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Sensory Modulation Disorder and Schizophrenia: Linking Behavioral Measures

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University.

by

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LIST OF ABBREVIATIONS

Activities of Daily Living	ADL
Adolescent/Adult Sensory Profile	A/ASP
Adult Sensory Interview	Adult SI
Adult Sensory Questionnaire	ASQ
American Psychiatric Association	APA
Autistic Spectrum Disorder	ASD
Autonomic Nervous System	ANS
Clinical Global Impressions Scale	CGI
Communication/Interaction Skills	C/I Skills
Community Counseling Center of Chicago	C4
Diagnostic and Statistical Manual of Mental Disorders Fourth Edition Text Revised	DSM-IV TR
Electrodermal Activity	EDA
Electroencephalography	EEG
Electromyography	EMG
Event-Related Potentials	ERP
Extrapyramidal Side Effects	EPS
Instrumental Activities of Daily Living	IADL
Mini Mental State Examination	MMSE
National Alliance for the Mentally Ill	NAMI
New York Longitudinal Scales	NYSL
Positive and Negative Syndrome Scale	PANSS
Positive and Negative Syndrome Scale Negative Symptoms Subscale	PANSS -
Positive and Negative Syndrome Scale Positive Symptom Subscale	PANSS +
Principle Investigator	PI
Rush University Medical Center	RUMC
Scales for the Assessment of Negative Symptoms	SANS
Scales for the Assessment of Positive Symptoms	SAPS
Sensory Modulation Disorder	SMD
Tardive Dyskinesia	TD

ABSTRACT

SENSORY MODULATION DISORDER AND SCHIZOPHRENIA: LINKING BEHAVIORAL MEASURES

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

Virginia Commonwealth University, 2011

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Schizophrenia is a devastating disorder affecting millions of people in the United States. Studies leading to new understanding of and intervention for this disorder are essential, as current interventions are minimally effective. The end result is high rates of re-hospitalization, impaired occupational performance and decreased community reintegration. According to the Diagnostic and Statistical Manual of Mental Disorders, symptoms of schizophrenia are categorized as positive or negative, with both types of symptoms impacting successful occupational engagement. Based on behavioral observations occupational therapists have hypothesized that this population may also experience sensory modulation disorder (SMD). Although electrophysiological studies support the presence of SMD, studies focusing on the relationship between the observable behaviors of these two disorders are lacking. The purpose of this project is to examine the relationship between symptoms of SMD and schizophrenia. A cross-sectional

design was used for this study. A convenience sample of 40 subjects was recruited from two outpatient psychiatric programs in Chicago, Illinois. Multi-site testing using the Positive and Negative Syndrome Scale (PANSS) and the Adolescent/Adult Sensory Profile (A/ASP) was used to address the following questions: 1) Is there a relationship between symptoms of schizophrenia and patterns of SMD? 2) Can positive and negative symptoms of schizophrenia reliably predict patterns of sensory modulation disorder? A Spearman correlation coefficient was used to examine the relationship between symptoms of schizophrenia and patterns of SMD, indicated a significant positive relationship between positive symptoms of schizophrenia and the low registration and sensory sensitivity quadrants of the A/ASP. Furthermore, a Mann Whitney U test uncovered significantly higher sensory sensitivity scores in African Americans compared to Caucasians. No significant relationships were found between negative symptoms and patterns of SMD. Stepwise regression found that positive symptoms predicted higher low registration scores and a combination of positive symptoms, race and gender were the best predictors of higher sensory sensitivity scores. This study did find a relationship between positive symptoms and patterns of SMD, suggesting that the relationship may actually be between psychosis and SMD and not schizophrenia. However, due to the small sample size, results should be interpreted cautiously and further studies completed.

CHAPTER 1: INTRODUCTION

Background on Schizophrenia

It has been estimated that 1-2 percent of the population or over two million people have a diagnosis of schizophrenia in the United States (National Alliance for the Mentally Ill [NAMI], 2007). Effective treatment for this disorder remains elusive. Contributing to this ineffectiveness is the unknown etiology of the symptoms and behaviors of this disorder. Occupational therapists have hypothesized that individuals with schizophrenia have deficits in their ability to regulate and respond to sensory input, a phenomenon referred to as Sensory Modulation Disorder (SMD) (Brown, Cromwell, Filion, Dunn & Tollefson, 2002; Dunn, 2001; Miller, Anzalone, Lane, Cermak, & Osten, 2007). This cross-sectional study will examine the relationship between behaviors seen in persons with schizophrenia and SMD.

Schizophrenia is a complex disorder. According to the Diagnostic and Statistical Manual of Mental Disorders Fourth Edition Text Revised (DSM-IV TR) (American Psychiatric Association [APA], 2000) schizophrenia is typically diagnosed during late adolescence or early adulthood. Symptoms consist of “positive symptoms: delusions, hallucinations, disorganized speech, grossly disorganized or catatonic behavior and

negative symptoms such as affective flattening, alogia (poverty of speech), or avolition” (APA, p. 312).

Schizophrenia has been categorized into three phases: prodromal, active and residual (APA, 2000). The prodromal phase occurs prior to the formal diagnosis of schizophrenia. During this phase there is typically a slow development of signs and symptoms related to the disorder such as social withdrawal, decreased interest in school or work, and decreased attention to self-care and hygiene activities. The active phase marks the official presence of schizophrenia. During this phase individuals experience the positive symptoms of the disorder, which include hallucinations, delusions and emotional instability. The final phase is the residual phase. Individuals are considered to be in the residual phase when active symptoms have been controlled and remaining symptoms are negative, including poverty of speech, decreased motivation, and decreased emotional response. Once diagnosed, persons with schizophrenia tend to fluctuate between the residual and active phases (APA). It should be noted that, in some individuals, positive symptoms never completely resolve, and they remain in the active phase throughout the course of the illness. Conversely, some individuals do not experience a reoccurrence of positive symptoms after the official diagnosis of schizophrenia is made and remain in the residual phase throughout the course of the illness.

Regardless of the illness phase or symptom type (positive or negative), these individuals demonstrate behavioral deficits such as decreased coping skills, inability to manage exacerbation of symptoms and/or difficulty dealing with unexpected demands of

the environment (Barbieri, Boggian, Falloon, & Lamonaca, 2006; Bonder, 2004; Cara & MacRae, 2005). In turn, these behaviors interfere with one or more of the major areas of functioning, such as work, interpersonal relationships, or self-care, that are required to live independently in the community (APA).

Interventions for Schizophrenia

There are a variety of treatments used with individuals with schizophrenia. Biological treatments include medication, electroconvulsive treatment (ECT) and, more recently, repetitive transcranial magnetic stimulation (Knapp et al., 2008; Sadock & Sadock, 2010). Psychosocial approaches to treatment include, but are not limited to, individual or group psychotherapy, skills training, and case management (Sadock & Sadock).

These treatments can be provided in a variety of settings. When there is an exacerbation of psychiatric symptoms resulting in an individual being incapable of caring for themselves or becoming a danger to themselves or someone else they are often admitted to an acute care inpatient psychiatric unit (Stein & Cutler, 2001). These hospitalizations tend to be short, i.e, five to ten days, and focus on symptom stabilization (Stein & Cutler).

Since the passage of the Community Mental Health Act of 1963, the goal of mental health services has been to provide treatment in the community (Stein & Cutler, 2001). As a result, there are a variety of outpatient services available for individuals with severe mental illness (SMI) such as partial hospitalization, community mental health

services or individual appointments with specific mental health professionals such as psychiatrists, psychologists or social workers (Stein & Cutler).

Relapse and Recidivism

Despite the many advances in treatment for individuals with schizophrenia and a thrust towards community-based care, there continues to be a high rate of hospital readmissions. It has been estimated that 40-50 percent of individuals who have been hospitalized for psychiatric issues will be readmitted within a one-year, period and 65-70 percent are readmitted within three to five years (Montgomery & Kirkpatrick, 2002).

Past studies have explored the reasons for this high level of recidivism (George & Howell, 1996; Montgomery & Kirkpatrick, 2002; Song, Biegel & Johnsen, 1998; Yamada, Korman, & Hughes, 2000). These studies identified significant factors that contribute to this recidivism, including noncompliance with medication and poor follow-up with aftercare plans. Bostelman et al. (1994) explored why people do not adhere to follow-up recommendations. They examined the impact of psychoeducation about the client's psychiatric disorder and medication, family education, and working with the client to develop a support network on compliance. The results indicated that the support network was the most significant predictor of adhering to aftercare recommendations. Stein and Cutler (2001) suggested that individuals may not be successful in aftercare treatment because mental health treatment has become too routine and not focused on individual patient needs. Aftercare recommendations may not be the right fit for what the individual needs, thus the individual's investment in follow-through may be minimal.

Etiology

Unknown etiology is a major factor in the ineffective treatment of schizophrenia. Researchers continue to struggle with the question of whether schizophrenia is a result of neurodevelopmental deficits or a neurodegenerative disorder (Buchanan & Carpenter, 2005). Results of genetic studies show an increased occurrence of this disorder among biological relatives, with the most dramatic findings of 50 percent co-occurrence rate in monozygotic twins. This rate is approximately four to five times greater than what is found in dizygotic twins or other first-degree relatives. Interestingly, this rate drops in second- or third-degree relatives, suggesting the genetic risk decreases across generations. And yet, many biological relatives who are vulnerable for the development of schizophrenia never experience the disorder suggesting that environmental factors may also play a role.

Researchers have also examined neuro-biochemical involvement in the etiology of this disorder (Buchanan & Carpenter, 2005). It has been hypothesized that dopamine abnormalities contribute to the development of schizophrenia (Buchanan & Carpenter). Although conclusive evidence of the role of this neurotransmitter remains elusive, it appears these abnormalities contribute to both positive and negative symptoms. Positive symptoms appear to result from increased levels of dopamine in the basal ganglia and limbic systems while decreased levels in the prefrontal cortex result in negative symptoms (Breier et al., 1997; Gao & Goldman-Rakic, 2003). It has also been hypothesized that serotonin metabolism is abnormal in individuals with persistent schizophrenia (Buchanan & Carpenter). Unfortunately, researchers are unable to identify

the exact abnormality, as these individuals experience both increased and decreased levels of serotonin activity. It has also been hypothesized that these individuals experience increased levels of norepinephrine, resulting in increased sensitivity to sensory input. Finally, decreased N-methyl-D-aspartate (NMDA) receptor binding in the prefrontal cortex and hippocampus leads to decreased transmission of glutamate. The resulting hypoglutamatergic action is believed to lead to increased positive symptoms. Glutamate abnormalities are also believed to interact with decreased dopamine in the prefrontal cortex leading to the presentation of negative symptoms (Buchanan & Carpenter).

Occupational Therapy

Occupational therapy is one health care discipline that works with people with schizophrenia. The main focus of occupational therapy is “supporting health and participation in life through engagement in occupation” (American Occupational Therapy Association [AOTA], 2008, p.626). The main belief of occupational therapists is that engagement in meaningful occupations contributes to overall health and well-being. In other words, occupational therapists believe that individuals need to be engaged in roles and activities that occupy their time in a meaningful way.

When an individual is having difficulty engaging in one or more of their daily life activities, such as self-care, work or leisure, an occupational therapist will conduct a thorough evaluation to identify factors that hinder performance. Evaluation typically addresses observable performance skills such as motor/praxis, cognitive, communication/social, emotional regulation and sensory perceptual skills, and assesses

underlying client factors that include both body functions and structures (AOTA, 2008). Body functions include both physiological and psychological functions, while the body structures include the anatomical parts of the body.

Occupational therapy practitioners provide services to individuals with schizophrenia in diverse settings, including acute care inpatient and long-term intermediate care facilities and a variety of outpatient settings (Stein & Cutler, 2001). The goal of these interventions is to increase performance in all daily life activities, ranging from basic ADL to more complex engagement in work and/or education (Bonder, 2004; Cara & MacRae, 2006). Although outcomes research is limited, a few studies examined the impact of occupational therapy intervention in individuals with schizophrenia. Results showed increased independence in IADL skills, greater involvement in occupational roles such as friend, hobbyist, family member, home-maintainer, worker, and student, and overall improvement in self-esteem and quality of life (Liu, Hollis, Warren, & Williamson, 2007; Rouleau, Saint-Jean, Stip, & Fortier, 2009; Zielinski et al., 2009; Poon, Siu, & Sin, 2010).

One performance skill that has been receiving increased focus in individuals with schizophrenia over the past ten years is sensory perceptual skills, specifically how these individuals interpret, organize, and respond to sensory stimuli (AOTA, 2008). Based on behavioral observations, it has been hypothesized that some individuals with schizophrenia may also experience Sensory Modulation Disorder (SMD) (Brown et al., 2002; Dunn, 2001; Miller et al., 2007). SMD has been defined as a deficient ability to effectively regulate and organize sensory input and turn that input into behavioral

responses that match the intensity of the input (Dahl Reeves, 1998; Lane, 2002; Miller 2007, McIntosh, Miller, Shyu, & Hagerman, 1999). Due to this inability to regulate sensory input, individuals with SMD may demonstrate over- or underresponsivity to sensory information, creating problems in engaging in daily occupations and functioning within their environments. Behaviors observed in individuals with SMD that are similar to those observed in individuals with schizophrenia include agitation, anxiety, withdrawal and/or inability to transition smoothly between activities and environments (Brown, et al.; Lane; Miller et al.).

Sensory Modulation Disorder

SMD is one aspect of a larger disorder referred to as Sensory Processing Disorder (SPD) (Miller et al., 2007). In addition to SMD, SPD includes two other symptom clusters: , Sensory-Based Motor Disorder and Sensory Discrimination Disorder. SPD is typically associated with children, who often have co-morbid disorders such as attention deficit hyperactivity disorder, pervasive developmental disorder, autism or cerebral palsy (Miller et al.). Although the historical focus of SPD investigation has been on children, there has been increasing interest in adults, recognizing that humans are sensory-beings and can experience dysfunction throughout the lifespan (Pfeiffer, 2002; Watling, Bodison, Henry, & Miller-Kuhaneck, 2006).

Many of the behaviors identified in SMD have also been observed in individuals with schizophrenia. These include increased anxiety and decreased functioning when faced with environments that are over-stimulating or unfamiliar, or require them to attend

to multiple, novel or ambiguous tasks (Bonder, 2004; Cara & MacRae, 2005; Palmer & Gatti, 1985; Stein & Cutler, 2001; Vogel, Bell, Blumenthal, & Neumann, 1989).

Purpose of Study

Although occupational therapists have suggested the co-occurrence of SMD and schizophrenia, studies substantiating this relationship are limited both within and outside the discipline. Electrophysiological studies of individuals with schizophrenia support the presence of impairments in the central nervous system that affect an individual's ability to effectively interpret and organize sensory input (Buchanan and Carpenter, 2005). However, studies examining the behavioral aspects of SMD as they relate to positive and negative symptoms in schizophrenia are lacking. Before interventions based on this hypothesis are developed it is essential to investigate the relationship between these two disorders. The purpose of this study is to examine the relationship between schizophrenia and SMD.

This study will address two research questions that will be tested through the related hypotheses:

Question 1: Is there a relationship between symptoms of schizophrenia and patterns of SMD?

H₁ There will be a positive association between positive symptoms of schizophrenia and the sensory sensitivity quadrant of the Sensory Profile.

H₂ There will be a positive association between negative symptoms of schizophrenia and the low registration quadrant of the Sensory Profile.

H₃ There will be a positive association between negative symptoms of schizophrenia and the sensation avoiding quadrant of the Sensory Profile.

H₄ There will be a negative association between positive and negative symptoms of schizophrenia and the sensory seeking quadrant of the Sensory Profile.

Question 2: After adjustment for individual characteristics and demographics, can positive and negative symptoms of schizophrenia reliably predict patterns of sensory modulation?

H₁ Negative symptoms will predict the low registration pattern of SMD.

H₂ Negative symptoms will predict the sensation avoiding pattern of SMD.

H₃ Positive symptoms will predict the sensory sensitivity pattern of SMD.

Research Design

These hypotheses were tested through the use of a non-experimental cross-sectional design. The goal was to recruit 50 subjects through a convenience sample from the Community Counseling Center of Chicago (C4) and Rush University Medical Center (RUMC) in Chicago, Illinois due to recruitment difficulties, however, only 40 subjects participated recruited. Inclusion criteria consisted of adults between the ages of 20 and 70 and a DSM-IV TR diagnosis of schizophrenia or schizoaffective disorder. Individuals with schizoaffective disorder were included, as individuals with this disorder must meet the same diagnostic criteria related to positive and negative symptoms as individuals diagnosed with schizophrenia. Exclusion criteria consisted of a score of 20 or less on the Mini Mental State Examination (MMSE), and a psychiatric inpatient hospitalization during the four weeks prior to participating in this study.

The Positive and Negative Syndrome Scale (PANSS) was administered to all study participants to determine if they were demonstrating primarily positive or negative symptoms of schizophrenia. This was followed by the administration of the Adolescent/Adult Sensory Profile (A/ASP) to determine patterns of SMD. Following completion of these assessments participants were given \$25.00 to thank them for their participation. A Spearman's rank correlation, Mann Whitney U and Kruskal Wallis tests, and stepwise and multiple regression were used to analyze the results.

