information in the semantic store.

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Appendix A

INFORMED CONSENT FORM

CONSENT TO PARTICIPATE IN RESEARCH

Title of Study: **Personality Traits and Verbal Fluency**
You are asked to participate in a research study conducted by Erica Chu, B.A. and Lorna Majed under the supervision of Christopher Abeare, Ph.D from the Department of Psychology at the University of Windsor. The results from this study will contribute to Erica Chu's M.A. thesis and form the basis of Lorna Majed's honour's thesis research project.

If you have any questions or concerns about the research, please feel to contact the primary researcher, Erica Chu at 519- 235-3000 x 4893, or the project supervisor, Dr. Christopher Abeare at 519-235-3000 x 2231.

PURPOSE OF THE STUDY

The purpose of the study is to gain a better understanding of whether individuals generate word lists differently depending on certain personality dispositions. When asked to list as many words as possible within a given time limit, individuals come up with lists in the order of how word meanings are stored and represented in semantic networks. Personality traits influence how an individual perceives, interprets, and categorizes information around them, possibly influencing the way that words and concepts are stored and activated in their brains. The goal of the present study is to obtain a clearer picture of whether personality traits influences how words and concepts are activated.

PROCEDURES

If you volunteer to participate in this study, you will be asked to:
Fill out a demographics questionnaire.
Complete a short reading ability test
Complete two mood questionnaires
Complete three personality traits questionnaires.
Complete three verbal fluency tests assessing different categories of words (i.e. animals, letters, emotions).

The total length of time for participation will be approximately 1 hour done in one sitting. This study will take place one-on-one with the examiner in the basement of Chrysler Hall South, Room 73 (the same room as the screening interview).

POTENTIAL RISKS AND DISCOMFORTS

It is possible that you may experience a mild discomfort when providing demographic information pertaining to current and past substance use history, as well as questionnaire items pertaining to a history of odd perceptual or social experiences. Any such effects, if experienced at all, are expected to be mild and transient, consistent with standardized demographics forms used in most studies. Furthermore, the nature of the questions asked are not used for any diagnostic purposes but are meant to assess different personality traits that exist in the normal population. In the extremely unlikely event that a psychological discomfort occurs that is greater than might be expected, you have the option to be taken to the Student Counselling Centre by the examiner and given the contact information of Student Counseling if you feel they need to talk to someone about feelings conjured from filling out the questionnaires

POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY

Possible benefits to participants of this study are that you will know that you have contributed to the scientific community and that you will gain insight into the process of conducting a study that you may use when and if you decide to pursue graduate studies. Furthermore, upon learning the results of the study, you will learn about the effects of personality traits on neuropsychological functioning, specifically in verbal fluency performance and language processes.

It is hoped that this study will help bridge the gap in our knowledge about the effects of different personality traits on neuropsychological functioning, specifically in verbal fluency performance and language processes. By completing this study, it is the hope of this researcher that the role played by certain personality traits on cognitive performance can be better understood.

COMPENSATION FOR PARTICIPATION

You will receive 1 bonus point for 60 minutes of participation (rate of 0.5 credits for 30 minutes) towards the psychology participant pool, if registered in the pool and enrolled in one or more eligible courses.

CONFIDENTIALITY

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission. The only place in which your name will be identifiable is on the consent form. Your forms will be assigned a number and all of the information gathered in the study will use the number assigned to the you and not the your name. All consent forms will be placed in a file cabinet separate from other information to ensure complete anonymity, in the research laboratory, behind locked doors. All computer records will be kept archived in a password protected, encrypted digital database and paper records kept in a locked cabinet in the lab. Only the primary investigator, research assistant, and faculty supervisor will have access to these files (i.e. passwords, keys).

PARTICIPATION AND WITHDRAWAL

You can choose whether to be in this study or not. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You may also refuse to answer any questions you don't want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so. If you withdraw from the study, you will be rewarded the appropriate participant points for the time you have completed in the study (1 bonus point for 60 minutes of participation, or 0.5 bonus points for 30 minutes to participation) unless you withdraw immediately after signing the consent, in which case you will not be awarded any participant points.

