Association Between Sensory Responsiveness and Attachment Style in College Students with and Without ADHD

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A Senior Thesis submitted in partial fulfillment
of the requirements for graduation
in the Honors Program
Liberty University
Spring 2016

Acceptance of Senior Honors Thesis

This Senior Honors Thesis is accepted in partial fulfillment of the requirements for graduation from the Honors Program of Liberty University.

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Abstract

The purpose of this study was to explore possible correlations between overall sensory processing responsivity and relationship attachment, as well as between sensory subscales and relationship attachment. It also tested for a difference between sensory processing patterns among young adults with and without ADHD. The sample included 370 college students: 32 who had received an ADHD diagnosis and 338 who had not. Participants completed an online self-report survey made up of various demographics questions, the Sensory Processing Quotient (SPQ), and the Experiences in Close Relationships – General/Global Scale (ECR-General). A significant correlation was discovered between general SPQ scores and relationship anxiety (r = -.119, p = .023). Significant correlations were also evident between vision scores and both relationship anxiety (r = -.183, p < .001) and avoidance (r = -.131, p = .013). Correlations were small but statistically significant. Finally, no significant difference in total SPQ scores was discovered between young adults with and without ADHD. Results imply that sensory reactivity is related to relationship attachment, but not to ADHD. Therefore, sensory processing difficulties may be completely unrelated to ADHD symptomology. However, these results are inconsistent with previous research, and further studies need to take place to ensure reliability of results.

Association Between Sensory Responsiveness and Attachment Style in College Students with and Without ADHD

Sensory processing is an important human cognitive function and is a subject area in dire need of further research. There is a controversy over whether deficits in sensory processing are merely a symptom of other disorders, and further studies need to address this controversy. This study explored associations between sensory processing and relationship attachment (avoidance and anxiety), as well as possible differences in sensory processing in those with and without sensory processing.

Sensory Processing Sensitivity

Sensory processing, or sensory responsiveness, is a three-step process that takes place within the brain. Those steps include receiving incoming stimuli from the environment, interpreting them, and responding appropriately (Schoen, Miller, & Sullivan, 2014). The processing of sensory stimuli never stops and tends to go unnoticed, as it is an unconscious process. However, there are special cases where processing does not come as naturally and there is a disconnect in the process. The abnormality is typically identified according to the quantity of stimuli received in the brain, which then goes on to influence the interpretation and response to such stimuli (Schoen et al., 2014).

Background and current standing. Dr. Jean Ayres, a well-known occupational therapist and psychologist, began studying individual sensory patterns. She coined the term "sensory integration dysfunction" to refer to cases of inability to correctly interpret and respond to sensory information (Flanagan, 2009, p. 22). The majority of her research was conducted on a population of children, and she noticed tendencies to respond intensely to low levels of stimuli, to fail to respond to high levels of stimuli, and to

consciously seek high levels of stimuli (Flanagan, 2009). A study of 21 typically-developing children ages 6-13 used electrical pulses from 32 electrodes to track the reception and interpretation of sensory information. Participants were tested no longer than 30 minutes and were exposed to clicking sounds, vibrations, and a combination of both at the same time. The general population was able to effectively process information from multiple sensory receptors at once and respond appropriately to different types of stimuli (Brett-Green, Miller, Gavin, & Davies, 2008). Another study used the Sensory Profile and electroencephalogram (EEG) testing to examine children's sensory gating, or the ability to filter out irrelevant or redundant stimuli. Twenty-five typically developing children, 28 children with sensory processing deficits, and 18 healthy adults were exposed to a variety of clicking sounds and were instructed to press a mouse button each time they heard a click. Davies, Chang, and Gavin (2009) found that children with processing deficiencies were unable to filter out repetitive auditory stimuli, were not successful in regulating responses to stimuli, and showed greater variations in their responses to similar stimuli. Research has provided evidence of how differences in sensory functioning impede on other areas of life.