There were several limitations associated with this study. The first was the study was underpowered. Only 40, out of the original goal of 50 participants were recruited. Given the small sample size and the number of statistics that were used to analyze the data, there is an increased risk of Type I error.

The use of a convenience sample and the inclusion of thank-you gifts for participation were also limitations, as they may have created selection bias. This sampling procedure was chosen due to increased levels of paranoia in individuals with schizophrenia. The use of a random sample has the potential to increase paranoia resulting in a relapse of positive symptoms. Due to decreased levels of motivation resulting from the negative symptoms of this disorder, the inclusion of thank-you gifts was use to increase motivation for participation and assist the PI in achieving the target of 50 subjects.

The A/ASP may have also introduced a bias as it may not have been sensitive enough to pickup subtle differences in the population studied. Reliability and validity studies were done on a mentally healthy population so it is not clear if the instrument is

reliable and valid in people with schizophrenia. Also, the negatively worded statements were difficult for the subjects to understand and they sought repeated clarification to respond to those questions.

Significance of Study

Given the ongoing difficulties with community reintegration, minimally effective and/or less than adequate treatment and high relapse rates, schizophrenia continues to be a public health concern that costs the American public billions of dollars each year.

Wu (2005) estimates the direct and indirect annual cost of schizophrenia to be \$62.5 billion. Direct costs include medical care and medication estimated at \$22.7 billion. Indirect costs, including unemployment, premature death, and caregiver costs are estimated to be \$32.4 billion. As health care costs continue to escalate it is essential to continue to explore areas that may hold potential for effective interventions for individuals with schizophrenia to help reduce the financial liability experienced by the American public.

Given the elusiveness of effective treatment in individuals with schizophrenia, it is essential to gain further understanding of behaviors that impact daily functioning. This study will examine established symptoms and behaviors associated with schizophrenia from a different perspective, contributing to both the psychiatric and occupational therapy communities. The results have the potential to shed new light on current interpretations of the positive and negative behaviors associated with schizophrenia. Results may provide groundwork for alternative interventions to address the daily living hurdles faced by individuals with schizophrenia.

Because this study is one of the first to examine the relationship of schizophrenia and SMD it will be essential, in the future, to embark on multi-site studies to increase replication and generalizability of findings. Furthermore, this information will pave the way to conduct studies exploring the relationship between behaviors associated with schizophrenia and the physiologic variables (sensory gating, sensory registration and orientation) hypothesized to reflect SMD. Future establishment of this relationship would provide further insight into variables that may contribute to schizophrenia and support the development of innovative interventions that would address both SMD and behavior. This could potentially increase clients' organization and functioning and decrease the overall cost of schizophrenia to the American public.

CHAPTER 2: LITERATURE REVIEW

Schizophrenia

Schizophrenia is a serious mental illness typically diagnosed in late adolescence or early adulthood. There are two categories of symptoms in schizophrenia, positive and negative (American Psychiatric Association [APA], 2000). Positive symptoms consist of hallucinations, delusions, and disorganized speech and behavior. Negative symptoms include affective flattening, decreased interest in areas of occupation such as school or work, and decreased attention to hygiene and grooming.

Schizophrenia has been categorized into three phases: prodromal, active and residual (APA, 2000). The prodromal phase occurs prior to the formal diagnosis of schizophrenia. There is typically a slow development of signs and symptoms such as social withdrawal, decreased interest in school or work, and decreased attention to self-care and hygiene activities. The active phase, during which individuals experience the positive symptoms of the disorder, marks the official presence of schizophrenia. Individuals are considered to be in the final or residual phase when active symptoms have been controlled and primarily negative symptoms are seen. Once diagnosed, individuals tend to fluctuate between the residual and active phases (APA, 2000). It should be noted that, in some individuals, positive symptoms never completely resolve and they remain in

the active phase throughout the course of the illness. Conversely, some individuals never experience a reoccurrence of positive symptoms after the official diagnosis of schizophrenia and remain in the residual phase throughout the course of the illness.

Occupational Performance

Impairment in all areas of occupational performance, including work, education, activities of daily living (ADL) and instrumental activities of daily living (IADL), social participation and leisure is a hallmark of schizophrenia (APA, 2000; Goulet, Rousseau, Fortier & Mottard, 2008; Kurtz, Seltzer, Fujimoto, Shagan, & Wexler, 2008). In fact, diagnosis of this disorder is predicated on a decline in occupational performance (APA; Kurtz et al.). Research exploring performance patterns and time use within this population have also found impairments. Results indicate individuals with schizophrenia spend more time in sedentary activity, including sleep, watching television, listening to the radio, and/or smoking (Bejerhol, 2010; Bejerholm & Eklund, 2004; Minato & Zemke, 2004).

It has been estimated that only 15- 20 percent of individuals with schizophrenia are able to obtain employment, and only half of those who secure jobs are able to maintain employment (Goulet et al., 2008; Kurtz et al., 2008; Rouleau et al., 2009). Further, individuals with schizophrenia lack daily living skills required for successful community living (Bonder, 2004; Cara & MacRae, 2005). As a result, they are unable to secure sufficient income to attain adequate housing and attend to daily needs.

Numerous studies have been conducted to better understand what contributes to decreased occupational performance in this population. Investigators have found that,

although positive symptoms contribute to decreased occupational performance, negative symptoms are far more detrimental, contributing to poor prognosis, decreased occupational performance and overall decreased quality of life (Breier, Schreiber, Dyer, & Pickar, 1991; Glozier, 2002; MacDonald-Wilson, Rogers & Anthony, 2001). In contrast, other investigators have found that symptoms of schizophrenia contribute less to occupational impairment than initially believed and that cognitive impairments are the greatest predictor of occupational impairments (Kurtz et al., 2008; Velligan et al., 1997). Limited communication/interaction skills and decreased coping skills also contribute to impairments in occupational performance (Freedman, 2005; Kopelowicz, Liberman, & Zarate, 2006; Wilder-Willis, Shear, Steffen, & Borkin, 2002).

Cognition

Kurtz et al. (2008) have identified three areas of cognition required for successful occupational performance: sustained attention, memory and problem-solving. Individuals with schizophrenia demonstrate deficits in all of these areas (Freedman, 2005; Wilder-Willis et al., 2002). Egeland et al. (2003) identified impairment in both the ability to sustain attention and selective attention that negatively impacted occupational performance.

Bowie and Harvey (2008) found that individuals with schizophrenia demonstrate deficits not only in cognitive skills that interfere with occupational performance, but also in the ability to access these skills when needed to engage in an activity or social interaction. These investigators found that attention/working memory and processing

speed predicted social and living skills competence, while verbal memory and executive functions were only able to predict competence in living skills.

Studies examining the relationship between cognitive deficits and symptom severity in schizophrenia have yielded mixed results. While Breier et al. (1991) found that cognitive deficits correlated only with negative symptoms, Kolakowska, Williams, Ardern, and Jambor (1985) found a significant correlation with both positive and negative symptoms. Investigators have also found cognitive deficits impact social functioning and problem-solving skills, which interfere with independent community living (Allen & Allen, 1987; Corrigan & Green, 1993; Penn, Mueser, Spaulding, Hope & Reed, 1995; Royall et al., 1993). A longitudinal study by Kurtz et al. (2008) examined the effects of cognition and symptoms on change in functional outcomes in individuals with schizophrenia. Five cognitive skills were examined: crystallized verbal ability, sustained visual vigilance, problem-solving, processing speed and repetitive learning. Of these five cognitive skills, repetitive verbal learning was the only one that predicted functional status change in these individuals. Furthermore, symptoms were not found to contribute to changes in functional outcomes.

Frith (1993) suggested that the symptoms of schizophrenia may actually be a result of cognitive dysfunction as opposed to the previous belief that symptoms cause the cognitive deficits. He believed that cognitive deficits lead to decreased ability to self-regulate and initiate activities. Further, Frith suggested that this decreased ability to self-regulate and initiate may actually be the precursor of both positive and negative symptoms of schizophrenia.

Communication/Interaction Skills

Competence in communication/interaction (C/I) skills is essential for effective occupational performance. Impairments in C/I skills in individuals with schizophrenia have been well documented and are considered a primary feature of the disorder (Bonder, 2004; Cara & MacRae, 2005; Halford & Hayes, 1995). Numerous studies have established the relationship between poor C/I skills and a decreased ability to obtain and maintain employment (MacEwan & Athawes, 1997; Mueser, Becker, et al., 1997; Mueser, Salyers, & Mueser, 2001; Velligan, Mahurin, Eckert, Hazleton, & Miller, 1997). Further, Breier et al. (1991) found a relationship between decreased C/I skills and engagement in ADL and IADL.

C/I skill impairments can be observed in both verbal and nonverbal communication. Verbal impairments may present as disconnected or disorganized speech or verbal underproductivity, which manifests as decreased verbal output (Bowie & Harvey, 2008). Bowie and Harvey state that, in general, these impairments remain stable throughout the course of the disorder. However, overtime individuals with severe and persistent schizophrenia may actually experience an increase in C/I deficits, with individuals displaying verbal underproductivity demonstrating the greatest level of decline.

Studies examining social cognition or the way people process and respond to both verbal and nonverbal social information provide insight into the nonverbal C/I deficits observed in individuals with schizophrenia. Researchers have found an inability in these individuals to recognize subtle or obvious social cues noted in facial features or verbal

intonations, further contributing to C/I skill impairment (Corrigan, 1997; Kosmidis, Aretouli, Bozikas, Giannakou, & Ioannidis, 2008). As a result, individuals are often unable to form social relationships and/or lack the social support necessary for successful community integration (Halford & Hayes, 1995; Bonder, 2004; Perese & Wolf, 2005). This lack of social support has been identified as one of the most significant factors leading to re-hospitalization in individuals with schizophrenia (Yomada & Korman, 2000).

Coping Skills

Hultman, Wieselgren, and Ohman (1997) identified two coping skills response patterns that individuals with schizophrenia employ when faced with unfamiliar, overstimulating or ambiguous environments. The first response pattern was more passive and typically manifested as withdrawal or avoidance of stressful situations. The second response pattern was characterized by increased anxiety and agitation, and decreased functioning. These behavior patterns have been consistently noted by other authors (APA, 2000; Bonder, 2004; Cara & MacRae, 2005; Palmer & Gatti, 1985; Stein & Cutler, 2001; Vogel, et al., 1989). The end result of these decreased coping skills, regardless of the response pattern, is the inability to successfully engage in area(s) of occupational performance.

Current Interventions

Management of this disorder is often ineffective, given its complex symptoms and unknown etiology (Freedman, 2005). The focus of medication management involving the use of antipsychotic medication to treat the symptoms of schizophrenia has been

minimally effective. The first generation of antipsychotic medication, referred to as typical antipsychotics, was introduced in the mid 1900's and includes Haldol and Thorazine (Sadock & Sadock, 2010). These medications have demonstrated greater effectiveness in treating the positive compared to the negative symptoms of schizophrenia.

A major problem associated with these drugs is the extrapyramidal side effects (EPS), which negatively impact daily functioning and include but are not limited to akathisia or dystonia. One of the most troublesome extrapyramidal side effects is tardive dyskinesia (TD), which is characterized by involuntary movements and facial grimacing. TD occurs after long-term antipsychotic use and cannot be reversed (Bonder, 2004; Cara & MacRae, 2006).

The second generation of antipsychotic medications was introduced in the late 1900's and is referred to as atypical antipsychotics (Sadock & Sadock, 2010). Examples include Risperidal, Zyprexa, and Abilify. These medications have been found to be more effective in treating the negative symptom of schizophrenia and less effective with positive symptoms. Although EPS occurs less frequently with these medications, they have been found to be more sedating and cause excessive weight gain.

Psychosocial skills training is a prominent intervention for individuals with schizophrenia. This intervention specifically targets identified behavioral deficits, and has demonstrated mixed results in effectiveness (Tungpunkon & Nicol, 2008). Although initially effective in increasing various performance skills, such as coping or communication/interaction skills, improvements in community functioning are limited

(Hayes, Halford, & Varghese, 1992). Further, the long-term effects of psychosocial skills training have not been adequately measured. It does appear, however that periodic contact with mental health providers and skills training refresher courses are beneficial for long-term carry-over. However funding for these sessions is limited, impeding their implementation. A limitation in these studies is that skills are typically assessed through the use of paper-pencil assessments and/or observation in contrived clinical settings. It would be interesting to explore the impact of real-life context, on skills training and changes in occupational performance (Crone & Van Dellen, 2005).

Occupational therapists also provide intervention within the schizophrenic population, focusing on improving performance skills and patterns, environmental and activity modifications and client factors such as cognition (Bonder, 2004; Cara & MacRae, 2006). Occupational therapy interventions that incorporate a psychosocial skills training approach have a positive impact on increasing independence in IADL, such as grocery shopping and meal preparation (Brown, Rempfer, & Hamera, 2002; Grimm et al., 2009). Occupational therapy has also been found to be effective in development of vocational and work-related stress management skills and job attainment/retainment (Lee, Tan, Ma, Tsai, & Lui, 2006; Rouleau et al., 2009).

Mairs and Bradshaw (2004) found that, although life skills training in individuals with schizophrenia reduced negative symptoms and overall psychopathology, it had no impact on social skills. A reduction in psychopathology was also reflected in Chan, Lee, and Chan's (2007) findings that individuals who engaged in occupational therapy demonstrated decreased hospital readmission.

Occupational therapist practitioners have also measured the effect of treatment on cognition. Jao and Lu (1999) found that implementation of Siegel and Spivach's Problem-Solving Therapy increased problem solving skills in individuals with severe and persistent schizophrenia. Raweh and Katz (1999) demonstrated increased engagement in routine daily activities when environmental and activity adaptations were incorporated to address cognitive deficits as measured by the Cognitive Disability Model. Although these studies suggest the positive contributions of occupational therapy to intervention with individuals with schizophrenia, results should be interpreted cautiously due to small sample sizes and lack of long-term follow-up. It should also be noted that the majority of these studies have been conducted internationally and it is not known if the results would generalize to the United States.

Due to the inconsistency of response to both biological and psychosocial interventions in this population, mental health practitioners continue to explore alternative explanations to better understand what contributes to these occupational impairments. Based on behavioral observations, some occupational therapists have hypothesized that, in some individuals these behaviors are the result of a co-occurring sensory modulation disorder (SMD) (Brown, et al., 2002; Dunn, 2001; Miller, 2007). SMD has been defined as a decreased ability to effectively regulate and organize sensory input and turn that input into behavioral responses that match the intensity of the input (Dahl Reeves, 1998; Lane, 2002; McIntosh et al., 1999; Miller, et al., 2007). Behaviors associated with this disorder include but are not limited to anxiety, agitation, withdrawal, and decreased engagement in activities and the environment (Lane, 2002). Because these

behaviors are similar to what is observed in the schizophrenic population, a potential relationship warrants further investigation.

Lane (2002) states there are two levels of sensory modulation, physiological and behavioral. Modulation at the physiological level “reflects balancing of excitatory and inhibitory inputs from both the external and internal environment and adapting to environmental change” (Lane, p. 103). Modulation at the behavioral level refers to the ability to “match the response to the demands and expectations of the environment” (Lane, p. 103).

Neuroscientists have identified three areas that may contribute to the understanding of SMD at the physiological level: sensory gating, sensory registration, and electrodermal activity (EDA). Sensory gating is defined as the brain’s ability to suppress repeated or irrelevant stimuli (Davies & Gavin, 2007). Sensory registration is the brain’s ability to attend to and register relevant environmental stimuli (Miller & Lane, 2000), while EDA reflects sympathetic nervous system activity (Hazlett, Dawson, Schell & Nuechterlein, 1997). Electrophysiological studies have found that individuals with schizophrenia have deficits in sensory gating, sensory registration and EDA, irrespective of their presentation of positive or negative symptoms (Dawson & Schell, 2002; Freedman, 2005).

Sensory Modulation Disorder

SMD can occur in one or more of the five external senses (sight, sound, touch, taste, and smell) or the two internal or “hidden” senses (proprioceptive and vestibular). These hidden senses provide information regarding movement, pressure on joints and

muscles, and the position of one's body in space (Bundy & Murray, 2002). Because of this dysregulation, individuals with SMD often demonstrate difficulties engaging in meaningful activities such as work, self-care and leisure activities.

Ayres' Model of Sensory Integration

The concepts inherent in SMD have roots in sensory integration (SI) theory. Sensory integration is defined as “the neurological process that organizes sensation from one's own body and from the environment and makes it possible to use the body effectively within the environment” (Ayres, 1972, p. 11). A. Jean Ayres, an occupational therapist and neuroscientist, developed this theory based on her work with children with learning disabilities (Bundy & Murray, 2002). She observed there was a subset of children with learning disabilities who demonstrated an inability to interpret body and environmental sensations, and hypothesized it was this inability that contributed to difficulties in academic and motor performance. Ayres believed that it was not only the ability to process visual input, but vestibular and proprioceptive input as well that contributed to effective learning (Sieg, 1988).