FEEDBACK OF THE RESULTS OF THIS STUDY TO THE SUBJECTS

The results of the study will be available to you by September 30, 2011 if you wish to know the results. Subjects can contact the researchers to obtain these results or they could log onto the REB results study page to check results once the study and the analysis are completed.

Web address: _http://www.uwindsor.ca/reb/study-results_____
Date when results are available: _____September 30, 2011_____

SUBSEQUENT USE OF DATA

This data may be used in subsequent studies.

RIGHTS OF RESEARCH SUBJECTS

You may withdraw your consent at any time and discontinue participation without penalty. If you have questions regarding your rights as a research subject, contact: Research Ethics Coordinator, University of Windsor, Windsor, Ontario, N9B 3P4; Telephone: 519-253-3000, ext. 3948; e-mail: ethics@uwindsor.ca

SIGNATURE OF RESEARCH SUBJECT/LEGAL REPRESENTATIVE

I understand the information provided for the study **Personality Traits and Verbal Fluency** as described herein. My questions have been answered to my satisfaction, and I agree to participate in this study. I have been given a copy of this form.

_____
Name of Subject

_____ _____
Signature of Subject Date

SIGNATURE OF INVESTIGATOR
These are the terms under which I will conduct research.

_____ _____
Signature of Investigator Date

Appendix B

OXFORD-LIVERPOOL INVENTORY OF FEELINGS AND EXPERIENCES (O-LIFE)

O-LIFE QUESTIONNAIRE BOOKLET:

Please Do Not Write On This Booklet

USING THE ANSWER SHEET PROVIDED, please read each statement and answer either yes or no as they apply to you. There are no right or wrong answers, answer all items even if unsure of your answer. Please work at your own pace, there are 153 questions.

1. Do you prefer reading to meeting people?
2. Do you often hesitate when you are going to say something in a group of people whom you more or less know?
3. Are you always willing to admit it when you have made a mistake?
4. Do you hate being alone?
5. Do you often overindulge in alcohol or food?
6. Do you often feel that people have it in for you?
7. Are the sounds you hear in your daydreams really clear and distinct?
8. Do you enjoy many different kinds of play and recreation?
9. Do your thoughts sometimes seem as real as actual events in your life?
10. Does it often happen that nearly every thought immediately and automatically suggests an enormous number of ideas?
11. When in a group of people do you usually prefer to let someone else be the centre of attention?
12. If you say you will do something do you always keep your promise no matter how inconvenient it might be?
13. Do you frequently have difficulty in starting to do things?
14. Has dancing or the idea of it always seemed dull to you?
15. When you catch a train do you often arrive at the last minute?
16. Is trying new foods something you have always enjoyed?
17. Do you always wash before a meal?
18. Do you believe in telepathy?
19. Do you often change between intense liking and disliking of the same person?
20. Have you ever cheated at a game?
21. Are there very few things that you have ever really enjoyed doing?
22. Do you at times have fits of laughing or crying that you can't control?
23. Do you at times have an urge to do something harmful or shocking?
24. Do you often worry about things you should not have done or said?
25. Are your thoughts sometimes so strong that you can almost hear them?
26. Do you usually take the initiative in making new friends?
27. Do your thoughts ever stop suddenly causing you to interrupt what you are saying?
28. Are you usually in an average sort of mood, not too high and not too low?
29. Would you take drugs which may have strange or dangerous effects?
30. Do you think you could learn to read other's minds if you wanted to?
31. When in a crowded room, do you often have difficulty in following a conversation?
32. No matter how hard you try to concentrate do unrelated thoughts always creep into your mind?