The term "Sensory Processing Disorder" (SPD) was most commonly used to refer to abnormal patterns of sensory responsiveness. However, it has become the stem of a current controversy, as many people have not been willing to recognize sensory deficiencies as a disorder of their own. Many of the symptoms have been identified as part of other widely recognized developmental disabilities, such as Autism Spectrum Disorders, Attention-Deficit Hyperactivity Disorder (ADHD), and various intellectual developmental disorders (Enel-Yeger, Hardal-Nasser, & Gal, 2011). Variations of

sensory processing dysfunction have been observed most often in people with other disabilities, at rates of 40-88%. However, research has increasingly observed them in children without other disabilities, at a rate of 5-16% (Ahn, Miller, Milberger, & McIntosh, 2007). SPD was submitted to the *Diagnostic and Statistical Manual of Mental Disorders-5* (DSM-5) for recognition as an official disorder but was rejected. Many of the concepts behind the disorder were valid. Nonetheless, shortcomings in current research lacked diagnostic criteria and measures specific enough to differentiate SPD from other disorders (Miller, Nielsen, Schoen, & Brett-Green, 2009). Further research was needed before a decision could be made. Psychologists were more accepting of the term "sensory processing sensitivity" as it referred to the biological trait that determines how responsive an individual is to different levels of stimuli (Aron, Aron, & Jagiellowicz, 2012, p. 262). Though unrelated to SPD as a disorder, this new term acknowledged the sensory differences in people and may be a stepping stone to acceptance of SPD by health professionals.

Subdivisions and symptomology. Ayres' sensory integration dysfunction includes three categories: sensory modulation, sensory discrimination, and sensory-based motor disorder (Flanagan, 2009). Sensory modulation involves the brain's regulation of responses to sensory stimuli (James, Miller, Schaaf, Nielsen, & Schoen, 2011). After receiving sensory information, the brain filters through all of its options and chooses the correct response and intensity according to the situation. When individuals have difficulty responding to sensory information, they experience sensory modulation dysfunction (James et al., 2011). Sensory modulation dysfunction can present itself in three different variations: overresponsivity, underresponsivity, and sensory seeking.

Overresponsivity occurs when an individual experiences stimuli for a longer amount of time and at a higher intensity than the average person, while underresponsivity is just the opposite – an individual is often withdrawn from his or her environment and responds to select few stimuli (Flanagan, 2009). Sensory seeking individuals tend to seek out intense or unusual sensory experiences. The next form of SPD is categorized under sensory discrimination. Sensory discrimination involves distinguishing between information coming from different sensory systems. Sensory discrimination dysfunction occurs when an individual struggles to identify different types of stimuli, such as loud noises and sudden movements occurring simultaneously (Flanagan, 2009). Finally, sensory-based motor disorder is when an individual experiences difficulty interpreting stimuli while the body is in motion.

Sensory-processing dysfunction is often associated with poor self-regulation skills and behavioral problems. Many symptoms can be easily identified in childhood, such as poor social skills, difficulty adapting to new environments, delayed life skills development, deficiencies in motor skills, and even low self-esteem (Ahn et al., 2007). More specifically, individuals with tendencies toward sensory underresponsivity often experience low energy levels and sensitivity to movement. Those with sensory seeking tendencies often seem impulsive, aggressive, or hyperactive (James et al., 2011). These symptoms can persist into adulthood depending on the level of severity or if sensory dysfunction goes untreated.

Treatment and research. One focus of current research involved identification and diagnostic procedures. Advances in brain imaging technology have allowed neurologists to directly observe abnormalities in brain functioning as they occur. One

study used EEG technology to send electrical impulses through the brain. Participants consisted of 53 children ages 5-12; 28 were diagnosed with SPD and 25 were typically functioning (Davies & Gavin, 2007). Each participant was administered a series of clicking sounds while watching a silent film. EEG technology recorded the reception of and reaction to stimuli from the environment and allowed researchers to analyze the parts of the brain that were activated. When presented with a variety of auditory stimuli, children with deficiencies in sensory processing demonstrated deficits in both sensory gating and detecting differences in stimuli than typically developing children (Davies & Gavin, 2007). Neurologists were further able to identify whether children were overresponsive or underresponsive. A more recent study found evidence of sensory processing abnormalities in white brain matter (Owen et al., 2013). Owen and his colleagues examined white matter microstructures and properties of diffusion in the brain through a technique called diffusion tensor imaging (DTI). They compared the results of 24 typically developing boys aged 8-11 and 16 with sensory processing delays throughout the reception and organization of sensory information. Fibers of the corpus callosum, which connects sensory regions of the right and left brain hemispheres, showed the greatest differences in microstructure among children with difficulties processing sensory stimuli (Owen et al., 2013). The differences were not in the volume of brain matter but rather in properties of individual sensory receptors, such as axon diameter, myelination, and diffusion capabilities. Children with SPD diagnoses displayed lower measurements of axon diameter and myelination of receptors and increased diffusion overall. However, typically developing children should display increasing measurements of axon diameter and myelination in receptors and decreasing diffusion levels as they

mature (Owen et al., 2013). These studies provide preliminary biological evidence in support of SPD as a disorder.