There are three major postulates related to SI theory:

1. Learning is dependent on taking in and processing sensation from the body and the environment, and using it to plan and organize behavior.
2. Individuals who have a decreased ability to process sensation may also have difficulty producing appropriate actions, which in turn may interfere with learning and behavior.

3. Enhanced sensation, as part of meaningful activity that yields an adaptive interaction, improves the ability to process sensation, thereby enhancing learning and behavior (Bundy & Murray, 2002, p. 5).

According to Bundy and Murray (2002) SI dysfunction manifests in two ways: poor praxis and/or poor modulation. Dyspraxia refers to deficits in ideation, planning, and the execution of a motor act. Ayres (1979) defined poor modulation as the inability to modify the level of activity required to maintain equilibrium within all areas of the nervous system. Although Ayres did not recognize sensory modulation deficits as a separate disorder, she did acknowledge that poor modulation contributed to occupational dysfunction (Ayres). She stated that poor modulation resulted in an individual over-attending to certain types of sensory input while under-attending to others. Ayres highlighted the importance of the proprioceptive, vestibular and tactile systems' contributions to emotional stability. She stated "if these three basic sensory systems are not functioning adequately, the child will probably react poorly to his [sic] environment" (p. 62).

Deficits in the proprioceptive and vestibular systems may lead to postural or gravitational insecurity and/or aversive response to movement (Ayres, 1979). Gravitational insecurity is the "fear of movement, being out of the upright position, or having one's feet off the ground" (Bundy & Murray, 2002, p.9). This fear has a strong emotional component and is out of proportion to the situation that is typically benign, lacking potential danger for injury or harm. Aversive response to movement differs from gravitational insecurity, as these individuals are not afraid of movement but rather

movement makes them uncomfortable. Responses are characterized by autonomic nervous system reactions and may present as nausea, vomiting, or dizziness (Lane, 2002). In both of these disorders there may be increased anxiety and avoidance of movements that result in increased physical or emotional discomfort, leading to withdrawal from typical daily activities and decreased occupational engagement.

Poor modulation in the tactile system may lead to either the need for increased tactile input for an individual to respond or over-reactivity to touch, also known as tactile defensiveness (Ayers, 1979). Individuals with tactile defensiveness experience a negative response to sensations that would typically go unnoticed by others. Ayers stated that these negative reactions can occur in the other sensory systems as well, and the term sensory defensiveness is used to describe this general over-reactivity. Individuals with sensory defensiveness demonstrate difficulty in habituating to certain stimuli, resulting in heightened responses, distractibility, fearfulness, or avoidance of situations where they may encounter the offensive stimuli (Pfeiffer & Kinnealey, 2003). Oliver (1990) found that adults with sensory defensiveness tended to report increased feelings of anxiety and discomfort in social situations and often avoided involvement in meaningful activities to minimize the overall level of discomfort.

Over the years, other occupational therapy practitioners have built on the concept of sensory modulation and conducted studies to better understand both its nature and the resulting disorder, SMD (Dunn, 1999; Dunn & Brown, 1997; McIntosh et al., 1999).

Bundy and Murray (2002) state that modulation disorders may present as one or more of

the following: aversive responses to movement, gravitational insecurity, sensory defensiveness (including tactile defensiveness), and underresponsiveness.

In contrast to the three previously mentioned disorders, underresponsivity to sensation involves decreased awareness of and/or response to stimuli (Bundy & Murray, 2002). Although behaviors related to underresponsivity are dependent on the sensory system affected, individuals are generally thought to cope in one of two very different ways. Some will simply seem unengaged or uninterested in their environment. The sensory environment may not provide the intensity of input they need to prompt registration and processing of input. Alternatively, others may engage in sensory seeking behaviors, leading to activities that provide more intense sensory input such as increased touch/physicality, listening to music at a higher volume, or eating spicier food.

While early models of SMD conceptualized a linear continuum of over- and underresponsiveness (Royeen & Lane, 1991), these models do not fully define the complexities of this disorder. Based on clinical reports that children with SMD may vary between over- and underresponsivity, Royeen and Lane (1991) proposed a more circular model. This model states, that while individuals may over- or underrespond to different sensory input, they may not be moving from one end of the continuum to the other but rather cycling. Individuals who demonstrate overresponsivity to sensory input may continue to do so until they reach a level of sensory overload and shutdown. At this point they may then demonstrate behaviors related to sensory underresponsivity.

Dunn's Model of Sensory Processing

Dunn (1997) suggests a multidimensional model of SMD, linking neurological thresholds to behavior. The model suggests that, “responses to sensory experiences can be organized across two dimensions into four quadrants” (Brown et al., 2002, p. 188). The first dimension addresses neurological thresholds. People with low neurological thresholds are more sensitive to sensory stimulation, requiring less input for sensation to be perceived. Those with high neurological thresholds may miss sensory cues, as they require input of greater amounts or intensity to perceive sensations. The second dimension represents behavioral responses which are either in accordance with (passive) or used to counteract (active) the neurological threshold. Four quadrants are derived from these two dimensions: sensory sensitivity, sensation avoiding, low registration and sensation seeking (Figure 1).

	Behavioral Responses	
Neurological Thresholds	Passive	Active
High	Low Registration	Sensation Seeking
Low	Sensory Sensitivity	Sensation Avoiding

Figure 1. Dunn's model of sensory processing disorder. From “The impact of sensory processing abilities on the daily lives of young children and their families: a conceptual model,” by W. Dunn, 1997, *Infants Young Children*, 9, p. 24. Reprinted with permission of Lippincott Williams & Wilkins

Individuals in the sensory sensitivity quadrant easily recognize sensory stimuli and are more sensitive than others to events in daily life (Dunn, 2001). They tend to be easily distracted and disorganized, and report sensory stimuli as being more intense than others. Although they report discomfort with sensory stimuli, their behavioral response is passive. Instead of modifying their environment or response they “let things happen” (Dunn, p. 612). Individuals who are sensation avoiding are similar to those demonstrating sensory sensitivity, except they find ways to limit their contact with sensory input. They tend to engage in rigid daily routines and become more anxious or agitated when this routine is disrupted. Individuals in both of these quadrants demonstrate low neurological thresholds, requiring less sensory stimulation than is typically experienced in everyday life activities and environments to function at their optimal level (Brown, et al., 2002).

Individuals who are in the low registration quadrant demonstrate decreased awareness of sensations of everyday living, which are readily noticeable to others (Dunn, 2001). Their behavioral response tends to be passive, and they require increased input to notice and respond. Individuals in the sensation seeking quadrant enjoy sensory experiences and seek them out. Behaviors observed in these individuals are similar to those observed in individuals who demonstrate underresponsivity as defined by Bundy and Murray. These behaviors may include greater engagement in activities that provide increased input in any of the sensory systems (Dunn, 2001).

Measuring Sensory Modulation Disorder

Sensory modulation occurs at behavioral and physiological levels (Lane, 2002). Occupational therapists have generally focused their research on the observable behavioral aspects of SMD, while neuroscientists have focused more on the physiological (Reynolds & Lane, 2008). Although occupational therapists have started to explore the relationship between these two levels, there is currently little research on this.

Behavior and Sensory Modulation Disorder

Several instruments have been developed by occupational therapists to examine the behaviors related to SMD. Instruments such as the Sensory Processing Measure (Parham, Ecker, Kuhaneck, Henry, & Glennon, 2006), Sensory Experiences Questionnaire (Baranek et al. 2006), Sensory Over-Responsivity Scale (Schoen, Miller, & Green, 2005), and Sensory Questionnaire (Liss, Saulnier, Fein, & Kinsbourne, 2006) have been developed for use with children. The Adult Sensory Questionnaire (ASQ) (Kinneally & Oliver, 2002), Adult Sensory Interview (ADULT-SI) (Kinneally, Oliver, & Wilbarger, 1995) and Adolescent/Adult Sensory Profile (A/ASP) (Brown & Dunn, 2002) are examples of instruments developed for adult populations.

The ASQ (Kinneally & Oliver, 2002) was developed to provide information regarding one specific aspect of SMD, sensory defensiveness. Instrument development grew out of the authors' work with children with sensory defensiveness and other sensory integrative disorders (Kinneally & Oliver). Through their research, the authors recognized that sensory defensiveness did not dissipate with age as was then the common belief. Instead they found problems that these individuals had as children transformed

into other problems when they became adults. These included dropping out of school, and increased family and vocational difficulties. Through a review of the literature and interviews, the authors found that individuals with sensory defensiveness experienced increased sensitivity to sensation, and this sensitivity impacted how they perceived and engaged in the world around them. The instrument consists of 26 true-false questions related to how respondents perceive various sensory experiences, such as “I get car sick” or “I am bothered by turtleneck shirts, tight fitting clothes, elastic, nylons, or synthetic material in clothes (any of the above)” as well as behavioral characteristics such as “I consider myself to be anxious” or “it is important for me to be in control and know what to expect.” A score of 10 or greater indicates the presence of sensory defensiveness.

The ADULT-SI (Kinneally, Oliver, & Wilbarger, 1995) is a tool used to identify patterns and the impact of sensory issues in an adult population. This 82 item semi-structured interview is designed to gather information on an individual’s perception of and response to various sensory stimuli. Each question receives a score of 1 (defensive) or 0 (non-defensive). The total score range is 0-82, with higher scores indicating higher levels of SMD.

The A/ASP (Brown & Dunn, 2002) is designed to provide insight into the overall sensory processing of an adolescent or adult, with a specific focus on sensory modulation. This instrument is part of a group of assessments developed to assess sensory modulation from infancy through adulthood, which includes the Sensory Profile (Dunn, 1999) and the Infant/Toddler Sensory Profile (Dunn, 2002). The A/ASP is based on the Sensory Profile (Dunn, 1999) that was developed to measure sensory processing in

children aged 3-10 years. Dunn's Model of Sensory Processing is the theoretical foundation for both the Sensory Profile and the A/ASP. The A/ASP is a 60-item, self-administered questionnaire. The individual is asked to describe the frequency of responses to everyday sensory experiences, with responses categorized as Almost Never, Seldom, Occasionally, Frequently, or Almost Always. The assessment is scored using a 5 point Likert scale as follows: Almost Never = 1 point, Seldom = 2 points, Occasionally = 3 points, Frequently = 4 points and Almost Always = 5 points. Raw scores are used to derive quadrant scores, based on the two continua (neurological threshold and behavioral response). Quadrants include: low registration, sensation seeking, sensory sensitivity, or sensation avoiding.

Only a few studies have used these instruments to examine behaviors of SMD in an adult population. Pfeiffer and Kinneally (2003) examined the relationship between sensory defensiveness and anxiety, using the ASQ, ADULT SI and Beck's Anxiety Index (BAI). Fifteen "normal" adult subjects between the ages of 26 and 46 identified as having sensory defensiveness as defined by the ASQ were administered the ADULT SI and BAI. Findings indicated a significant relationship between sensory defensiveness as measured by the ADULT SI and anxiety as measured by the BAI. Furthermore, following an intervention designed for individuals with SMD, the authors found a significant decrease in both sensory defensiveness and anxiety.

Jerome and Liss (2005) examined the relationship of sensory processing styles as defined by the A/ASP, adult attachment as defined by the Experiences in Close Relationships Scale, and coping style as defined by the COPE scale, in a population of

college students in an Introduction to Psychology course. These investigators found a positive relationship between the sensory sensitive quadrant and relationship anxiety, sensation avoiding quadrant and relationship avoidance, and low registration quadrant and both relationship anxiety and relationship avoidance. Individuals who were sensory sensitive were more likely to use a coping style of venting emotions, while those who were low registration used denial and disengagement.

These studies lend insight into how SMD may impact someone with schizophrenia. Given the increased levels of anxiety noted in individuals with schizophrenia (Palmer & Gatt, 1985; Vogel, et al., 1989; Stein & Cutler, 2001; Bonder, 2004; Cara & MacRae, 2005) it is possible that the relationship between sensory defensiveness and anxiety found by Pfeiffer and Kinnealey (2003) also exists within the schizophrenic population. Further, individuals with schizophrenia demonstrate decreased social relationships and tend to live in isolation (Bonder; Cara & MacRae), possibly due to poor coping skills that increase problems in social relationships (Corrigan, 1997, Hultman et al., 1997). Based on Jerome and Liss's (2005) findings, one could hypothesize that sensory processing styles contribute to the impairments in coping styles and social relationships seen in the schizophrenic population. However, before this hypothesis can be substantiated, additional studies are needed to document a relationship between sensory processing preferences and schizophrenia, and to replicate the findings of the Jerome and Liss study. Further, more research within the schizophrenic population is required to substantiate a relationship between behaviors associated with schizophrenia and SMD.

Electrophysiology and Sensory Modulation Disorder

Neuroscientists have focused their study of SMD at the physiological level, measuring central nervous system activity through a variety of electrophysiology methods. These include electroencephalography (EEG), electromyography (EMG) and electrodermal activity (EDA). EEG is the measure of the brain's activity and is characterized by positive and negative waves. These waves provide information on the brain's response to spontaneous or specific stimuli, referred to as event-related potentials (ERP) (Barrett, Barman, Boitano, & Brooks, 2010). EMG is a measure of electrical activity produced by muscle activity in response to a stimulus (Stern, Ray, & Quigley, 2001). It provides an opportunity to examine the gradation. EDA is defined as the electrical occurrences of the skin and is a reflection of the sympathetic branch of the autonomic nervous system (ANS) (Stern et al.). Specifically, it is a reflection of an individual's emotional response to environmental stimuli and/or the emotion elicited by cognitive activity (Siddle, 1991). All of these measurement methods can be used to characterize a response. Sensory gating, sensory registration and electrodermal response (EDR) have been associated with SMD and studied to increase understanding of SMD at the physiological level.

Sensory Gating and Registration. Sensory gating is defined as the brain's "ability to suppress repeated or irrelevant stimuli" (Davies & Gavin, 2007, p.179). It is thought to be associated with SMD, as its absence reflects an inability to attend to important environmental stimuli. Individuals with deficits in sensory gating have difficulty

inhibiting irrelevant stimuli such as background noise or visual clutter and in attending to important aspects of the environment required for effective task completion.

Sensory Registration refers to the ability to “attend to or register relevant environmental stimuli” (Davies & Gavin, 2007). Individuals with deficits in sensory registration have difficulty attaching meaning to a stimulus. Davies and Gavin state that registration can be described as the brain’s ability to register information when multiple stimuli are presented at one time. Sensory registration is associated with a variety of cognitive activities such as decision making, attention, discrimination of environmental stimuli, determining significance of stimulus and classifying and updating memory (Andreassi, 2000).

Researchers have consistently found deficits in both sensory gating and sensory registration in individuals with schizophrenia (Cadenhead, Light, Shafer & Braff, 2005; Higashima, et al., 2005; Kogoj, Pirtosek, Tomori, & Vodusek, 2005; Kumari, Fannon, SUMich, & Sharma, 2007; Liu, Tam, Xue, Yao, & Wu, 2004; Young, et al., 2001). Investigation of differences in sensory gating and registration based on positive or negative symptoms have, however, yielded conflicting results (Arnfred & Chen, 2004; Kirihaara, et al., 2005; Louchart-de la Chapelle, et al., 2005; Mathalon, Ford, & Pfefferbaum, 2000;. Potter, Summerfeldt, Gold & Buchanan, 2006; Ringel et al., 2004; St. Clair, Blackwood, & Muir, 1989; Turetsky, Colbath, & Gur, 1998).

Studies examining the effects of medication on sensory gating have demonstrated mixed results. In general, findings indicate conventional antipsychotic medication such as Haldol or Prolixin are ineffective in improving sensory gating (Duncan et al., 2006;

Light, Geyer, Clementz, Cadenhead, & Braff, 2000; Potter et al., 2006). Atypical antipsychotics such as amisulpride, olanzapine and risperidone have resulted in mixed responses in normalizing sensory gating (Duncan et al.; Light et al.; Potter et al.; Quednow et al., 2006; Wynn et al., 2007), and results should be interpreted with caution due to lack of consistency and replication of findings.

Electrodermal Response. EDR reflects changes in electrical activity of the skin in response to internal or external stimuli. The relationship between EDR and SMD is unknown. Royeen and Lane (1991) hypothesize that deficits in sensory modulation may stem from impairments in the limbic system and hypothalamus. They believe that this relationship may explain the emotional response in individuals who overrespond to stimuli, account for the presence of SMD across sensory systems, and explain the inconsistencies in responsivity (either over- or underresponsivity) in individuals with SMD.

Studies related to EDR and schizophrenia have demonstrated mixed findings. Although there is agreement that deficits are present, the level of EDR response has been contradictory (Dawson & Schell, 2002). Some studies indicate individuals with schizophrenia tend to be nonresponders, indicating hyporesponsivity to stimuli, while others indicate overresponsivity (Brekke, Raine, Ansel, Lencz, & Bird, 1997; Dawson & Schell, 2002; Lencz, Raine, & Sheard, 1996). Studies examining differences in EDR based on primary symptom presentation in this population have yielded similar inconsistencies (Brekke, Rain, & Thomson, 1995; Dawson, Nuechterlein, Schell, &

Mintz, 1992; Hultman, Ohlund, Wieselgren, Ohman, & Ost, 1996; Katsanis & Iacono, 1994; Schell et al., 2005; Zahn, et al., 1997).