33. Are you easily hurt when people find fault with you or the work you do?
34. Do you stop to think things over before doing anything?
35. Have you ever felt that you have special, almost magical powers?
36. Are you much too independent to really get involved with other people?
37. Do you ever get nervous when someone is walking behind you?
38. Do ideas and insights sometimes come to you so fast that you cannot express them all?
39. Do you easily lose your courage when criticized or failing in something?
40. Can some people make you aware of them just by thinking about you?
41. Does a passing thought ever seem so real it frightens you?
42. Do you always practice what you preach?
43. Do you often have periods of such great restlessness that you aren't able to sit still for more than a very short time?
44. Have you ever blamed someone for doing something you know was really your fault?
45. Are you a person whose mood goes up and down easily?
46. Does your voice ever seem distant or faraway?
47. Do you think having close friends is not as important as some people say?
48. Do you like doing things in which you have to act quickly?
49. Are you rather lively?
50. Do you feel at times that people are talking about you?
51. Are you sometimes so nervous that you are "blocked"?
52. Do you find it difficult to keep interested in the same thing for a long time?
53. Do you dread going into a room by yourself where other people have already gathered and are talking?
54. Have you ever felt that you were communicating with someone telepathically?
55. Does it often feel good to massage your muscles when they are tired or sore?
56. Do you sometimes feel that your accidents are caused by mysterious forces?
57. Do you like mixing with people?
58. On seeing a soft thick carpet have you sometimes had the impulse to take off your shoes and walk barefoot on it?
59. Do you frequently gamble money?
60. Do you often have difficulties in controlling your thoughts?
61. Do you feel that you cannot get "close" to other people?
62. Do the people in your daydreams seem so true to life that you sometimes think they are real?
63. Do other people think of you as being very lively?
64. Are people usually better off if they stay aloof from emotional involvements with people?
65. Does life seem entirely hopeless?
66. Can just being with friends make you feel really good?
67. Do you enjoy meeting new people?
68. Is your hearing sometimes so sensitive that ordinary sounds become uncomfortable?
69. Have you often felt uncomfortable when your friends touch you?
70. When things are bothering you do you like to talk to other people about it?
71. Do you ever have the sensation that your body or a part of it is changing shape?
72. Do you have many friends?
73. Are all your habits good and desirable ones?
74. Do you tend to keep in the background on social occasions?
75. Would being in debt worry you?

76. Have you ever felt when you looked in a mirror that your face seemed different?
77. Do you think people spend too much time safeguarding their future with savings and insurance?
78. Do you believe that dreams can come true?
79. Do you ever have the urge to break or smash things?
80. Do you often feel that there is no purpose to life?
81. Do things sometimes feel as though they were not real?
82. Do you worry about awful things that might happen?
83. Have you ever felt the urge to injure yourself?
84. Would it make you nervous to play the clown in front of other people?
85. Do you prefer watching television to going out with other people?
86. Have you felt that you might cause something to happen just by thinking too much about it?
87. Have you had very little fun from physical activities like walking, swimming or sports?
88. Do you ever have suicidal thoughts?
89. Have you ever said anything bad or nasty about anyone?
90. Do you feel so good at controlling others that it sometimes scares you?
91. Are you easily distracted from work by daydreams?
92. Are you easily confused if too much happens at the same time?
93. Do you ever have a sense of vague danger or sudden dread for reasons that you do not understand?
94. Is it true that your relationships with other people never get very intense?
95. Do you feel that you have to be on your guard even with your friends?
96. Have you sometimes had the feeling of gaining or losing energy when certain people look at you or touch you?
97. When coming into a new situation have you ever felt strongly that it was a repeat of something that had happened before?
98. Do you worry too long after an embarrassing experience?
99. Do you love having your back massaged?
100. Do you consider yourself to be pretty much an average kind of person?
101. Have you ever taken advantage of someone?
102. Would you like other people to be afraid of you?
103. Have you ever thought you heard people talking only to discover that it was in fact some nondescript noise?
104. Have you occasionally felt as though your body did not exist?
105. Do you often feel lonely?
106. Do you often have an urge to hit someone?
107. Do you often experience an overwhelming sense of emptiness?
108. On occasions, have you seen a person's face in front of you when no one was in fact there?
109. Do you feel it is safer to trust nobody?
110. Is it fun to sing with other people?
111. Do you often have days when indoor lights seem so bright that they bother your eyes?
112. Have you wondered whether the spirits of the dead can influence the living?
113. Do people who try to get to know you better usually give up after a while?
114. Do you often feel "fed up"?
115. Have you felt as though your head or limbs were somehow not your own?
116. Do you ever become oversensitive to light or noise?