More traditional forms of measurement and diagnosis have also been used in the identification of sensory processing deficits, such as self-report questionnaires. While much of the research on sensory processing has been done with child populations, three main scales have been developed for adult use. The first was called the Adolescent/Adult Sensory Profile (AASP), a 60-item scale that measures sensory responses in comparison to most people. It was standardized on a sample of 900 people aged 11-65 and was designed to classify responses to sensory stimuli as low registration, sensory seeking, sensory avoiding, and sensory sensitivity (Blanche, Parham, Chang, & Mallison, 2014). Its items were categorized through the use of factor analysis. However, the AASP measured sensory responses in general rather than responses according to each sensory system. This need for greater specificity is what drove the creation of the Adult Sensory Processing Scale (ASPS).

The 39-question ASPS, developed at the University of Southern California, was designed to measure three categories – overresponsivity, underresponsivity, and sensory seeking – by targeting individual sensory systems (Blanche et al., 2014). It has allowed researchers to observe individual functioning throughout the integration of different sensory information and was built upon the original research of Dr. Ayres. Originally administered to 491 adults aged 18 to 64 by way of an online self-report survey, the ASPS was determined to have an item-object correlation $\geq .70$ on 64 out of its original 71 items. Upon narrowing the items through factor analysis, the final 39-item scale had an internal consistency reliability measure of α=.87 (Blanche et al., 2014). Finally, the

Sensory Perception Quotient (SPQ) is a self-report questionnaire that measures basic sensory perception and sensitivity without taking into account the resulting affect or cognition (Tavassoli, Hoekstra, & Baron-Cohen, 2014). It focuses on the five main senses: hearing, sight, taste, smell, and touch. Originally developed with a sample of 196 adults with autism and 163 without, the SPQ allows for comparison of processing patterns across different populations. Statistical analyses showed evidence of reliability with high Cronbach's alpha values ranging from $\alpha = .92$ to .93, as well as high correlations to measures of similar constructs, such as the Sensory Over-responsivity (SensOR) scale, where $r = -.50$, $P < .0001$ (Tavassoli et al., 2014).

The variety in available methods to identify sensory processing patterns has made treatment of abnormalities more available. Ayres designed her own intervention called sensory integration therapy, which is most often used to treat children. Treatment plans are designed on an individual basis, and the client participates in activities that engage the senses (Yunus, Liu, Bissett, & Penkala, 2015). The brain is constantly learning and changing, and sensory integration sought to bring about changes in the processing of stimuli. The focus was to teach the brain to organize sensory stimuli and be able to react appropriately in day-to-day situations (Lane & Schaaf, 2010). The therapy's results have suggested improved behavioral self-regulation in children (Roberts, King-Thomas, & Boccia, 2007). Arbesman and Lieberman (2010) found that it was most helpful in the area of motor performance. Sensory integration has also been used among the adult population as awareness of sensory problems is increasing. Clients are encouraged to intentionally surround themselves with sensory stimuli outside of therapy sessions to further engage their sensory receptors (Pfeiffer & Kinnealey, 2003). Adults are often

encouraged to use their own coping strategies as well, such as talking through overwhelming stimuli, and mentally preparing themselves for stimulating situations (Kinnealey, Oliver, & Wilbarger, 1995). Such communication allows clients to think through the situations that are difficult for them and to take on intimidating situations with a plan for processing stimuli.

Sensory integration is now being applied in the classroom setting. Children are individually assessed to determine which senses are hardest to organize and respond to, and education plans are drawn to help children create their best learning environment. Studies have shown that children's learning preferences have a direct effect on the sensory information they are most sensitive to during the school day (Mahdjoubi & Akplotsyi, 2012). For example, students with auditory learning preferences are most sensitive to auditory stimuli, while students with visual learning preferences are most sensitive to visual stimuli. Students can best absorb and retain information that is presented according to their sensory preferences. In addition, students who have difficulty processing visual and auditory information often display reading disabilities as well. Though this association occasionally declines when controlling for IQ, an association remains between sensory processing difficulties and below average language skills (Hulslander et al., 2004). Teachers and therapists can be more intentional about creating the best learning environment for their students when they understand the academic difficulties their students may experience. This increase in research on sensory processing has allowed for students' greater opportunities for success despite struggling with sensory information.