Relationship of Behaviors of SMD and Physiological Activity

Currently no studies have been published examining the relationship of sensory gating and sensory registration deficits and behaviors of SMD, as defined by occupational therapists, in the schizophrenic population. Davies and Gavin (2007) examined the presence of sensory gating and sensory registration in children with SMD, as measured by the Sensory Profile. The investigators found that children with SMD, compared to typically developing children, consistently demonstrated less sensory gating and registration. Further, a significant relationship between sensory gating and age was found within the typically developing group but not in children with SMD. According to the investigators, this indicates that the sensory gating mechanism may develop throughout childhood, reaching maturity in adolescence or early adulthood, and children with SMD demonstrate deficits in the maturation process.

Davies and Gavin's (2007) hypothesis of sensory gating maturation may provide insight into the relationship of SMD and schizophrenia at the behavioral and CNS levels. Although the etiology of schizophrenia is unclear, it is likely a neurodevelopmental disorder. Findings of longitudinal studies suggest that children who developed schizophrenia in late adolescence or early adulthood had demonstrated earlier deficits in communication/interaction skills and cognition, resulting in decreased school performance and social withdrawal (APA, 2000; Buchanan & Carpenter, 2005; Murray & Bramon, 2005). These findings support the possibility that development of the CNS,

including sensory gating, in individuals who develop schizophrenia is impaired throughout childhood, leading to sensory modulation deficits in adulthood.

Although more studies have examined the relationship between behaviors of SMD and EDR, the evidence is still limited. A construct validity study of the A/ASP by Brown, Tollefson, Dunn, Cromwell, and Fillion (2001) examined the relationship between the preference for one or more of the sensory processing patterns and response patterns of skin conductance amplitude and trials to habituation. The authors found that both the sensory sensitivity and sensation avoiding groups were significantly more responsive to stimuli as measured by increased amplitude of SCR than the low registration and sensation seeking groups. Further, they were slower to habituate.

Brown et al. (2001) also examined the neurological threshold and behavioral dimensions of sensory processing. The sensory sensitivity and sensation avoiding groups that represent low neurological thresholds both demonstrated increased SCR to stimuli. However the sensation avoiding group habituated more quickly than the sensory sensitivity group. The high neurological threshold groups (low registration and sensation seeking) demonstrated decreased responsivity to stimuli. However, the low registration group habituated more quickly than the sensation seeking group.

McIntosh et al. (1999) compared EDR in children diagnosed with SMD as defined by the Sensory Profile with a control group. The authors found that participants with SMD had higher magnitude responses to sensory stimuli and decreased habituation compared to healthy control children. Furthermore, children with SMD demonstrated

more responses to each stimulus than healthy controls. Finally, nonresponders were found to have lower Sensory Profile scores than the hyperresponsive group.

Summary

In summary, sensory modulation can be measured at behavioral and CNS levels. There are several instruments that measure behaviors of SMD in adults, the most common being the A/ASP, ASQ and ADULT SI. Researchers have found significant correlations between SMD and symptoms of anxiety and depression, as well as abnormal attachments with others and decreased coping skills. Researchers examining modulation at the physiological level have found deficits in sensory gating, sensory registration and EDR. Although these studies consistently indicate impairment in these three areas of physiological activity, the results are inconsistent and often contradictory when examining the electrophysiological differences between the positive and negative symptoms. Although studies examining the relationship between behaviors of SMD and physiological impairments are limited, preliminary outcomes have suggested a relationship between these levels. However, further research is needed before a definitive relationship can be determined.

Occupational Therapy Studies

Although research on the presence of SMD in schizophrenia is limited, studies on SMD in the pediatric literature may shed light on this disorder within the schizophrenic population. SMD was first identified in children and was suggested to occur with or without other various disorders.

Childhood/Adolescent Studies

It has been suggested that 5 to 20 percent of children without disabilities demonstrate behaviors of SMD (Ahn, Miller, Milberger, & McIntosh, 2004; Dunn & Westman, 1997). This percentage increases in children with disabilities such as attention deficit hyperactive disorder, developmental disorders, autism spectrum disorder (ASD) and Fragile X (Baker, Lane, Angley, & Young, 2008; Baranek, David, Poe, Stone, & Watson, 2006; Roberts, King-Thomas & Boccia, 2007). The limited studies available suggest a prevalence rate between 40 and 80 percent (Adrien et al., 1993; Baranek et al., 2002; Dahlgren & Gillberg, 1989; Kientz & Dunn, 1997; Ornitz, Guthrie, & Farley, 1977; Talay-Ongan & Wood, 2000).

Most studies examining SMD in children focus on those with autism. It has long been hypothesized that children with ASD have co-occurring SMD (Dunn, 2001; Kientz & Dunn, 1997; Miller, 2006). Researchers have found 45-95 percent of children with autism also exhibit behaviors suggesting SMD (Adamson, O'Hare & Graham, 2006; Baker et al., 2008; Baranek et al., 2006; Tomcheck & Dunn, 2007). Ben-Sasson et al. (2009) conducted a meta-analysis of 14 studies examining SMD in children with ASD. They found that the greatest difference in response patterns when compared to typically developing children was underresponsivity, followed by overresponsivity and sensation seeking. There was also a relationship between the severity of ASD and general sensory symptoms, although no relationship between severity and specific sensory patterns. Adamson, O'Hare, and Graham (2006) found that sensory modulation deficits were present in children of all ages diagnosed with ASD, suggesting sensory modulation

difficulties remain as children grow older. However, the authors cautioned that this was a cross-sectional study and lacked the perspective of a longitudinal study, i.e., this may not have reflected a true developmental finding.

Childhood schizophrenia and autism were previously seen as overlapping conditions (Matson & Nebel-Schwalm, 2007). Over the years this relationship has been questioned with many purporting that autism and childhood schizophrenia are separate disorders (APA, 2000; Konstantareas & Hewitt, 2001). Matson and Nebel-Schwalm point out however, that studies establishing these differences are “almost non-existent.”

In a review of studies exploring the co-existence of autism and schizophrenia, Werry (1992) states that, there is evidence of symptom overlap in higher functioning individuals with autism, who are able to engage in verbal interaction, and positive symptoms of schizophrenia. He goes on to explain these symptoms may also be present in lower functioning children and adults with autism, but due to their low functioning or mute status, it may not be possible to document these symptoms. Konstantareas and Hewitt found that over fifty percent of males with autism demonstrated symptoms of schizophrenia. Dykens, Volkmar, and Glick (1991) found that high-functioning adolescents and young adults with autism demonstrated negative symptoms of schizophrenia, suggesting a co-occurrence of these two disorders. Clarke, Littlejohns, Gorbett, and Joseph (1989) reviewed the cases of five individuals with Asperger disorder or autism, ranging in age from 18 to 44. Of these five, four developed symptoms of schizophrenia later in life.

Rapoport, Chavez, Greenstein, Addington, and Gogtay (2009) conducted a systematic review of the co-occurrence on ASD and childhood onset schizophrenia. Two large studies cited by the authors found the diagnosis of childhood onset schizophrenia was preceded by a diagnosis of Pervasive Developmental Disorder in 30-50% of cases. Further, they found evidence of an association between ASD and childhood onset schizophrenia in epidemiological and family studies, as well as increased identification of risk genes and chromosomal variants shared by these disorders.

Schizophrenia Studies

Brown et al. (2002) compared patterns of sensory processing disorder in adults with schizophrenia to both adults with bipolar disorder and without mental illness, using the A/ASP. The authors reported that individuals with schizophrenia demonstrate highly varied behaviors that are indicative of both over- and underresponsivity to sensory stimuli, and therefore would not fit neatly into one quadrant of the A/ASP. Based on the authors' review of first person accounts articulated by McGhie and Chapman (1961), and electrophysiological studies that supported sensory gating deficits in individuals with schizophrenia, they hypothesized that individuals with schizophrenia would score higher on the sensory sensitivity quadrant compared to individuals with bipolar disorder and those without mental illness. Through clinical observations, the authors found that individuals who were not actively psychotic and demonstrated primarily negative symptoms of schizophrenia tended to seek out more predictable and less demanding environments. This environmental preference is similar to that seen in individuals in the sensation avoiding quadrant. Therefore, the authors hypothesized that individuals with

schizophrenia would also score higher on the sensation avoiding quadrant compared to individuals with bipolar disorder or those without mental illness. Finally, individuals with schizophrenia tended to demonstrate decreased responsiveness to sensory stimuli, slower reaction times, and a failure to attach meaning to sensory stimuli, consistent with individuals demonstrating low registration as defined by the A/ASP. Based on this information, the authors hypothesized that individuals with schizophrenia would demonstrate increased scores on the low registration quadrant compared to individuals with bipolar disorder and those without mental illness.

Results of this study indicated significantly higher scores in the sensation avoiding and low registration quadrant, and significantly lower scores on the sensation seeking quadrant in individuals with schizophrenia compared to mentally healthy individuals (Brown et al., 2002). In addition, individuals with schizophrenia had significantly lower scores in the sensation avoiding quadrant compared to individuals with bipolar disorder. No other significant differences between groups were found, even, surprisingly, on the sensory sensitivity quadrant.

The lack of difference between individuals with schizophrenia and bipolar disorder on the sensory sensitivity quadrant may be explained by the electrophysiological studies related to sensory gating. These studies have found that individuals with bipolar disorder who have had a history of psychosis demonstrate similar sensory gating deficits as those with schizophrenia (Adler et al., 1990; Perry, Minassian, Feifel, & Braff, 2001; Olincy & Martin, 2005; Sanchez-Morla et al., 2008). Brown and colleagues did not

provide such a history for individuals with bipolar disorder who participated in the study, but it is possible that some or many had experienced psychosis.

It is surprising that both groups with mental illness demonstrated no significant differences compared to individuals without mental illness in the sensory sensitivity quadrant. Although electrophysiological studies indicate deficits in individuals with schizophrenia or bipolar disorder, it is possible that the observable behaviors related to sensory sensitivity are not as pronounced as the authors believed. It is also possible that study participants with schizophrenia were not then actively psychotic and therefore were demonstrating increased negative symptoms of the disorder. Some studies have indicated that sensory gating deficits are not present in individuals demonstrating negative symptoms of schizophrenia (Potter et al., 2006). Thus, it is possible that behaviors related to sensory modulation in individuals demonstrating primarily positive symptoms of schizophrenia are different than those demonstrating primarily negative symptoms. Because of the inconsistency in findings, additional research is warranted.

The concept of sensory overload suggested by Royeen and Lane (1991) may have contributed to the similar scores on the sensory sensitive quadrant and the significantly higher scores on the low registration quadrant for individuals with schizophrenia. It is possible that individuals with schizophrenia had experienced sensory overload, had shut down as a coping mechanism, and were demonstrating behaviors indicative of low registration.

The significantly lower scores of individuals with schizophrenia on the sensation avoiding quadrant compared to individuals with bipolar disorder warrants further

discussion. It is not known in this study if the individuals with schizophrenia were demonstrating primarily positive or negative symptoms. If they were demonstrating primarily negative symptoms, these findings are not unexpected. Since anhedonia is a primary feature of the negative symptoms of schizophrenia, it would be unlikely that such individuals would have the energy or motivation to actively adapt to their environment or the tasks in which they were engaged. Clearly, symptom presentation may impact observable behaviors of SMD.

In a manuscript explaining how sensory processing needs relate to the recovery process of individuals with psychiatric disabilities, Brown (2001) cited first person accounts from individuals with schizophrenia first presented by McGhie and Chapman (1961). These narratives suggest that individuals with schizophrenia experience behaviors reflective of SMD. These individuals described experiences of distractibility and increased perceived intensity of sensory stimuli that may be related to sensory sensitivity as defined by the A/ASP, although these individuals took no action to modify their environment. Others related experiences consistent with low registration, stating they felt slow and had difficulty picking up on what was going on around them. They reported experiencing stimuli as coming at them very fast, and indicated they had difficulty attending to all the relevant information at any one time. They also recognized that the information was not being presented too fast but rather they were processing it too slowly. These individuals presented as passive, and their accounts suggest that they did not modify the environment to adapt to these difficulties.

Brown (2001) notes that subjects' comments in MacGhie and Chapman (1961) about feeling increased discomfort and overwhelmed in new environments and situations may be reflective of sensation avoiding. Unlike those who are sensory sensitive, these individuals report actively removing themselves from such situations only to return when they feel they can cope. Brown states that it is important for individuals to increase their awareness of sensory processing preferences so they can modify their environments and activities to support those preferences. In addition, increased awareness of sensory processing preference provides greater understanding of why a person responds in certain ways to certain situations. It is also important for providers of mental health services to understand sensory processing preferences so they can tailor interventions to meet individual client needs.

General Adult Studies

The studies by Jerome and Liss (2005) and Pfeiffer and Kinneally (2003), mentioned previously, found that SMD is present in adults without co-morbid psychiatric disorders. Additionally, a study by Johnson and Irving (2008) found that 23 percent of students and faculty at a midsize New England university demonstrated definite levels of sensory defensiveness as measured by the ASQ. Another 45 percent demonstrated moderate levels of sensory defensiveness.

These studies provide insight into how SMD may impact adults with schizophrenia. Given the relatively high rates of sensory defensiveness in a "normal" population, it is likely that individuals with schizophrenia would also experience this disorder. Johnson and Irving's (2008) findings may help explain how the presence of

sensory defensiveness could impact overall occupational performance in individuals with schizophrenia. Johnson and Irving note that schizophrenia is typically diagnosed in late adolescence and early adulthood, a time of transition for all individuals. Even if individuals with schizophrenia are not going to college, it is a time when they are assuming more independence. Not unlike college students, they are experiencing changes in their areas of occupation, performance patterns, context, and activity demands, which can be impacted by the presence of sensory defensiveness. Therefore, it is possible that the global occupational deficits observed in this population are not solely a result of the symptoms of schizophrenia.

Intervention Studies

Over the past ten years, occupational therapy practitioners have begun implementing a variety of sensory-based interventions to treat individuals with psychiatric disorders. However, studies examining the effectiveness of these interventions are limited. In general this intervention typically focuses on increasing the individual's awareness of the disorder and providing activities to help manage responses to stimuli in a more functional manner, with the ultimate goal of increased functioning within the environment (The Sensory Processing Disorder Foundation, 2011).

Interventions that have been used include multi-sensory rooms, the therapeutic pressure program and sensory diets (Champagne & Stromberg, 2004; Costa, Morra, Solomon, Sabino, & Call, 2006). Specialized multi-sensory rooms offer a variety of sensorimotor activities that provide calming and alerting options to meet the individual's needs (Champagne & Stromberg). These rooms were first introduced in the 1970's at the

Hartenburg Institute in the Netherlands and were then and now referred to as Snoezelen Rooms. Sensory rooms address all sensory systems and include activities such as the use of stress balls, rubbing stones or arts and crafts projects for the tactile system; posters, pictures or lighting effects for the visual system; a variety of music selections, sound machines or musical instruments for the auditory system; scented candles or aromatherapy diffusers for the olfactory system; foods with different spices and textures for the gustatory system; and, weighted blankets or lap pads, rocking chairs or therapy balls for the proprioceptive and vestibular systems.

The Therapeutic Pressure Program involves provision of deep pressure to the upper and lower extremities, back, legs and feet with a densely bristled brush, followed by compression to joints in the upper and lower extremities and the trunk (Wilbarger & Wilbarger, 2002). This procedure is repeated every 90 minutes to 2 hours. It was originally designed for children demonstrating sensory defensiveness, with the belief that engaging in certain sensory experiences on a regular basis would decrease their symptoms. According to Wilbarger and Wilbarger, no studies have used this intervention with adults with SMD, and only a few with children. However, clinical anecdotal reports suggest a successful reduction of sensory defensiveness behaviors in some clients.

A sensory diet is the “therapeutic use of sensation in the context of daily activities” (Wilbarger & Wilbarger, 2002, p. 336). It involves the use of planned interventions and environmental adaptations to decrease the negative response to sensory input, and promote optimal functioning. Use of a sensory diet is seen as crucial when using the Therapeutic Pressure Program. Sensory diet activities are chosen based on the

likelihood that they will reduce symptoms of sensory defensiveness and typically include deep pressure, proprioception and movement. Examples include the Morfam vibrator (large muscle vibrator), lifting weights, sitting in a rocking chair, doing jumping jacks and/or jumping on a small trampoline (Costa et al., 2006; Pfeiffer & Kinnealey, 2003; Wilbarger & Wilbarger). The sensory diet should consider all activities and environments in which an individual participates and, since periods of transition are especially difficult for these individuals, focus on developing consistent and predictable routines. In addition, those involved in caring for the individual should also be educated on the sensory diet and trained in strategies to minimize the effects of sensory over- or underresponsivity in a given environment (Wilbarger & Wilbarger).