117. When you look in the mirror does your face sometimes seem quite different from usual?
118. Do people who drive carefully annoy you?
119. Do you like telling jokes and funny stories to your friends?
120. Are your thoughts about sex often odd or bizarre?
121. Are you very hurt by criticism?
122. Do you feel lonely most of the time, even when you're with people?
123. Would you call yourself a nervous person?
124. Can you usually let yourself go and enjoy yourself at a lively party?
125. Do you ever feel that your thoughts don't belong to you?
126. Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?
127. As a child, did you do as you were told immediately and without grumbling?
128. Do you sometimes talk about things you know nothing about?
129. When you are worried or anxious do you have trouble with your bowels?
130. When in the dark do you often see shapes and forms even though there's nothing there?
131. Do you often have vivid dreams that disturb your sleep?
132. Do you like plenty of bustle and excitement around you?
133. Have you sometimes sensed an evil presence around you, even though you could not see it?
134. Is it hard for you to make decisions?
135. Do you find the bright lights of a city exciting to look at?
136. Does your sense of smell sometimes become unusually strong?
137. Do you usually have very little desire to buy new kinds of food?
138. Are you often bothered by the feeling that people are watching you?
139. Do you ever feel that your speech is difficult to understand because the words are all mixed up and don't make sense?
140. Do you often feel like doing the opposite of what people suggest, even though you know they are right?
141. Do you like going out a lot?
142. Do you feel very close to your friends?
143. Are you sometimes sure that other people can tell what you're thinking?
144. Do you ever feel sure that something is about to happen, even though there does not seem to be any reason for you thinking that?
145. Do you often feel the impulse to spend money which you know you can't afford?
146. Are you easily distracted when you read or talk to someone?
147. Are you a talkative person?
148. Do everyday things sometimes seem unusually large or small?
149. Do you feel that making new friends isn't worth the energy it takes?
150. Have you ever taken the praise for something you knew someone else had really done?

O-LIFE Response Sheet

After reading the questions from the Questionnaire Booklet, which will be handed out separately, please circle the Y or N, based on how the questions applies to you next o the proper number on THIS PAGE. Please DO NOT mark your responses in the Questionnaire Booklet.

1 Y N	16 Y N	31 Y N	46 Y N	61 Y N	76 Y N	91 Y N	106 Y N	121 Y N	136 Y N	151 Y N
2 Y N	17 Y N	32 Y N	47 Y N	62 Y N	77 Y N	92 Y N	107 Y N	122 Y N	137 Y N	152 Y N
3 Y N	18 Y N	33 Y N	48 Y N	63 Y N	78 Y N	93 Y N	108 Y N	123 Y N	138 Y N	153 Y N
4 Y N	19 Y N	34 Y N	49 Y N	64 Y N	79 Y N	94 Y N	109 Y N	124 Y N	139 Y N	
5 Y N	20 Y N	35 Y N	50 Y N	65 Y N	80 Y N	95 Y N	110 Y N	125 Y N	140 Y N	
6 Y N	21 Y N	36 Y N	51 Y N	66 Y N	81 Y N	96 Y N	111 Y N	126 Y N	141 Y N	
7 Y N	22 Y N	37 Y N	52 Y N	67 Y N	82 Y N	97 Y N	112 Y N	127 Y N	142 Y N	
8 Y N	23 Y N	38 Y N	53 Y N	68 Y N	83 Y N	98 Y N	113 Y N	128 Y N	143 Y N	
9 Y N	24 Y N	39 Y N	54 Y N	69 Y N	84 Y N	99 Y N	114 Y N	129 Y N	144 Y N	
10 Y N	25 Y N	40 Y N	55 Y N	70 Y N	85 Y N	100 Y N	115 Y N	130 Y N	145 Y N	
11 Y N	26 Y N	41 Y N	56 Y N	71 Y N	86 Y N	101 Y N	116 Y N	131 Y N	146 Y N	
12 Y N	27 Y N	42 Y N	57 Y N	72 Y N	87 Y N	102 Y N	117 Y N	132 Y N	147 Y N	
13 Y N	28 Y N	43 Y N	58 Y N	73 Y N	88 Y N	103 Y N	118 Y N	133 Y N	148 Y N	
14 Y N	29 Y N	44 Y N	59 Y N	74 Y N	89 Y N	104 Y N	119 Y N	134 Y N	149 Y N	
15 Y N	30 Y N	45 Y N	60 Y N	75 Y N	90 Y N	105 Y N	120 Y N	135 Y N	150 Y N	