Attention-Deficit Hyperactivity Disorder

One disorder often comorbid with atypical sensory processing patterns is Attention-Deficit Hyperactivity Disorder (ADHD). ADHD is diagnosed when an individual displays abnormal levels of inattention, impulsive behavior, and motor activity according to his or her age group (Frazier, Barratt, & Smith, 1999). It can be perceived as a learning disability, social issue, neurological disorder, or even merely a result of low self-esteem (Dunn & Bennett, 2002). ADHD is commonly observed alongside other developmental disorders or delays, such as oppositional defiant disorder (ODD), conduct disorder (CD), depression and anxiety disorders, and learning disabilities (Dunn & Bennett, 2002). While most cases of ADHD are diagnosed throughout childhood, the symptoms continue throughout the life span.

Research and scales. ADHD is an officially recognized diagnosis, and the disorder is included in the DSM-5. The DSM description includes 18 items under the categories of hyperactive, inattentive, and impulsive behaviors. The three subtypes of ADHD are hyperactive-impulsive, inattentive, and combined, and are determined by the DSM's description (Gomez, 2011). Most of the research on ADHD has been conducted on children, and a majority of symptomology scales are designed for parents to complete. However, psychologists have begun to investigate the effects of ADHD into adulthood. For example, researcher Gomez (2011) developed the Current Symptoms Scale (CSS), which is an adult self-report scale that measures the same 18 items listed in the DSM-5. New research on adult populations allows psychologists to design coping strategies that will last throughout a patient's lifetime.

Symptomology. Observable symptoms of ADHD can take a variety of forms. Neurological testing has shown differences in brain tissue between children with ADHD

and typically developing children, as well as abnormally low levels of coordination (Dunn & Bennett, 2002). Anxiety, moodiness, and lack of social skills are common, as well as an inhibited ability to regulate one's own behavior. Individuals with ADHD may be easily distracted, have trouble focusing on a task, or have trouble sitting still. ADHD is commonly identified alongside anxiety and depressive disorders, obsessive-compulsive disorder, as well as various learning disabilities (Dunn & Bennett, 2002). Visible symptoms vary on an individual basis.

ADHD and sensory processing. Individuals with ADHD often experience difficulties with processing sensory information. Typically, children with ADHD have greater sensorimotor difficulties than typically developing children, specifically in the areas of vision, touch, and motor skills. Children with ADHD had lower scores than children without disabilities on 94% of the items on the Sensory Profile, a parent-report sensory scale (Cheung & Siu, 2009). Miller, Nielsen, and Schoen (2012) also found that children with ADHD had significantly lower scores on the Sensory Profile than typically developing children, specifically in the areas of sensitivity to tactile and visual stimuli, low energy levels, auditory filtering, and sensory-seeking tendencies. They observed that a high percentage of children with ADHD demonstrated difficulty responding to sensory stimulation in daily behaviors. Mangeot et al. (2001) discovered that children with ADHD showed greater sensory reactivity than typically developing children both on parent-report scales and brain imaging tests. However, some children tended to avoid sensory stimuli, depending on their ADHD classification. This research implies great variability in sensory responsiveness within the diagnosis.

Research occasionally demonstrates that individuals with ADHD may show the greatest difference in responsiveness in one particular sensory system. For example, visual, auditory, and tactile perception are the most common systems that produce difficulty with sensory processing. One study in particular examined auditory processing in adult females aged 18-34 with and without ADHD. Twenty were diagnosed with SMD, 20 had SMD and ADHD, 6 had ADHD, and 20 without either diagnosis served as a control group (Mazor-Karsenty, Parush, Bonneh, & Shalev, 2015). Each participant completed an executive attention task under normal conditions and again while being presented with recordings of everyday noises determined to be bothersome. Research demonstrated that when trying to complete a task, auditory stimuli were distracting and difficult to process for individuals regardless of an ADHD diagnosis (Mazor-Karsenty et al., 2015). While some individuals with ADHD focus better with background noise, others try to avoid any kind of auditory stimuli when trying to complete a task. In addition, Sanz-Cervera, Pastor-Cerezula, Fernandez-Andres, and Tarraga Mingues (2015) revealed that a sample of children with ADHD symptomology had greater difficulty focusing in a classroom setting when in the presence of auditory and tactile stimuli. The teachers of 41 early elementary students reported that an abundance of sensory information was distracting for the students, and they were not able to process both class material and sensory stimuli at once.