Although descriptive articles have been written about sensory rooms, outcome studies are limited. Champagne and Stromberg (2004) conducted a quality improvement study examining the use of seclusion and restraints following the implementation of a sensory room in a 24-bed acute care psychiatric unit. Results indicated that 89% of the patients who used the sensory room reported positive benefits and exhibited a 54% decrease in the use of seclusion and restraints during the first year of implementation. Although this study indicates benefits of the intervention, no measures were used to indicate the presence of SMD and/or improvements in the specific behaviors of SMD in the population studied. In addition, there was no discussion of the population other than that it was a general psychiatric population. As a result, it is not clear if this study actually addressed issues of SMD and/or if this approach is more beneficial only to a specific subgroup of a psychiatric population rather than the entire group. If occupational

therapists and other mental health providers are going to move forward with this type of intervention, it is essential that more targeted information on patterns of sensory modulation within the psychiatric population be collected to better identify their needs.

Costa, et al. (2006) cited two studies that incorporated Snoezelen rooms, the Therapeutic Pressure Program and sensory diets with adults with mental illness (including substance abuse) attending an outpatient treatment program. The intent of the first study was to have participants engage in the Therapeutic Pressure Program and sensory diets on a regular basis to address sensory processing issues. Although the authors used the A/ASP as a pre/posttest measure, results were not reported. However, qualitative results reported indicated that clients felt better and more relaxed when engaged in intervention activities in the clinic, but had difficulty following through with these activities, i.e., the sensory diet, outside of the clinic.

Due to the reported difficulties in follow-through with activities outside of the clinic, the intervention was modified and that component was eliminated in the second study (Costa, et al., 2006). This second study focused on individuals with substance abuse disorders and how deficits in sensory processing affect substance use. Although the intervention incorporated use of the Snoezelen room, it was primarily psychoeducational in nature, including exploration of different senses and how they impact substance use. Results indicated significant decreases in sensory defensiveness as measured by the ASQ (Kinnealy & Oliver, 2002), stress as measured by the Brief Tension Scale (Mooney, 2001), and the urge to use substances as measured by self-

report. There was also a significant increase in self-reported community activity involvement.

These two studies are limited in that there were no specifics related to the subjects' diagnoses or demographics other than the second study was focused on individuals with substance abuse. Second, although outcome measures were employed, the authors did not provide information on the presence of SMD or sensory defensiveness in the populations prior to intervention. Finally, in the Costa et al. (2006) studies there was no mention of the results of readministration of the A/ASP in the first study. The favorable outcomes in the second study suggest that the interventions can be effective in reducing sensory defensiveness in individuals with substance abuse, but the specific impact of the Snoezelen Room versus psychoeducation is not clear.

Although these studies provide hope that interventions can positively impact SMD in clients with mental health deficits, it is essential that a foundational relationship between various psychiatric disorders and SMD is identified and further defined. Once defined, further refinement of interventions, hopefully resulting in more adaptive behaviors and increased occupational engagement, can occur.

Summary

Schizophrenia is a devastating disorder, and effective treatment for it remains elusive. As a result, individuals with schizophrenia demonstrate global occupational impairments. Performance skills and client factors that contribute to these impairments include deficits in cognition, communication/interaction skills, and coping skills.

Through behavioral observations, occupational therapy practitioners have hypothesized

that individuals with schizophrenia have a co-occurring SMD. They have further hypothesized that SMD contributes to occupational impairments that interfere with the ability to regulate, organize and respond efficiently to sensory input.

Lane (2002) states there are two levels of sensory modulation, behavioral and the CNS. Although general adult studies suggest a relationship between SMD and anxiety and depression, there have been no behavioral studies of SMD in a schizophrenic population. Further, one study found that individuals with SMD as defined by the A/ASP demonstrated poor social relationships and ineffective coping skills. Studies related to CNS activity in individuals with schizophrenia are more plentiful, with results suggesting decreased sensory gating and sensory registration. Although studies show EDR abnormalities in individuals with schizophrenia, results are inconsistent, demonstrating both hypo- and hyperresponsiveness to sensory stimuli. The results of studies examining differences in these three measures of CNS functioning in individuals demonstrating primarily positive symptoms of schizophrenia compared to negative symptoms are inconclusive. Only one study has directly examined the relationship of the two levels of SMD in adults. Brown et al. (2001) found that sensory sensitivity and sensation avoiding groups as measured by the A/ASP demonstrated increased amplitude of SCR and slower habituation.

Occupational therapy studies examining the presence of SMD in individuals with schizophrenia are also limited. A study by Brown et al. (2002) suggests the presence of SMD in individuals with schizophrenia, manifested as increased patterns of sensation avoiding and low registration, and decreased pattern of sensory seeking. No studies have

looked at differences in the behaviors of SMD in individuals demonstrating primarily positive symptoms of schizophrenia versus negative symptoms.

Despite the lack of empirical evidence for co-existing SMD, occupational therapy practitioners have implemented interventions designed for individuals diagnosed with mental illness. Due to numerous methodological flaws, it is unclear if these interventions are truly targeting behaviors of SMD. Before occupational therapy practitioners continue to provide such interventions, it is essential to establish a relationship between these two disorders. Further, it is important to determine if behaviors of SMD differ in individuals demonstrating primarily positive symptoms of schizophrenia compared to negative symptoms to assist in planning appropriate interventions.

The purpose of the current study is to examine the relationship between behaviors of SMD and schizophrenia. By establishing this relationship, professionals in both the psychiatric and occupational therapy communities will increase their understanding of behaviors related to schizophrenia and how they contribute to occupational impairments. The results have the potential to contribute to the development of interventions that will complement existing biological and psychosocial interventions. Determination of similarities or differences in behaviors of SMD in individuals demonstrating primarily positive or negative symptoms of schizophrenia will allow therapists to modify intervention depending on the phase of the illness these individuals are experiencing. Finally, it will assist occupational therapists working in inpatient settings to make more educated discharge recommendations.

CHAPTER 3: METHODS

Research Design

A non-experimental cross-sectional design was used to examine the relationship between behaviors of schizophrenia and Sensory Modulation Disorder (SMD). Forty subjects were recruited from the Community Counseling Center of Chicago (C4) and Rush University Medical Center (RUMC), both located in Chicago, Illinois. Subjects were administered the Positive and Negative Syndrome Scale (PANSS) and the Adolescent/Adult Sensory Profile (A/ASP). These instruments used in this study provided information on symptom severity of schizophrenia and patterns of SMD. Demographic information, including age, gender, race, ethnicity, employment status, highest level of education, number of years since onset of schizophrenia/schizoaffective disorder, number of hospitalizations since onset of disorder, antipsychotic medication(s), and other psychiatric diagnoses, was collected. Although concurrent psychiatric treatment/interventions data was collected at C4, it was not included in the analysis, as all subjects were involved in the same interventions and this information was not available for the RUMC subjects.

This design was used to address the following research questions that were tested through the related hypotheses:

Question 1: Is there a relationship between symptoms of schizophrenia and patterns of SMD?

- H₁ There will be a positive association between positive symptoms of schizophrenia and the sensory sensitivity quadrant of the Sensory Profile.
- H₂ There will be a positive association between negative symptoms of schizophrenia and the low registration quadrant of the Sensory Profile.
- H₃ There will be a positive association between negative symptoms of schizophrenia and the sensation avoiding quadrant of the Sensory Profile.
- H₄ There will be a negative association between positive and negative symptoms of schizophrenia and the sensory seeking quadrant of the Sensory Profile.

Question 2: After adjustment for individual characteristics and demographics, can positive and negative symptoms of schizophrenia reliably predict patterns of sensory modulation?

- H₁ Negative symptoms will predict the low registration pattern of SMD.
- H₂ Negative symptoms will predict the sensation avoiding pattern of SMD.
- H₃ Positive symptoms will predict the sensory sensitivity pattern of SMD.

Population and Recruitment

Population

Subjects from C4 and RUMC of Chicago, Illinois were recruited for this study. C4 is a community mental health agency established to meet the behavioral health needs of individuals and families on Chicago's north side (Community Counseling Centers of Chicago [C4], n.d.). This agency serves more than 5,000 adults recovering from mental

illness, including schizophrenia/schizoaffective disorders, substance use and emotional trauma. A wide range of services are provided such as, medication management, psychosocial group intervention, and case management. Subjects were recruited at one of C4's eight neighborhood facilities.

RUMC offers a continuum of services for individuals with psychiatric disorders. These services include partial hospital and intensive outpatient programs, and a variety of specialty clinics (Psychiatric Services (Ambulatory), n.d.). One of those clinics is a psychosis clinic, which provides services to individuals experiencing a variety of psychotic disorders including schizophrenia/schizoaffective disorders. Services at this site differ from C4 as they are limited to medication management and psychotherapy.

Recruitment

Institutional Review Board (IRB) approval was obtained at C4 and RUMC as well as Virginia Commonwealth University (VCU) where the principal investigator (PI) is a doctoral student. The goal was to recruit 50 subjects for this study through the use of a convenience sample. However, due to difficulty recruiting subjects, 40 subjects were recruited, 38 from C4 and two from RUMC. The inclusion criteria for this study consisted of adults between the ages of 20 and 70 with a DSM IV-TR diagnosis of schizophrenia or schizoaffective disorder. Schizoaffective disorder was included because individuals with this disorder must meet the same diagnostic criterion related to positive and negative symptoms as individuals with schizophrenia. Exclusion criteria were a score of 20 or less on the Mini Mental State Examination (MMSE), to assure adequate cognitive functioning in subjects, or psychiatric inpatient hospitalization during the four

weeks prior to the interview, to increase assurance of stability of psychiatric symptoms. Six of the 40 subjects were excluded because a diagnosis of schizophrenia or schizoaffective disorder was not confirmed when the chart review was completed. Therefore, 34 subjects were included in the analysis for this study.

The principal investigator (PI) was responsible for subject recruitment and served as the primary contact for individuals interested in participating in this study.

Recruitment at C4 consisted of posting flyers that included the PI contact information in the main meeting area. Flyers were also given to staff members who regularly see clients. (See Appendix A). Interested individuals were invited to contact the PI for more information regarding the study. If they did not feel comfortable contacting the PI they were asked to complete the permission to contact form at the bottom of the flyer, place it in a box identified for the study located in the main meeting area. The PI checked this box once a week and initiated contact with those interested in the study. In addition, the PI attended four community meetings at C4 to explain the study and recruit subject. RUMC recruitment consisted of providing outpatient psychiatry staff with information regarding the study and having staff member telephone the PI with contact information for interested clients.

All prospective subjects were contacted to explain the study, and inclusion/exclusion criteria were reviewed. During this initial contact, appointments were scheduled for those who met the inclusion/exclusion criteria and were still interested in participating. The appointments took place at C4 or RUMC with the PI or

the other member of the study staff who collected data. During this appointment the informed consent was reviewed and signed by those subjects who wanted to participate.

Instruments

Three measurement tools were used in this study. The MMSE (Folstein, Folstein, & McHugh, 1975) was used as a screening tool to determine if criteria were met related to cognitive functioning. The Positive and Negative Syndrome Scale (PANSS) (Kay, Fiszbein, & Opler, 2006) was used to measure symptom severity and the Adolescent/Adult Sensory Profile (A/ASP) (Brown & Dunn, 2002) to measure patterns of SMD.

Mini Mental State Examination

The MMSE (Folstein, Folstein, & McHugh, 1975) is a brief quantitative measure used to assess cognitive functioning in adult populations. It was used in this study as a screening tool to assure individuals demonstrated adequate cognitive functioning to participate in the study. The evaluator asked a series of questions to assess areas of orientation, attention and calculation, following written and verbal directions, and short-term memory (Ascher, 1996). This instrument yields a total of 30 possible points. Scores of 25 and above indicate normal cognitive functioning. Scores between 21 and 24 indicate mild cognitive impairment, and a score of 20 or below indicates moderate to severe impairment (Folstein, et al.). Individuals who scored 20 or less were excluded from this study. Folstein et al. reported good test-retest reliability with the MMSE. Validity studies have found the MMSE demonstrates good ability to discriminate among diagnostic categories, as well as distinguishing between individuals with cognitive

disabilities and those without (Asher, 2007). Concurrent validity was found between the MMSE and the Wechsler Adult Intelligence Scale (Folstein et al.).

The Positive and Negative Syndrome Scale

The PANSS (Kay et al., 2006) is a 30-45 minute interview used to assess symptom severity in individuals with mental illness, accompanied by a 30-item rating scale. Each item is rated on a seven-point scale based on the presence and severity of symptoms, with 1 representing an absence of symptoms and 7 representing extreme symptoms (Kay et al.). Ratings are scored using either the Standard Model or the Pentagonal Model. The Standard Model is comprised of three subscales: Positive Symptoms, Negative Symptoms and General Psychopathology. The Positive and Negative Symptom subscales consist of seven items each, while the General Psychopathology subscale is composed of 16 items. The alternative Pentagonal Model uses 25 of the 30 PANSS items and is comprised of five different subscales: Negative Symptoms, Positive Symptoms, Activation, Dysphoric Mood and Autistic Preoccupation (White, Harvey, Opler, Lindenmayer & the PANSS Study Group, 1997).

A third model has recently been suggested by Santor, Ascher-Svanum, Lindenmayer, and Obenchain (2007). An item-response study by these authors supported the sound psychometric properties of the Standard Model of the PANSS. Additionally, the subscales most sensitive to discrimination of symptom severity in individuals with schizophrenia or schizoaffective disorder were the Positive and Negative Symptom Scales. The authors recommended the construction of a “mini PANSS,” comprised of the items from these two subscales; however, further research is needed to support this.

Kay et al. (2006) state, that when deciding what model to use, the investigator should determine what content areas will be studied. For this study, the areas of interest were the Positive and Negative Symptom Scales. Since both models have Positive and Negative Symptom Scales, the psychometric properties of each were reviewed to make the final determination. Although Kay et al. state the Pentagonal Model is psychometrically superior, this is not supported by Lykouras et al.'s (2000) study. Further, since two occupational therapists collected data in the current study inter-rater reliability was important, and there are no inter-rater reliability studies of the Pentagonal Model. Therefore the decision was made to use the Standard Model.

Scoring to classify an individual as having primarily positive or negative symptoms of schizophrenia for either the Standard or Pentagonal Model can be done in two ways. The first method is more exclusionary and involves:

Counting how many ratings of 4 (moderate) or higher are obtained on the Positive and Negative subscales (Lindenmayer, Kay, & Opler, 1984; Opler, Kay, Rosado, & Lindenmayer, 1984). Patients are classified as belonging to the "positive subtype" if they score three or more moderate ratings on the Positive scale but fewer than three moderate ratings on the Negative scale. Patients are classified as belonging to the "negative subtype" if they score at least three moderate ratings on the Negative scale but fewer than three on the Positive scale. Patients who score at least three moderate ratings on both scales are regarded as belonging to the "mixed

type,” while those who reach this criterion for neither scale are considered “neither type” (Kay et al., 2006, p. 13).

The second method is more inclusive and involves determining a Composite index by subtracting the Negative scale score from the Positive scale score. If the Composite index is greater than 0, the individual is classified as a “positive subtype,” less than 0, a “negative subtype,” and equal to zero a “mixed subtype” (Singh, Kay, & Opler, 1987). Since the current research was a pilot study, the more inclusionary method was used. This decision was made due to concern that the more stringent, exclusionary method would omit too many subjects and there would not be adequate representation of subjects classified as the primary or negative symptom subtypes.

According to Kay et al. (2006), psychometric studies on the Standard Model of the PANSS found adequate reliability. Internal consistency for the Positive, Negative and General Psychopathology scales were all high, with alphas of .72, .81, and .77, respectively. However, average item-total correlations for each of the subscales alphas were lower ranging from .41 to .17. The authors attribute these lower alpha ratings to the decreased number of items representing each subscale.

Test-retest reliability is mixed. Kay and Singh (1989) examined 62 sub-acute patients with schizophrenia and found test-retest correlations after three to four months of $r = .37$ for the positive and $r = .43$ for the negative subscales. In an earlier study conducted by Kay, Fizbein & Opler (1987), subjects had higher test-retest coefficients; $r = .80$ for the Positive Symptom and $r = .68$ for the Negative Symptom scales ($n = 15$,

test-retest at three and six months). More consistent with Kay's later study, Lindenmayer et al. (1984) found low test-retest coefficients in a sample of 19 individuals in the active phase of schizophrenia from baseline testing to a two-year follow-up ($r = .24$ for the Positive, $r = -.13$ for the Negative and $r = -.18$ for the General Psychopathology scales). The authors hypothesized that these low test-retest coefficients were a result of changes in subjects' psychiatric status. The subjects first completed the PANSS when they were in an active phase of their illness, with the second administration occurring during the more chronic or residual stage. Inter-rater reliability was found to be high, with correlations ranging from .83-.87 ($p < .0001$) (Kay, Opler, & Lindenmayer, 1988).