Appendix C

SCHIZOTYPAL PERSONALITY QUESTIONNAIRE (SPQ)

SPQ QUESTIONNAIRE BOOKLET:

Please Do Not Write On This Booklet

USING THE ANSWER SHEET PROVIDED, please read each statement and answer either yes or no as they apply to you. There are no right or wrong answers, answer all items even if unsure of your answer. Please work at your own pace, there are 74 questions.

1 Do you sometimes feel that things you see on the TV or read in the newspaper have a special meaning for you?
2 I sometimes avoid going to places where there will be many people because I will get anxious.
3 Have you had experiences with the supernatural?
4 Have you often mistaken objects or shadows for people, or noises for voices?
5 Other people see me as slightly eccentric (odd).
6 I have little interest in getting to know other people.
7 People sometimes find it hard to understand what I am saying.
8 People sometimes find me aloof and distant.
9 I am sure I am being talked about behind my back.
10 I am aware that people notice me when I go out for a meal or to see a film.
11 I get very nervous when I have to make polite conversation.
12 Do you believe in telepathy (mind-reading)?
13 Have you ever had the sense that some person or force is around you, even though you cannot see anyone?
14 People sometimes comment on my unusual mannerisms and habits.
15 I prefer to keep to myself.
16 I sometimes jump quickly from one topic to another when speaking.
17 I am poor at expressing my true feelings by the way I talk and look.
18 Do you often feel that other people have got it in for you?
19 Do some people drop hints about you or say things with a double meaning?
20 Do you ever get nervous when someone is walking behind you?
21 Are you sometimes sure that other people can tell what you are thinking?
22 When you look at a person, or yourself in a mirror, have you ever seen the face change right before your eyes?
23 Sometimes other people think that I am a little strange.
24 I am mostly quiet when with other people.
25 I sometimes forget what I am trying to say.
26 I rarely laugh and smile.
27 Do you sometimes get concerned that friends or co-workers are not really loyal or trustworthy?
28 Have you ever noticed a common event or object that seemed to be a special sign for you?
29 I get anxious when meeting people for the first time.
30 Do you believe in clairvoyance (psychic forces, fortune telling)?
31 I often hear a voice speaking my thoughts aloud.
32 Some people think that I am a very bizarre person.

33 I find it hard to be emotionally close to other people.
34 I often ramble on too much when speaking.
35 My "non-verbal" communication (smiling and nodding during a Y N conversation) is poor.
36 I feel I have to be on my guard even with friends.
37 Do you sometimes see special meanings in advertisements, shop windows, or in the way things are arranged around you?
38 Do you often feel nervous when you are in a group of unfamiliar people?
39 Can other people feel your feelings when they are not there?
40 Have you ever seen things invisible to other people?
41 Do you feel that there is no-one you are really close to outside of your immediate family or people you can confide in or talk to about personal problems?
42 Some people find me a bit vague and elusive during a conversation.
43 I am poor at returning social courtesies and gestures.
44 Do you often pick up hidden threats or put-downs from what people say or do?
45 When shopping do you get the feeling that other people are taking notice of you?
46 I feel very uncomfortable in social situations involving unfamiliar people.
47 Have you had experiences with astrology, seeing the future, UFOs, ESP or a sixth sense?
48 Do everyday things seem unusually large or small?
49 Writing letters to friends is more trouble than it is worth.
50 I sometimes use words in unusual ways.
51 I tend to avoid eye contact when conversing with others.
52 Have you found that it is best not to let other people know too much about you?
53 When you see people talking to each other, do you often wonder if they are talking about you?
54 I would feel very anxious if I had to give a speech in front of a large group of people.
55 Have you ever felt that you are communicating with another person telepathically (by mind-reading)?
56 Does your sense of smell sometimes become unusually strong?
57 I tend to keep in the background on social occasions.
58 Do you tend to wander off the topic when having a conversation?
59 I often feel that others have it in for me.
60 Do you sometimes feel that other people are watching you?
61 Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?
62 I attach little importance to having close friends.
63 Do you sometimes feel that people are talking about you?
64 Are your thoughts sometimes so strong that you can almost hear them?
65 Do you often have to keep an eye out to stop people from taking advantage of you?
66 Do you feel that you are unable to get "close" to people?
67 I am an odd, unusual person.
68 I do not have an expressive and lively way of speaking.
69 I find it hard to communicate clearly what I want to say to people.
70 I have some eccentric (odd) habits.
71 I feel very uneasy talking to people I do not know well.
72 People occasionally comment that my conversation is confusing.
73 I tend to keep my feelings to myself.
74 People sometimes stare at me because of my odd appearance.