In summary, although inter-rater reliability of the PANSS appears adequate, test-retest reliability is questionable. The results of test-retest reliability in individuals with schizophrenia are inconsistent. This inconsistency may be explained by the variability of symptoms of schizophrenia, as suggested by Lindenmayer and colleagues, however due to the small sample size in two of three studies results should be interpreted cautiously.

Kay, Fiszbein, and Opler (1986) examined construct validity of the PANSS with 101 individuals with schizophrenia. Results indicated a modest correlation between the Positive Symptom and Negative Symptom subscales ($r = .27$, $p < .01$). Once the items from the two scales sharing a common association with the General Psychopathology scale were partialled out, an inverse correlation was found ($r = -.23$, $p < .001$). Kay and Singh (1989) examined construct validity with 62 individuals with schizophrenia in an inpatient setting, the initial correlation was $r = .52$, $p < .001$. However, when these same individuals were tested when not on medication the correlation was negligible ($r = .06$,

ns). These findings indicate that the positive and negative subscales represent two separate constructs. Studies examining criterion-related validity of the PANSS revealed a significant inverse relationship between items on the positive and negative subscales (Lindenmayer et al., 1984).

The PANSS has also demonstrated a strong correlation between the Scale for the Assessment of Positive Symptoms (SAPS), Scale for the Assessment of Negative Symptoms (SANS) and the Clinical Global Impressions Scale (CGI). The Positive Symptom subscale was significantly correlated with the SAPS ($r = .77, p < .001$), the Negative Symptom subscale was significantly correlated with the SANS ($r = .77, p < .001$), and the General Psychopathology scale was significantly correlated with the CGI ($r = .52, p < .001$). A study by Ramirez (1989) yielded similar results with significant correlations between the positive symptom subscale and the SAPS, and the negative symptom subscale and the SANS.

In general, the PANSS demonstrates good internal consistency and inter-rater reliability. Furthermore, construct validity studies support that the positive and negative subscales represent two separate constructs that demonstrate good criterion-related validity with the SAPS and the SANS. Based on the results of these studies and the purpose of this study it was determined this would be an appropriate instrument to be used to identify individuals demonstrating positive versus negative symptoms of schizophrenia. Although test-retest reliability is questionable, the current study was a cross-sectional design with participants only being assessed at one period of time, therefore this was not a concern.

According to Kay et al. (2006), individuals administering the PANSS should have a basic understanding of psychological testing and interpretation. It should be administered by trained mental health professionals who have experience working with and interviewing individuals with schizophrenia. Formal training beyond reading the manual is not required to administer this assessment. (See Appendix B for sample questions from this instrument).

The Adolescent/Adult Sensory Profile

The A/ASP (Brown & Dunn, 2002) is a 60-item self-administered questionnaire that provides an overall understanding of the sensory processing of an individual. The individual is asked to check the box that reflects the frequency of responses to everyday sensory experiences (Almost Never, Seldom, Occasionally, Frequently, or Almost Always). For individuals who are unable to complete the assessment independently, it is recommended that the assessment administrator read each item and record the individual's response. In scoring the assessment, Almost Never = 1 point, Seldom = 2 points, Occasionally = 3 points, Frequently = 4 points and Almost Always = 5 points. Following completion of the questionnaire, the test administrator completes a Quadrant Grid that sums the Raw Scores of items related to each of the four defined quadrants: low registration, sensation seeking, sensory sensitivity, or sensation avoiding. These scores are then transferred to the Quadrant Summary Chart to determine the individual's sensory processing preferences.

The A/ASP demonstrates good internal consistency for each sensory processing quadrant, with coefficient alpha values ranging from .64 to .78 (Brown & Dunn, 2002).

A factor analysis supported the four-factor structure (Brown, et al., 2002). Several items on the sensory sensitivity and sensation avoiding factors cross-loaded and were re-written to more intentionally reflect the factor for which they were intended. Test-retest was not reported.

Content validity was deemed good, based on collection of pilot data and review by an expert panel (Brown & Dunn, 2002). The panel accurately sorted each item of the instrument into the appropriate sensory processing quadrants following the revision of one item. Convergent validity was assessed by comparing scores on the A/ASP with scores on the New York Longitudinal Scales (NYSL) Adult Temperament Questionnaire (Chess & Thomas, 1998). Correlations between subscales on the two instruments were moderate (.30 and above, $1 < .001$) (Brown & Dunn).

Evidence of construct validity was found when responses on the A/ASP were compared with skin-conductance responses (Brown et al., 2001). This study was conducted with 20 occupational therapy students selected from a group who had previously completed the A/ASP. A one-way analysis of variance (ANOVA) and follow-up tests revealed a significant difference between the four quadrants in responsivity ($F(3,17) = 8.28, p = .001$), with the sensory sensitivity and sensation avoiding groups being more responsive than the low registration and sensation seeking groups. There was also a significant between-group difference in habituation ($F(3,17) = 46.85, p < .001$), with sensory sensitivity and sensation seeking groups taking longer to habituate than the low registration and sensation avoiding groups. As with the PANSS no formal training is required to administer the A/ASP. .

Procedures

Recruitment at C4 consisted of posting flyers containing the PI's contact information in the common meeting area at C4. These flyers were also given to staff members. Space was allotted at the bottom of the flyer for interested individuals to put their contact information. Interested individuals were asked to contact the PI by phone or email, or place the completed flyer in an identified study box located in the meeting area at C4. The PI checked the study box weekly to collect sheets placed in the box and contacted those individuals who expressed interest. The PI also attended four community meetings at C4 to explain the study and recruit subjects. Following the meeting, the PI was available to meet with interested individuals to further explain the study and schedule appointments. Recruitment flyers were also given to staff members at RUMC. When the staff member identified an individual who was interested in the study, the staff member telephoned the PI with the individual's contact information and the PI, in turn, contacted the individual to explain the study. (See Appendix c for the narrative explanation provided to potential participants). Following this initial contact, individuals still interested in participating were given an appointment to meet with either the PI or the other study staff member (another occupational therapist). The meeting occurred in a private office at C4 or RUMC.

During the individual meeting, the study staff member assigned to the subject further explained the study, including risks and benefits of participating. Those who were still interested signed the informed consent. The study staff member collected demographic information from the participant and administered the MMSE to assure that

subjects demonstrated adequate cognitive functioning. Those who scored 21 or greater were entered into the study. None of the individuals who expressed interest in the study scored less than 21 (See Appendix D for the Demographic Information Data Collection Sheet).

The study staff member administered the PANSS during this same meeting to those subjects who were admitted into the study. Subjects were then asked to independently complete the A/ASP, with the study staff member available to answer questions and clarify information related to the assessment as needed. Approximately half of the subjects had difficulty completing the assessment independently, so the study staff member read each item and recorded the subject's response, as deemed acceptable by Brown and Dunn (2002). The five possible responses were written on a sheet of paper and given to the subject to use as a reference. At the completion of the two assessments, subjects were given \$25.00 in cash to thank them for their participation. It should be noted that all individuals who expressed interest in the study completed both the PANSS and A/ASP.

Due to privacy and staffing issues, the study staff member was not able to review the subject's medical record at the time of the interview. Therefore the PI met with clinic coordinators at C4 and RUMC at a designated time after the interview to review the medical record to confirm the diagnosis and demographic information. As a result, six of the 40 participants were excluded from the study, because the medical record did not support the diagnosis of schizophrenia or schizoaffective disorder.

Personnel

The PI, an occupational therapist, was responsible for recruiting subjects and was the primary contact for individuals interested in participating. The PI and one other occupational therapist were involved in meeting with subjects to explain the study, obtain informed consent and administer the two assessments. The PI was also responsible for reviewing the medical record to insure inclusion criteria were met.

The PI engaged in the necessary training for administering the three instruments used in this study. Training involved reading the manuals and practice administration on a sample psychiatric population available through the Rush University Medical Center inpatient psychiatric unit prior to the start of the study. The PI then provided training to the other occupational therapist who assisted with conducting the study. The second occupational therapist read the manuals for the PANSS and the A/ASP to become familiar with the assessments. The PI had face-to-face meeting with the second occupational therapist to further explain and answer questions regarding the assessments, as well as the MMSE, as needed. The second occupational therapist practiced administering the assessments to individuals in the mental health setting where she works, prior to the start of the study. Both members of the study staff administered both assessments to six participants from C4 concurrently to assess inter-rater reliability. Following the scoring of the PANSS, the occupational therapists discussed their ratings, the reasoning behind them, and agreed on scoring methods to increase inter-rater reliability. It should be noted that there were few differences between raters at the onset, and consistency increased as they progressed through the six subjects.

Three faculty members from VCU Department of Occupational Therapy served as consultants in the area of mental health and SPD/SMD. A faculty member at Northwestern University provided statistical consultation.

Analysis

Variables

Symptoms of schizophrenia served as the independent variable in this study. These symptoms were defined as the raw scores on the PANSS. Mean scores and standard deviations were used to describe the PANSS subscales, and counts and percentages used to describe the prevalence of positive or negative symptoms.

Patterns of SMD were the dependent variables. The patterns of SMD were defined as the raw scores for the four quadrants of the A/ASP: low registration, sensation seeking, sensory sensitivity, and sensation avoiding. Mean scores and standard deviations were used to describe the A/ASP quadrants.

Co-variables were the demographic information that was collected. Age was represented by mean age and standard deviation. Frequency and percentages were used to describe the remaining categorical data, such as disease duration, and number of hospitalizations. It should be noted that disease duration was transformed from continuous to categorical data due to the subjects' inability to provide exact information regarding when they were first diagnosed with schizophrenia or schizoaffective disorder. The categories were defined as less than or equal to 25 years and greater than 25 years.

Data Analysis

The potential association between symptoms of schizophrenia and patterns of SMD was examined using a Spearman's rank correlation coefficient. Significant correlations were followed up with a series of Mann Whitney U and Kruskal Wallis tests to explore if there were significant differences in response between positive and negative symptoms based on categorical demographic data.

Stepwise regression was used to determine if positive and/or negative symptoms reliably predicted an associated pattern of SMD. Demographic covariates were entered to see if they added to the variance and predictability of the positive and negative symptoms in the associated pattern of SMD. Multiple regression was used to examine the relationship between selected demographic variables and positive symptoms on patterns of SMD.

Missing Data

In six instances, subjects were missing a single item from the A/ASP. This missing data was handled by using the mean scores from answered questions within the same quadrant for that subject.

CHAPTER 4: RESULTS

Demographics

Of the 34 subjects included in the analysis, 59% were diagnosed with schizophrenia and 41% with schizoaffective disorder. The mean age was 49 years, and 56% of the subjects were first diagnosed with schizophrenia/schizoaffective disorder over 25 years ago; 56% were male and 44% female. African Americans and Caucasians were the only races accounted for in this study, and subjects were evenly split between the two. Ethnicity was predominantly Non-Hispanic/Non-Latino (88%). Eighty-two percent of the subjects were unemployed. Overall there were 13 different antipsychotic medication combinations. Twelve percent of the subjects were not on any antipsychotic medication, while 73% were on only one medication, the most common being Clozaril. The remaining 15% of subjects were on two different antipsychotic medications. A summary of demographic information can be found in Table 1.

The composite score of the PANSS indicated that, although subjects reported experiencing both positive and negative symptoms of schizophrenia, they primarily experienced negative symptoms. Further examination indicated that 9% of the subjects experienced primarily positive symptoms, 74% primarily negative symptoms, and 18% mixed symptoms. Raw mean scores for the PANSS can be found in Table 2.

Table 1. Demographics

	Mean (SD)	n (%)
Age (yr)	49.12 (9.45)	
Gender		
Male		19 (55.9)
Female		15 (44.1)
Race		
African American		17 (50)
Caucasian		17 (50)
Ethnicity		
Hispanic/Latino		4 (11.8)
Non-Hispanic/Non-Latino		30 (88.2)
Diagnosis		
Schizophrenia		20 (58.8)
Schizoaffective Disorder		14 (41.2)
Employment Status		
Employed		6 (17.6)
Unemployed		28 (82.4)
Education		
High School Graduate or Below		20 (58.8)
Some College or College Graduate		13 (38.2)
GED		1 (2.9)
Years Since Diagnosis		
≤ 25		15 (44.1)
> 25		19 (55.9)
Number of Antipsychotic Medications		
No Medication		4 (11.8)
Single Medication		25 (73.5)
Multiple Medications		5 (14.7)

(n = 34)

Table 2. Positive and Negative Syndrome Scale Mean Scores

	Mean (SD)	n (%)
PANNS		
Composite	-4.82 (6.7)	
Positive Subscale	12.68 (4.6)	7 (20.6)
Negative Subscale	17.50 (5.2)	25 (73.5)
Mixed	0.0	2 (5.9)

(n = 34)

The raw mean scores for the A/ASP can be found in Table 3. These scores indicate that scores for all subjects were similar to most people in all quadrants except low registration, which was more or much more than most people. Subjects with primarily positive symptoms scored more than most people in all quadrants except

Table 3. Adolescent/Adult Sensory Profile Mean Scores

	Low Registration	Sensation Seeking	Sensory Sensitivity	Sensation Avoiding
All Subjects (N = 34)	38.26 (9.4)	45.29 (7.6)	38.82 (7.7)	41.12 (6.8)
Positive Symptoms (N = 7)	45.00 (5.4)	47.00 (7.7)	43.86 (5.4)	42.86 (8.4)
Negative Symptoms (N = 25)	36.72 (9.5)	45.24 (7.8)	37.48 (7.4)	41.00 (6.3)
Mixed Symptoms (N = 2)	34.00 (12.7)	40.00 (7.1)	38.00 (15.6)	36.50 (7.8)

(n = 34)

sensation seeking, which was similar to most people. Those with primarily negative symptoms scored similar to most people in all quadrants except Low Registration, which was more than most people. It should be noted that one participant was over 65 years old. This was taken into account when analyzing the quadrant summary. A complete summary of the frequency of A/ASP quadrant scores can be found in Table 4.

Table 4. Adolescent/Adult Sensory Profile Quadrant Frequencies (n = 34)

	All Subject (N = 34)	Positive Symptoms (N = 7)	Negative Symptoms (N = 25)	Mixed Symptoms (N = 2)
Low Registration				
Much Less than Most People	0%	0%	0	0%
Less than Most People	6%	0%	8%	0%
Similar to Most People	27%	0%	32%	50%
More than Most People	38%	43%	36%	50%
Much More than Most People	29%	57%	24%	0%
Sensation Seeking				
Much Less than Most People	15%	14%	12%	50%
Less than Most People	21%	14%	24%	0%
Similar to Most People	59%	72%	56%	50%
More than Most People	6%	0%	8%	0%
Much More than Most People	0%	0%	0%	0%
Sensory Sensitivity				
Much Less than Most People	0%	0%	0%	0%
Less than Most People	3%	0%	4%	0%
Similar to Most People	65%	57%	68%	50%
More than Most People	21%	14%	24%	0%
Much More than Most People	12%	29%	4%	50%
Sensation Avoiding				
Much Less than Most People	0%	0%	0%	0%
Less than Most People	3%	0%	4%	0%
Similar to Most People	47%	57%	44%	50%
More than Most People	38%	14%	44%	50%
Much More than Most People	12%	29%	8%	0%

(n = 34)

Relationship of Symptoms to Sensory Processing Preferences

Spearman's correlation coefficient was used to examine the relationship between positive and negative symptoms of schizophrenia, the composite score of the PANSS, the four quadrants of the A/ASP, age, MMSE score, and years since diagnosis (See Table 5). There were significant positive correlations between the positive symptom subscale of the PANSS and the Low Registration and Sensory Sensitivity Quadrants of the A/ASP, $r_s = .540$ ($p < .001$) and $r_s = .355$ ($p = .02$), respectively. The PANSS composite score demonstrated significant positive correlations with the Low Registration ($r_s = .492$, $p = .003$), Sensory Sensitivity ($r_s = .381$, $p = .026$), and positive symptom subscale of the PANSS ($r_s = .550$, $p < .001$), and the MMSE ($r_s = .343$, $p = .047$). Significant positive correlations were also noted between the Low Registration Quadrant and the Sensory Sensitivity and Sensation Avoiding Quadrants, $r_s = .752$ ($p < .001$) and $r_s = .478$ ($p = .002$), respectively. There were no significant positive correlations between demographic data (age, MMSE, years since diagnosis, and education) and the four quadrants.

Significant negative correlations were found between age and positive symptoms of the PANSS, and negative symptoms of the PANSS and MMSE scores, $r_s = -.305$, $p = .04$ and $r_s = -.341$, $p = .024$, respectively. There was also a significant negative correlation between the PANSS composite score and negative symptom subscale of the PANSS ($-.753$, $p < .001$), meaning that as PANSS composite scores reflect primarily positive symptoms, there is a coinciding decrease in negative symptom scores.

Table 5. Spearman Correlations between patterns of SMD and symptom severity

	Low Registration	Sensation Seeking	Sensory Sensitivity	Sensation Avoiding
Low Registration	--			
Sensation Seeking	.208	--		
Sensory Sensitivity	.752**	.142	--	
Sensation Avoiding	.478**	.100	.562**	--
PANSS +	.540**	.030	.355*	.125
PANSS -	-.186	-.172	-.192	-.052
PANSS Composite	.492	.174	.381*	.059

(n = 34)

Mann Whitney and Kruskal-Wallis tests were run to determine if there were significant differences in Low Registration and Sensory Sensitivity scores when considering diagnosis, data collection site, interviewer, gender, race, medication, and education. The only significant difference was found in the Sensory Sensitivity Quadrant when considering race with African Americans having significantly higher scores than Caucasians (41 and 38, respectively, $p = .035$).

Predictability of Positive Symptoms of Schizophrenia

A stepwise regression analysis model using forward selection was fit to examine if positive symptoms of schizophrenia predicted Low Registration and Sensory Sensitivity Quadrant scores of the A/ASP. The demographic factors of MMSE scores, age, education, years since diagnosis, number of medications, site, race, and gender were included in the analysis to determine if the addition of these factors improved prediction of Low Registration and Sensory Sensitivity scores. Education and years since diagnosis were transformed into categorical data for the regression analysis.

Low Registration

Table 6 contains the estimated coefficients for the regression model examining if positive symptoms of schizophrenia predict Low Registration Quadrant scores. Positive symptoms was the only variable that contributed significantly to prediction of Low Registration scores, $F(1,32) = 9.331$, $p = .005$. The bivariate correlation for positive symptoms was .47, accounting for 20% of variance in Low Registration Quadrant scores. The demographic variables did not reliably improve R^2 and were not included in the prediction model.

Table 6. Low Registration Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	25.873	4.306		6.009	.000
PANSS +	.978	.320	.475	3.055	.005

Dependent Variable: Low Registration
n = 34

Sensory Sensitivity

A second stepwise linear regression model was fit to determine if positive symptoms of schizophrenia predict Sensory Sensitivity Quadrant scores. The estimated coefficients are found in Table 7. After adding race and gender to the positive symptom variable, the predictability of the model improved. The model with positive symptoms alone accounted for only 6.7% the variability in Sensory Sensitivity, whereas the the model with positive symptoms, race, and gender accounted for 31.6% of variability in Sensory Sensitivity Quadrant scores.

Table 7. Sensory Sensitivity Coefficients

Model	Unstandardized Coefficients		Standardized Coefficients	T	Sig.
	B	Std. Error	Beta		
1 (Constant)	33.322	3.864		8.624	.000
PANNS +	.434	.287	.258	1.511	.141
2 (Constant)	35.661	3.807		9.368	.000
PANSS +	.461	.272	.274	1.696	.100
Race	-5.366	2.452	-.354	-2.189	.036
3 (Constant)	32.079	3.875		8.279	.000
PANSS +	.567	.258	.337	2.197	.036
Race	-5.733	2.298	-.378	-2.495	.018
Gender	5.484	2.346	.359	2.337	.026

a. Dependent Variable: Sensory Sensitivity
n = 34

Since we did not initially determine a relationship between gender and Sensory Sensitivity, we further explored the relationship between race, gender, and positive symptoms on Sensory Sensitivity (Table 8). We examined interactions between gender and positive symptoms, and race and positive symptoms in multiple regression models. There was no evidence of an interaction between race and positive symptoms on Sensory Sensitivity ($p=0.752$), suggesting that there is a positive relationship between positive symptoms and Sensory Sensitivity that does not vary by race. Although there was no statistical evidence of an interaction between gender and positive symptoms on sensory sensitivity ($p=0.182$), the coefficient of the interaction was larger in magnitude (-0.876) than the coefficient for positive symptoms (0.742). This may suggest that the positive relationship between positive symptoms and Sensory Sensitivity may only be true for males, whereas there is no relationship between positive symptoms and Sensory

Table 8. Coefficients (p-values) of models with interactions with positive symptoms

Predictors	Model 1	Model 2
Intercept	33.679 (<0.001)	29.86 (<0.001)
PANSS+	0.439 (0.369)	0.742 (0.014)
Gender	5.497 (0.028)	16.104 (0.056)
Race	-8.021 (0.296)	-5.966 (0.014)
Race*PANSS+	0.182 (0.752)	---
Gender*PANSS+	---	-0.876 (0.182)

(n = 34)

Sensitivity for females (See Figure 2). Unfortunately, our sample size was too small to determine if, this is in fact, true.

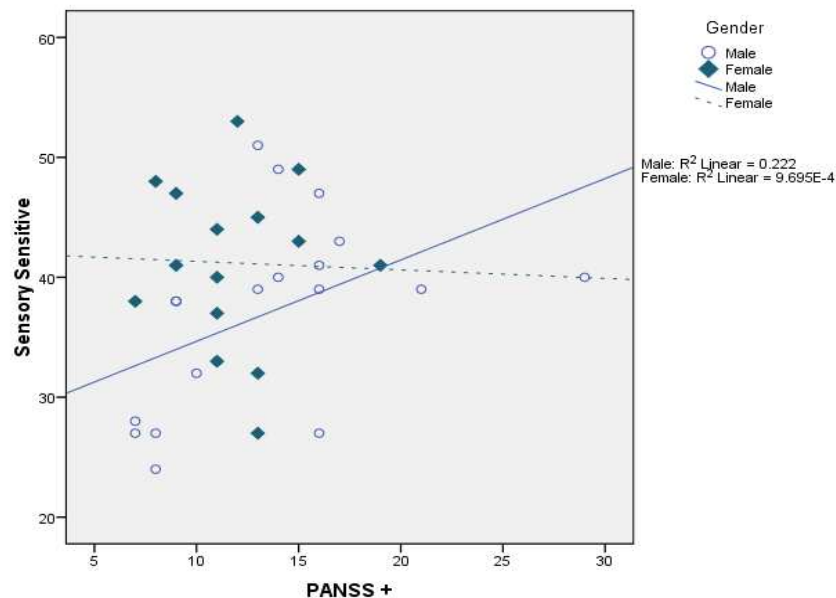


Figure 2. Interaction between positive symptoms, sensory sensitivity and gender

Predictability of Negative Symptoms of Schizophrenia

Although univariate analyses failed to detect any relationship between negative symptoms of schizophrenia and either Low Registration or Sensation Avoidant Quadrant Scores, multiple regression models using a stepwise approach were fit. None of the

demographic variables of age, MMSE scores, years since diagnosis, education, medication, site, race and gender improved the predictability of these quadrant scores.

Power Analysis

While non-parametric analyses were used, power calculations were run for parametric analyses due to the complexity of non-parametric power calculations (Power analysis and sample size software program [PASS], 2000). The power analysis was run on the anticipated recruitment of 50 subjects. The analysis indicated that 50 subjects provided 80% power to detect a Pearson's correlation coefficient of 0.61 with an alpha-level = .05 to control for Type I error. For t-tests with equal group allocation, 50 subjects would have the power to detect a moderate to large effect size of 0.80.

CHAPTER 5: DISCUSSION

Although the majority of subjects demonstrated both positive and negative symptoms of schizophrenia, not surprisingly, subjects as a whole demonstrated primarily negative symptoms. It was expected that most individuals being treated in an outpatient setting would be in the residual phase of their illness, the hallmark of this phase being the presence of negative symptoms (APA, 2000; Bonder, 2010; Cara & MaCrae, 2004). It was also expected that individuals who were demonstrating primarily positive symptoms would be more hesitant to participate due to increased symptoms of paranoia and/or disorganization (APA). Also, as individuals with schizophrenia age they tend to have decreased episodes of positive symptoms (APA; Buchanan & Carpenter, 2005). Since the average age of subjects in this study was 49, it would be expected that there would be a decrease in positive symptoms. This is further supported by the negative correlation that was found between positive symptoms and age in this study. However, these findings should be interpreted with caution, due to the small sample size of individuals with positive symptoms.

The A/ASP scores for all subjects in this study were similar to most people with the exception of the low registration quadrant, which was more than most people. Although this was similar to Brown et al.'s (2002) findings, it was somewhat surprising.

Based on the increased use of sensory approaches for intervention in mental health settings and behavioral observations, it was anticipated that subjects would demonstrate scores that were more extreme and/or different from the similar to most people classification in all areas but sensation seeking (Champagne & Stromberg, 2004; Costa et al., 2006; Hope, 1997; Knight, Adkinson, Kovach, 2010).

The aim of this study was to examine differences in sensory modulation patterns based on the presence of primarily positive or negative symptoms. The findings indicated that subjects with positive symptoms demonstrated scores that were more or much more than most in all quadrants except sensation seeking. Those with negative symptoms scored similar to most in all quadrants except low registration, in which they scored much more than most. These findings were expected, as individuals who are in the active phase of schizophrenia, experiencing primarily positive symptoms tend to be more disorganized, anxious, and distracted. These behaviors are more congruent with what is seen in individuals demonstrating higher scores in the sensory sensitivity quadrant. On the other hand, individuals in the residual phase, demonstrating primarily negative symptoms, present as more withdrawn, less motivated and less engaged in activities or social relationships, similar to behaviors observed in individuals with higher scores in low registration. Scores of similar to most in the sensation avoiding quadrant in individuals with primarily negative symptoms was unanticipated. Based on the research of Brown et al. (2002) and Buchanan and Carpenter (2005), it was expected that these scores would be more or much more than most. The similar to most scores in the

sensation seeking quadrant in individuals with both positive and negative symptoms was also unexpected. Based on the work of Brown et al. and behavioral observations in these individuals, scores suggesting less or much less than most were anticipated.

Relationship Between Schizophrenia and SMD

Results of the Spearman's correlation coefficient indicate a significant positive relationship between positive symptoms of schizophrenia and the sensory sensitivity and low registration quadrants of the A/ASP. This supports the hypothesis of a positive association between positive symptoms of schizophrenia and the sensory sensitivity quadrant of the A/ASP.

Mann Whitney and Kruskal Wallis analyses were run to determine if there were significant differences in these two quadrants based on demographic information. The results revealed a significant difference in sensory sensitivity scores based on race, with African Americans scoring higher. This difference was not anticipated. A review of the literature yielded no studies examining racial differences in sensory modulation in individuals with schizophrenia. However, a review of the schizophrenia literature provided information that may explain this finding. Research results have found a higher prevalence of schizophrenia in African Americans than Caucasians (Flaskerud & Hu, 1992; Lawson, Hepler, Holladay, & Cuffel, 1994). In fact, it has been estimated that African Americans are five times more likely to be diagnosed with schizophrenia compared to Caucasians (Strakowski et al., 1996). Furthermore, it has been suggested that African Americans receive less consistent treatment for schizophrenia compared to

Caucasians. Therefore, it is possible that positive symptoms are less controlled in this population.

Results of several studies indicate that African Americans demonstrate an increased use of emergency department and inpatient treatment and decreased access to or follow-up with outpatient treatment recommendations (Barnes, 2008; Barrio et al. 2003; Horvitz-Lennon, McGuire, Alegria, & Frank, 2009; and Wang, Demler, & Kessler, 2002). Additionally, the increased use of atypical antipsychotic medication in current mental health treatment may also contribute to the potential for decreased control of positive symptoms. African Americans demonstrate higher use of injectable antipsychotics due to decreased compliance with oral medication, however Buchanan and Carpenter (2005) state that the option of injectable medications are limited with current atypical antipsychotics (Kreyenbuhl, Zito, Buchanan, Soeken, & Lehman, 2003; Kuno & Rothbard, 2002). The combination of decreased compliance with oral medications and unavailability of injectable medication results in African Americans not receiving the medication necessary to control symptoms of schizophrenia. It is possible that if African Americans are experiencing an increase in positive symptoms that there would be a correlated increase in sensory sensitivity scores as well. Given the small sample of subjects with positive symptoms, these results should be interpreted cautiously. However further study is recommended, as it may provide increased insight into what may be contributing to an individual's agitation, disorganization, etc., as well as less intrusive interventions that may decrease the need for inpatient hospitalization.

Although the positive relationship between positive symptoms and low registration scores was not anticipated, it is intriguing. This relationship may provide some interesting parallels into why people with schizophrenia experience psychotic symptoms. Individuals who score higher in the low registration quadrant require more intense sensory input in order for it to be perceived and registered. Therefore, these individuals may not be processing available sensation, which may result in some level of sensory deprivation. Previous study results suggest that when mentally healthy individuals are deprived of sensory input they have difficulty discriminating between their inner thoughts and external events, thereby creating abnormal perceptual experiences such as hallucinations and delusions (Bentall, 1990; McCreery & Claridge, 1996). Mason and Brady (2009) found that even after a brief period of sensory deprivation individuals prone to psychosis had increased hallucinations and paranoia and even those who were not prone to psychosis still reported distortions in thinking. Although findings of this study should be interpreted cautiously due to the limited number of subjects, it is something that should be explored further.

Given the similarity of behaviors such as withdrawal, decreased social interaction, and avolition associated with both negative symptoms and low registration, it was hypothesized that there would be a positive correlation between these two variables. However, results of the study did not support this hypothesis. Not only was the correlation not significant, but directionality was opposite of what had been hypothesized suggesting that as negative symptoms increased low registration scores decreased. This is interesting because 60% of subjects with negative symptoms scored more or much

more than most and only 8% scored less than most. Based on the results of the correlation, scores in this quadrant would have been expected. The correlation coefficient was -0.186 indicating that there was virtually no relationship between these two variables and no conclusions can be made related to their relationship. It is unclear why these results occurred and further research is recommended to examine this relationship.

The hypothesized positive association between negative symptoms and the sensation avoiding quadrant was also not supported. Similar to the previous hypothesis, there was a non-significant negative relationship between negative symptoms and sensation avoiding. Rationale for this hypothesis was based on the findings of studies by Brown et al. (2002) and Thoma et al. (2005). These previous findings suggested that although individuals with negative symptoms demonstrated low neurological thresholds, their behavioral response was active and they engaged in activities and environments that limited sensory input. However, the results of this study do not support the findings of these previous studies and imply that observable behaviors associated with negative symptoms are more passive with individuals demonstrating decreased actions to modify activities and their environment.

Finally, the hypothesis related to a negative association between positive and negative symptoms of schizophrenia and the sensory seeking quadrant was not supported. There were no significant relationships, and like the results above, negative symptoms were negatively correlated to sensory seeking scores, while positive symptoms were positively correlated. The positive relationship between positive symptoms and sensory seeking brings into question the inclusion of the diagnosis of schizoaffective disorder.

Although this study did not explore the affective symptoms related to schizoaffective disorder, symptoms of mania and/or depression that are included in the diagnostic criteria for this disorder should be considered. Individuals with mania present with more energy and increased engagement in activities, while those with depression demonstrate the opposite, decreased energy and involvement in activities (APA, 2000; Cara & MacRae, 2005; Bonder, 2010). Is it possible that the behaviors associated with affective disorders influenced behaviors measured by the A/ASP in the population studied? This should be considered in future studies.

The fact that significant relationships were only found between positive symptoms of schizophrenia and patterns of sensory modulation suggests that SMD may be related to psychosis in general and not schizophrenia in particular. In electrophysiological studies, sensory gating deficits have been found, not only in individuals diagnosed with schizophrenia but in those diagnosed with bipolar disorder who were currently experiencing or had a history of psychosis as well (Olinicy & Martin, 2005; Sanchez-Morla et al., 2007). Additionally, Adler et al. (1990) and Perry et al. (2001) found evidence of the presence of sensory gating deficits in individuals experiencing a psychotic episode related to bipolar disorder, although the deficits were transient, diminishing as the psychotic episode remitted.

The relationship between positive symptoms and the low registration and sensory sensitivity quadrants, which are both associated with behavioral passivity. This suggests that individuals with schizophrenia do not actively modify their environment, or behavior to increase or decrease sensory input. This raises the question as to whether it is possible

that neurological threshold is impaired and the low registration and sensory sensitivity quadrants represent a dichotomy similar to symptoms of depression related to sleep or appetite. In the general population, individuals with depression may experience disruption in sleep but the response represents two ends of the continuum, too much or too little sleep. Individuals with depression also tend to overeat or report decreased appetite. It might be possible, in individuals with schizophrenia that impairment in their neurological threshold may present as low registration (decreased responsiveness to input) or sensory sensitivity (increased responsiveness to input). Electrophysiological studies support the notion of neurological threshold impairment. Results of sensory gating, sensory registration, and electrodermal response studies demonstrate impairment within the CNS, but there are inconsistencies in how these impairments manifest, for instance results of EEG, EMG, and SCR demonstrate overresponsiveness to stimuli while others demonstrate underresponsiveness (Dawson & Schell, 2002; Duncan et al., 2006; Kirihara et al, 2005; Kumari et al., 2004; Mathalon et al., 2000; Potter et al, 2006; St. Clair et al., 1989; Swerdlow et al, 2006). The concept of a continuum of responses may continue to help uncover these relationships and responses. However, as mentioned previously, these results must be interpreted cautiously due to the very small sample size.