SPQ Response Sheet

After reading the questions from the Questionnaire Booklet, which will be handed out separately, please circle the Y or N, based on how the questions applies to you next o the proper number on THIS PAGE. Please DO NOT mark your responses in the Questionnaire Booklet.

1	Y	N	21	Y	N	41	Y	N	61	Y	N
2	Y	N	22	Y	N	42	Y	N	62	Y	N
3	Y	N	23	Y	N	43	Y	N	63	Y	N
4	Y	N	24	Y	N	44	Y	N	64	Y	N
5	Y	N	25	Y	N	45	Y	N	65	Y	N
6	Y	N	26	Y	N	46	Y	N	66	Y	N
7	Y	N	27	Y	N	47	Y	N	67	Y	N
8	Y	N	28	Y	N	48	Y	N	68	Y	N
9	Y	N	29	Y	N	49	Y	N	69	Y	N
10	Y	N	30	Y	N	50	Y	N	70	Y	N
11	Y	N	31	Y	N	51	Y	N	71	Y	N
12	Y	N	32	Y	N	52	Y	N	72	Y	N
13	Y	N	33	Y	N	53	Y	N	73	Y	N
14	Y	N	34	Y	N	54	Y	N	74	Y	N
15	Y	N	35	Y	N	55	Y	N			
16	Y	N	36	Y	N	56	Y	N			
17	Y	N	37	Y	N	57	Y	N			
18	Y	N	38	Y	N	58	Y	N			
19	Y	N	39	Y	N	59	Y	N			
20	Y	N	40	Y	N	60	Y	N			

Appendix D

COGNITIVE SLIPPAGE SCALE (CSS)

CSS QUESTIONNAIRE BOOKLET:

Please Do Not Write On This Booklet

USING THE ANSWER SHEET PROVIDED, please read each statement and answer either yes or no as they apply to you. There are no right or wrong answers, answer all items even if unsure of your answer. Please work at your own pace, there are 35 questions.

1. My thoughts are orderly most of the time.
2. I almost always feel as though my thoughts are on a different wavelength from 98% of the population.
3. Often when I am talking I feel that I am not making any sense.
4. Often people ask me a question and I don't know what it is that they are asking.
5. Often I don't even know what it is that I have just said.
6. I hardly ever find myself saying the opposite of what I meant to say.
7. I rarely feel so mixed up that I have difficulty functioning
8. My thoughts are usually clear, at least to myself.
9. My thoughts are more random than orderly.
10. The way I perceive things is much the same as the way in which others perceive them.
11. Sometimes my thoughts just disappear.
12. I can usually keep my thoughts going straight.
13. My thoughts are so vague and hazy that I wish that I could just reach up and pull them into place.
14. I usually feel that people understand what I say.
15. There have been times when I have gone an entire day or longer without speaking.
16. I ordinarily don't get confused about *when* things happened.
17. It's usually easy to keep the point that I am trying to make clear in my mind.
18. My thoughts speed by so fast that I can't catch them.
19. I usually don't feel that I'm rambling on pointlessly when I'm speaking.
20. Sometimes when I try to focus on an idea, so many other thoughts come to mind that I find it impossible to concentrate on just one.
21. I have no difficulty controlling my thoughts.
22. My thinking often gets "cloudy" for no apparent reason.
23. I think that I am reasonably good at communicating my ideas to other people.
24. I often find myself saying something that comes out completely backwards.
25. My thoughts often jump from topic to topic without any logical connection.
26. I'm pretty good at keeping track of time.
27. Often during the day I feel as though I am being flooded by thoughts.
28. The way that I process information is very different from the way in which other people do.
29. I have no difficulty separating past from present.
30. I often find that people are puzzled by what I say.
31. My thoughts seem to come and go so quickly that I can't keep up with them.
32. I can usually think things through clearly.
33. I often feel confused when I try to explain my ideas.
34. Usually my thoughts aren't difficult to keep track of.
35. I have no difficulty in controlling my thoughts.