It is also interesting to consider the effects of medication on the behaviors of SMD in this population. Although the results of electrophysiological studies examining the effects of medication on sensory gating, registration and EDR are inconclusive, it may be that medication does not address the CNS impairment, but does address and control behaviors related to these impairments (Duncan et al., 2006; Light et al., 2000;

Potter et al., 2006; Quednow et al., 2006; Wynn et al., 2007). Atypical antipsychotics have been found to be more effective controlling negative than positive symptoms (Sadock & Sadock, 2010). Since all but one of the 34 subjects in this study were currently on one or more atypical antipsychotic, it is possible that these medications controlled not only negative symptoms but behaviors that would reflect deficits in sensory modulation as well. Further studies examining the relationship between negative symptoms of schizophrenia and behaviors of SMD specific to the effects of medication are recommended to better understand this relationship.

Several other significant unanticipated relationships were discovered. The first is the positive relationship between the low registration and sensory sensitivity quadrants. There may be several explanations for this. First, Cromwell (1993) suggested that individuals with schizophrenia may experience behaviors of both sensory sensitivity and low registration. She hypothesized that these individuals may need increased intensity of input for it to register, but when it is strong enough, it may be perceived as aversive, and individuals take action to avoid it. Another potential explanation is related to Lane and Royeen's (1991) hypothesis that sensory modulation is circular in nature, and that individuals who demonstrate sensory sensitivity may continue to do so until they reach a level of sensory overload and then shut down. At this point they demonstrate behaviors that are more indicative of low registration. Finally, it is possible that individuals may experience varying levels of sensory responsiveness in different sensory systems. For instance, they may demonstrate sensory sensitivity in the auditory and tactile senses and low registration in the taste and olfactory systems. Examining responses in the varying

sensory systems was not the aim of this study but an area that should be explored further in future studies in individuals with schizophrenia.

The positive relationship between low registration and sensation avoiding was surprising because low registration is a high threshold, passive behavioral response while sensation avoiding is the opposite, low threshold, active behavioral response. Both Brown et al. (2002) and Buchanan and Carpenter (2005) suggest that the distress caused by positive symptoms often leads people to develop strategies to withdraw and limit sensory input. Given the relationship that was found between low registration and positive symptoms and the possibility that the perceived sensory deprivation may increase perceptual abnormalities, it was initially thought that these individuals may also engage in behaviors to limit sensory exposure and distress caused by the positive symptoms. However, the findings of this study do not support this suggestion as there was no significant relationship between positive symptoms and sensation avoiding. Further studies exploring this relationship are warranted to further explain these findings.

Finally, the negative relationship between negative symptoms and MMSE scores indicates that the higher the negative symptom score, the lower the MMSE score. Given the average age of participants this finding makes sense. Research findings demonstrate that, although the presence of positive symptoms diminish as the individual ages and the disorder progresses, the functional deficits, including cognitive impairments that occur early in the disease process are rarely overcome (Buchanan and Carpenter, 2005; Fiorvanti, Carlone, Vitale, Cinti, & Clare, 2005; van Os & Kapur, 2009).

Predictability of Symptoms of Schizophrenia

None of the hypotheses related to predictability of symptoms of schizophrenia and sensory processing preferences were supported by the results of this study. Although there was a significant relationship between positive symptoms and sensory sensitivity, results of the stepwise regression did not support the predictive ability of positive symptoms on this sensory preference. However, race and gender, coupled with positive symptoms were found to be predictive of sensory sensitivity. African American males with positive symptoms were more likely to demonstrate behaviors of sensory sensitivity. This makes sense based on the findings of the relationship between positive symptoms and race. It is less clear how gender plays into this equation. The findings suggest that being male is a stronger predictor of sensory sensitivity and account for 31.6% of the variance of sensory sensitivity scores when coupled with positive symptoms and race. Although men are more likely to have schizophrenia, are diagnosed earlier, and have a poorer prognosis, they tend to demonstrate more negative symptoms of the disorder (APA, 2000). This becomes more interesting in the follow-up analysis of interactions between positive symptoms and race and gender. The results indicate no variation of the relationship of positive symptoms and sensory sensitivity by race. Even though there was no significant relationship, the results suggest the possibility that positive symptoms only predict sensory sensitivity in men.

Following up on the significant relationship between positive symptoms and low registration, positive symptoms were found to predict higher scores in the low registration quadrant. This is especially important for staff in inpatient settings as they

typically see people with schizophrenia when their positive symptoms have increased. At these times, individuals are often experiencing hallucinations and delusions, which interfere with their ability to safely care for themselves in the community. These symptoms may result in increased violence against self or others, resulting in the need not only for inpatient hospitalization but for the use of seclusion and restraints (S/R) until the individual is deemed safe and able to return to the general inpatient unit (Cleary, Hunt, & Walter, 2010). Ironically, S/R increase isolation and sensory deprivation, potentially increasing psychosis.

These results are timely, as there has been a national call for the elimination of seclusion and restraints (National Association of State Mental Health Program Directors, 2000; United States Department of Health and Human Services, 2003). Although the use of S/R has a positive effect in calming agitated patients, it comes with a cost (Palazzolo, 2004). Many patients report the experience as humiliating, disorienting, frightening and traumatic (Wadeson & Carpenter, 1976). Some patients have reported the occurrence of “comforting” hallucinations that Wadeson and Carpenter suggest are a result of the sensory deprivation that occurs during S/R.

Different interventions have successfully been used as alternatives to S/R. These efforts include, but are not limited to the use of advocacy efforts, state policy changes, and increase in staff-to-patient ratios (Gaskin, Elsom, & Happell, 2007). The Pennsylvania State Hospital System has incorporated the use of Psychiatric Emergency Response Teams to diffuse crisis situations. The goal of this approach is to “bring together a large group of hospital workers to manage a crisis by using conflict resolution,

mediation, therapeutic communication, and violence-prevention skills to diffuse and safely resolve a crisis” (Smith et al., 2005, p. 1119). Environmental modification has also been identified as beneficial in reducing S/R (Donovan, Siegel, Zera, Plant, & Martin, 2003; Fisher, 2003; Greene, Ablon, & Martin, 2006; Regan, Curtin, & Vorderer, 2006; Taxis, 2002).

Related to environmental modification is the use of multi-sensory interventions, such as sensory rooms, as an alternative to S/R. The National Executive Training Institute (2003) has been a strong proponent of incorporating sensory-based interventions to create a more healing environment in acute psychiatric settings. Champagne (2006, 2008, 2010) has also advocated for the incorporation of interdisciplinary education on sensory modulation disorder and incorporation of sensory modulation interventions to address agitation in psychiatric patients. Champagne and Stromberg’s (2004) quality improvement study exploring the use of a sensory room as an alternative for seclusion and restraints supports the use of a nurturing environment. Sensory rooms can provide a variety of interventions that both calm and alert different senses. In this study, 89 percent of patients who used the sensory room reported benefits and there was a 54 percent decrease in the use of seclusion and restraints during a one-year period. Based on the work of Champagne and others sensory interventions have become an integral strategy in the State of Massachusetts’s S/R reduction initiative (LeBel & Champagne, 2010).

The results of this current study suggest the presence of sensory modulation abnormalities in individuals with schizophrenia and provide foundational information on sensory-based interventions that would be beneficial as an alternative to S/R.

Surprisingly, not only does it support the use of calming activities, but based on the predictive ability of positive symptoms on low registration scores, activities that alert the sensory system at times are also essential in addressing patient behavior at times of psychiatric crisis.

Limitations

Several limitations need to be considered in this study, the first being the limited number of subjects that were enrolled. Although the goal was 50 subjects, only 40 were enrolled, and of those 40, six were excluded because they did not meet the inclusion criteria. Therefore, it is recognized that the study was under-powered.

It is also acknowledged that the convenience sample may have produced a selection bias because the individuals who volunteered to participate may have been different from those who did not (Polit & Beck, 2004). This strategy was used due to paranoia that often accompanies schizophrenia. There was concern that the use of other sampling strategies may have increased paranoia and negatively impacted recruitment strategies and overall client well-being.

The use of the \$25.00 financial incentive, thanking them for their participation is also a concern. The merit of this approach is the convenience of recruiting subjects. The subjects included in this study all reported limited incomes, with many reliant on government entitlements. As a result, subjects participation may have been more focused on the financial incentive and not on contributing to the study and may limit the generalizability of results, as these subjects may not be reflective of the schizophrenic population as a whole.

Another concern is the use of the A/ASP and its ability to pick-up more subtle differences in an individual's response to sensory stimuli. Currently it is the only adult measure available that explores both over and underresponsiveness and was determined to be the best choice for this study. There is however, some concern regarding the individual's ability to attend to all 60 statements and reliably respond using the 5-point scale. The instrument may be too long and the 5-point scale too difficult for these patients to effectively interpret. The use of negatively worded statements may have confused individuals resulting in non-accurate responses. For example, subjects frequently needed clarification on statements such as, "I don't seem to notice when my face or hands are dirty. Or, I don't notice when my name is called." Furthermore, reliability and validity studies were completed on those without a diagnosis of mental illness and it is possible that the instrument is not reliable and valid for this population. Furthermore, this instrument was administered following the PANSS, and it is possible that subjects were unable to attend adequately to both instruments during one meeting due to testing fatigue.

Finally, numerous statistical analyses were used, increasing risk of Type I error. All of these limitations indicate that the results should be interpreted cautiously and further research is needed to further understand the relationship between behaviors of SMD and schizophrenia.

Future Studies

Larger studies including more patients and more clinical sites are recommended to determine if these findings can be replicated and generalized beyond the two sites used for this study. Based on the suggestion that SMD may be related to psychosis as opposed

to symptoms of schizophrenia as a whole, it would be important to design research to further examine the difference between individuals with schizophrenia that are experiencing psychosis compared to those who are not.

Additionally, longitudinal studies are needed to explore the stability of sensory processing patterns, especially in individuals who fluctuate between the active and residual phases of schizophrenia. Studies are also recommended to explore the relationship between physiological and behavioral measures, such as the A/ASP.

It would also be important to build on the Brown et al. (2002) study to see if there are differences in sensory processing preferences in individuals with schizophrenia compared to those with other mental health disorders. Given the findings of this study related to positive symptoms, it would be especially important to examine the similarities and differences in individuals experiencing psychosis with other disorders, such as Bipolar Affective Disorder and Depression.

These studies would serve as a foundation to develop and examine the effectiveness of sensory modulation interventions in both inpatient and outpatient settings. These interventions could include the use of a sensory room or sensory diets or general environmental modifications incorporating aspects of both a sensory room and diet. Outcomes of interest in an inpatient setting would be the impact on use of S/R, as well as potential changes in length of stay. Outpatient setting outcomes would be impact on need for re-hospitalization as well as changes in observable behaviors such as anxiety, agitation, withdrawal, anhedonia, and the overall effect on occupational performance.

Conclusions

The results of this study suggest that, although there does not appear to be a relationship between behaviors of schizophrenia and SMD in the schizophrenic population in general, when the differences between positive and negative symptoms are explored a relationship exists. Positive symptoms of schizophrenia correlated with both quadrants related to behavioral passivity, low registration and sensory sensitivity. This suggests that the SMD impairment may be related to the neurological threshold and elicits a dichotomous response between these two quadrants.

The predictive ability of positive symptoms on the low registration quadrant provides a foundation for future intervention planning. As individuals begin to demonstrate increased positive symptoms, introduction of a sensory rich environment and sensory strategies for the individual to engage in outside of the clinic may help circumvent admission to an acute care psychiatric unit. The additional information related to the predictive ability of positive symptoms on sensory sensitivity scores is also important. Positive symptoms, race, and gender have the strongest predictive value on sensory sensitivity scores with a trend towards the interaction of being male with positive symptoms scoring higher in the sensory sensitivity quadrant.

The lack of relationship and predictability between negative symptoms and SMD raised several questions. First, is the relationship that has been hypothesized between schizophrenia and SMD, really a relationship between psychosis and SMD? Second, what is the role of medication in addressing/impacting behaviors of SMD? Although research results regarding the impact of medication on sensory gating, sensory

registration and EDR are inconsistent, it is possible that certain medications are effective controlling behaviors related to the electrophysiological deficits.

Although this study suggests a relationship between behaviors of SMD and symptoms of schizophrenia, it does not assume the co-occurrence of these disorders. It is possible that the behaviors identified by the A/ASP may actually reflect symptoms of schizophrenia or general stress related behaviors not related to SMD. Furthermore, this was a small study and results need to be interpreted cautiously. However, this study does provide a good foundation for future research to explore the relationship between these disorders. It will be important to engage in studies to replicate these findings, explore stability of behaviors of sensory modulation in this population through longitudinal studies, and explore the relationship between the behavioral and CNS levels of sensory modulation. As more knowledge is gained regarding the relationship between schizophrenia and SMD, it will provide clinicians the opportunity to advocate for change in not only occupational therapy interventions but interdisciplinary interventions as well. We can become leaders in providing alternate solutions for seclusion and restraint reduction and identifying sensory interventions that will facilitate successful community re-integration and occupational engagement for individuals with schizophrenia.

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APPENDIX A

Study Flyer

Participants Needed

**SENSORY RESPONSIVITY AND
SCHIZOPHRENIA STUDY**

- Have you ever been diagnosed with either schizophrenia or schizoaffective disorder?
- Are you between 18 and 70 years of age?

If you answered yes to both questions you may qualify for a study examining the relationship between schizophrenia and an individual's response to everyday sensory experiences, also known as sensory modulation.

- Participants will be asked to complete one interview and one written assessment
- Time Requirement: 1-1.5 hour
- In appreciation of your time you will receive up to \$25.00 for participation in this study

For more information, please contact:

Linda Olson, MS, OTR/L

312-942-7109

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OR

- **Fill-out the form below**
- **Drop it in the box identified for Sensory Responsivity and Schizophrenia Study, and**
- **We will contact you**

Sensory Responsivity and Schizophrenia Study
Permission to Contact Form

Please contact me. I am interested in the Sensory Responsivity and Schizophrenia Study.

Name: _____

Phone Number: _____

Email (if you have one): _____

I would like you to contact me by:

APPENDIX B

Positive and Negative Syndrome Scale Sample Questions

Data on Delusions (General) and Unusual Thought Content:

- Some people tell me they believe in the Devil: what do you think?
- Can you read other people's mind?

Data on Hallucinatory Behavior and associated delusions:

- Sometimes people tell me that they can hear noises or voices inside their head that others can't hear. What about you?
- Do you sometimes receive personal communications from the radio or TV?

Data on Grandiosity:

- If you were to compare yourself to the average person, how would you come out: a little better, maybe a little worse, or about the same?
- Do you have special powers?

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APPENDIX C

Explanation of Study to Participants/Potential Participants

The purpose of this research study is to examine if there is a relationship between symptoms of schizophrenia and how you respond to sensory experiences in everyday life. The examination of this relationship will help us get a better understanding of schizophrenia. It will also help us develop treatment activities that will help you function better in the community.

You will be involved in one interview that asks questions about your symptoms and one questionnaire related to how you respond to everyday sensory experiences. The whole session should last between one to one and one-half hours. Your name will not be used to identify you on the interview form or questionnaire. You will not be identified in any way in any oral or written report of this study.

Your participation in this study will not affect your treatment at C4 or Rush University. You may continue in all your other therapies. Twenty-five dollars will be given to people who finish both the interview and the questionnaire. Because this research study is voluntary there is no penalty if you decide not to participate. Also, if you volunteer to participate and then decide to stop before you have completed the interview and/or questionnaire you will not be penalized other than you will not receive the \$25.00 gift card. Do you have any questions?

APPENDIX D

Demographic Information Data Collection Sheet

Client: _____ Age: _____ M _____ F _____

Race: AA/Black _____ Caucasian/White _____ Asian _____ Other _____

Ethnicity: Hispanic/Latino _____ Non-Hispanic/Non-Latino _____

Diagnosis Schizophrenia _____ Schizoaffective _____

Employment Status Employed _____ Unemployed _____

Highest education level: Some Grade School _____ Grade School Graduate _____
 Some HS _____ HS Graduate _____ Some College _____
 College Grad _____ Some Grad School _____
 Grad School Graduate _____

Number of years since onset of schizophrenia/schizoaffective disorder? _____

Number of hospitalizations since onset of disorder: _____

Antipsychotic Medication Type & Dosage:
 List All: _____

Other psychiatric diagnoses: _____

Concurrent psychiatric treatments/interventions: _____

VITA

Linda Marie Olson was born on September 8, 1958, in Elgin, Illinois, and is an American citizen. She graduated from Prospect High School, Mt. Prospect, Illinois in 1976. She received her Bachelor of Science in Business from Eastern Illinois University, Charleston, Illinois in 1980. Following her graduation, she worked for the A.C. Nielsen Company from 1980 to 1985, prior to returning to school to pursue a degree in occupational therapy. She received her Bachelor of Science in Occupational Therapy in 1987 and Master of Science in Occupational Therapy in 1998, both from the University of Illinois at Chicago in Chicago, Illinois. Since receiving her degree in occupational therapy she worked at Northwestern Memorial Hospital from 1987 to 1993 and University of Illinois at Chicago Medical Center from 1993 to 2001. Since 2001 she has worked as an assistant professor at Rush University.