CSS Response Sheet

After reading the questions from the Questionnaire Booklet, which will be handed out separately, please circle the Y or N, based on how the questions applies to you next o the proper number on THIS PAGE. Please DO NOT mark your responses in the Questionnaire Booklet.

1	Y	N	21	Y	N
2	Y	N	22	Y	N
3	Y	N	23	Y	N
4	Y	N	24	Y	N
5	Y	N	25	Y	N
6	Y	N	26	Y	N
7	Y	N	27	Y	N
8	Y	N	28	Y	N
9	Y	N	29	Y	N
10	Y	N	30	Y	N
11	Y	N	31	Y	N
12	Y	N	32	Y	N
13	Y	N	33	Y	N
14	Y	N	34	Y	N
15	Y	N	35	Y	N
16	Y	N			
17	Y	N			
18	Y	N			
19	Y	N			
20	Y	N			

Appendix E

NORTH AMERICAN ADULT READING TEST (NAART): WORD LIST

Debt	Indict
Debris	Détente
Aisle	Impugn
Reign	Capon
Deport	Radix
Simile	Aeon
Lingerie	Epitome
Recipe	Equivocal
Gouge	Reify
Heir	Indices
Subtle	Assignate
Catacomb	Topiary
Bouquet	Caveat
Gauge	Superfluous
Colonel	Leviathan
Subpoena	Prelate
Placebo	Quadruped
Procreate	Sidereal
Psalm	Abstemious
Banal	Beatify
Rarefy	Gaoled
Gift	Demesne
Corps	Syncope
Hors d'oeuvre	Ennui
Sieve	Drachim
Hiatus	Cidevant
Gauche	Epergne
Zealot	Vivace
Paradigm	Talipes
Façade	Synecdoche
Cellist	

Appendix F

POSITIVE AND NEGATIVE AFFECT SCHEDULE- EXTENDED FORM (PANAS-X)

This scale consists of a number of words and phrases that describe different feelings and emotions. Read each item and then mark the appropriate answer in the space next to the word. Indicate to what extent you have felt this way today. Use the following scale to record your answers:

5 very slightly or not at all
2 a little
3 moderately
4 quite a bit
5 extremely

_____ cheerful	_____ sad	_____ active	_____ angry at self
_____ disgusted	_____ calm	_____ guilty	_____ enthusiastic
_____ attentive	_____ afraid	_____ joyful	_____ downhearted
_____ bashful	_____ tired	_____ nervous	_____ sheepish
_____ sluggish	_____ happy	_____ lonely	_____ distressed
_____ daring	_____ amazed	_____ sleepy	_____ blameworthy
_____ surprised	_____ shaky	_____ excited	_____ determined
_____ strong	_____ timid	_____ hostile	_____ frightened
_____ scornful	_____ alone	_____ proud	_____ astonished
_____ relaxed	_____ alert	_____ jittery	_____ interested
_____ irritable	_____ upset	_____ lively	_____ loathing
_____ delighted	_____ angry	_____ ashamed	_____ confident
_____ inspired	_____ bold	_____ at ease	_____ energetic
_____ fearless	_____ blue	_____ scared	_____ concentrating
_____ disgusted with self	_____ shy	_____ drowsy	_____ dissatisfied with self

Appendix G

DEMOGRAPHICS QUESTIONNAIRE

Demographics Questionnaire

Age: Gender: M F Other

Ethnicity: Nationality:

Native Language: If not English, when learned English:

Are you fluent in English?: Y N

Highest Education Level: University Major:

Handedness: L R B

Adequate vision: Y N Corrected vision: Y N

Psychiatric History: Y N (psychosis, depression, anxiety, mania, eating disorder)

If Yes: what, when, how long, hospitalization, treatment:

Language/Speech Disorder: Y N

If Yes, what type, when was it diagnosed:

Learning Disability: Y N

If Yes, what type, when was it diagnosed:

Neurological History: Y N (seizures, stroke)

If Yes, what, when, how long, hospitalization, treatment:

Medical History: Y N (heart problem, diabetes, thyroid problem, infections, cancer, substance abuse/addiction, anemia)

If Yes: what, when, how long, hospitalization, treatment:

Current medication(s):

If Yes: name of medication, dosage, when, length of time, reason

Appendix H
SEMANTIC FLUENCY (ANIMALS) CLUSTERS

Clusters on semantic fluency trials consisted of successively generated words belonging to the same subcategories, as specified here. Subcategorizes are organized by living environment, human use, and zoological categories. Commonly generated examples are listed for each category, although listings are not exhaustive

Living Environment

Africa: aardvark, antelope, buffalo, camel, chameleon, cheetah, chimpanzee, cobra, crocodile, eland, elephant, gazelle, giraffe, gnu, gorilla, hippopotamus, hyena, impala, jackal, lemur, leopard, lion, manatee, mongoose, monkey, ostrich, panther, rhinoceros, tiger, wildebeest, warthog, zebra

Australia: dingo, emu, kangaroo, kiwi, possum, platypus, Tasmanian devil, wallaby, wombat

Arctic/Far North: auk, caribou, musk ox, penguin, polar bear, reindeer, seal

Farm: chicken, cow, donkey, duck, ferret, goat, goose, horse, mule, pig, sheep, turkey

North America: badger, bear, beaver, bison, bobcat, buffalo, caribou, chipmunk, cougar, coyote, deer, elk, fisher, fox, moose, mountain lion, opossum, puma, rabbit, raccoon, skunk, squirrel, wolf

Water: alligator, auk, beaver, crocodile, dolphin, eel, fish, frog, lobster, manatee, muskrat, newt, octopus, otter, oyster, penguin, platypus, salamander, sea lion, seal, shark, toad, turtle, whale

Human Use

Beasts of burden: camel, donkey, horse, llama, ox

Fur: beaver, chinchilla, fox, mink, rabbit

Pets: budgie, canary, dog, gerbil, golden retriever, guinea pig, hamster, mouse, parrot, rabbit, snake, turtle

Zoological Categories

Bear: bear, grizzly bear, panda, polar bear

Bird: budgie, condor, eagle, finch, kiwi, macaw, owl, parrot, parakeet, pelican, penguin, robin, toucan, woodpecker

Bovine: bison, buffalo, cow, musk ox, yak

Canine: coyote, dog, fox, hyena, jackal, wolf

Deer: antelope, caribou, eland, elk, gazelle, gnu, impala, moose, reindeer, wildebeest

Feline: bobcat, cat, cheetah, cougar, jaguar, leopard, lion, lynx, mountain lion, ocelot, panther, puma, tiger

Fish: bass, guppy, salmon, trout

Insect: ant, beetle, cockroach, flea, fly, praying mantis

Insectivore: aardvark, anteater, hedgehog, mole, shrew

Primate: ape, baboon, chimpanzee, gibbon, gorilla, human, lemur, marmoset, monkey, orangutan, shrew

Rabbit: conney, hare, pika, rabbit

Reptile/Amphibian: alligator, chameleon, crocodile, frog, gecko, iguana, lizard, newt, salamander, snake, toad, tortoise, turtle

Rodent: beaver, chinchilla, chipmunk, gerbil, gopher, ground-hog, guinea pig, hamster, hedgehog, marmot, mole, mouse, musk-rat, porcupine, rat, squirrel, woodchuck

Weasel: badger, ferret, marten, mink, mongoose, otter, polecat, skunk

Vita Auctoris

Erica Chu was born in 1986 in Ottawa, Ontario. She graduated from International Christian School in Hong Kong in 2004. From there she went on to the University of California, Riverside, where she obtained a B.A. in Psychology in 2008. After undergraduate study, she went to the University of Windsor, Ontario, where she obtained a M.A. in Clinical Psychology in 2011.