Likewise, another study found that 20 children aged 6 to 8 with a diagnosis of both ADHD and SPD showed less accuracy in processing visual tasks than 18 children with ADHD and no SPD diagnosis (Jung, Woo, Kang, Choi, & Kim, 2014). Visual processing was measured through the administration of the Korean Developmental Test

of Visual Perception-2, which assessed performance on eight different visual tasks. Those with ADHD demonstrated less visual accuracy than typically developing children, demonstrating that sensory processing difficulties are present in children with ADHD, though the level of difficulty may vary according to other diagnoses (Jung et al., 2014). Finally, Ghanizadeh (2013) found that parents of 189 children with ADHD reported that their children had greater oral sensitivity than typically developing children. The study utilized the parent-report Oral Overresponsivity and Underresponsivity Behaviors Inventory (OOUBI). The OOUBI consisted of 15 items on which parents rated their children's oral behaviors on a Likert scale from 0 (never) to 3 (always). Parents reported that their children were less open to trying new foods than typically developing children and tended to stick to specific food preferences in their daily diets (Ghanizadeh, 2013). While oral sensitivity is not as common as visual, tactile, or auditory, research has shown sensitivity in this area, and sensitivity differs on an individual basis.

Those with an ADHD diagnosis often struggle with high levels of anxiety as well. Research is now showing that sensory overresponsivity in individuals with ADHD may be correlated with anxiety (Reynolds & Lane, 2009). When a person is already on edge about social situations and has difficulty adapting to their surroundings, he or she may naturally be more sensitive to the sensory stimuli from the environment (Reynolds & Lane, 2009; Lane, Reynolds, & Dumenci, 2012). However, this relationship does not determine causality. In general, individuals with ADHD are more likely than typically developing individuals to experience sensory processing difficulties, and this tendency may explain some of their inappropriate behaviors (Shimizu, Bueno, & Miranda, 2014). For example, if a child is overwhelmed by the amount of stimuli his or her brain is trying

to process at a given moment, he or she may be more prone to disrupt a classroom or display abnormal motor activity.

One study discovered new details important to differentiating between sensory symptoms of ADHD and sensory processing dysfunction as a disorder. Miller et al. (2012) studied children with a mean age of 8.16 who were diagnosed with ADHD, SPD, or both. Those with ADHD were found to have greater inattention and hyperactivity than those with SPD. Those with SPD demonstrated greater difficulties processing sensory information and responding appropriately than those with ADHD. Those with both showed a mix of symptoms. However, it is important to note that those with SPD had greater sensory processing difficulties than those with ADHD. While processing deficits are seen in abundance in individuals with ADHD, there are people who experience even greater deficits without the symptoms of other diagnoses.

Relationship Attachment

Relationship attachment is another factor that plays into patterns of sensory processing. The idea of "attachment" is concerned with the bond that develops between a child, usually within the first year of life, and his or her primary caregiver. The consequences, whether positive or negative, of this relationship extend into a child's self-concept and view of the world amid development, as well as the quality of all relationships the child will have throughout life (Collins & Read, 1990). There are three primary attachment styles that may develop: secure, anxious, and avoidant. Secure attachment occurs when children feel secure and loved with their caregiver. They continue to develop confidence in their relationships, enjoy social situations, and have a sense of independence (Fraley & Shaver, 2000). Secure attachment is the most healthy

and desirable attachment style. Anxiety and avoidance develop as a result of an overprotective, inattentive, or emotionally distant parent. Anxious attachment involves worrying about not being loved, constantly seeking greater depth of relationships, and sometimes scaring people away with the intensity of interactions. Those with an avoidant attachment style are uncomfortable being close and vulnerable with others and have difficulty trusting people. They are not very social and often have few friends who are regularly involved in their lives (Fraley & Shaver, 2000).

Contributing factors. There are many factors that play into the attachment style a child develops. Parental sensitivity is the primary factor, as the parent-child relationship is the first relationship human beings experience (Collins & Read, 1990). If young children cannot trust their own parents, who are supposed to love unconditionally, provide for, and support their children; then they will have difficulty trusting anyone else. However, a supportive, loving parental relationship will foster trust for other people and encourage the formation of healthy, supportive relationships in the future. While childhood experiences and relationships are considered most influential on attachment style, other temperamental and genetic factors may also play a role (Jerome & Liss, 2005). For example, an introverted or shy individual may have a loving relationship with his or her parents, but tend to avoid social situations and be content without having close friends. Highly emotional individuals may develop anxious relationships because they allow their feelings and emotions to produce unnecessary worry or stress. Other biological disorders may affect a person's ability to develop intimate, fulfilling relationships and therefore inhibit the development of a healthy attachment style. Finally, coping strategies often affect relationship styles. Avoidant individuals may tend to

emotionally or mentally disengage from their surroundings or deny the reality of their circumstances. People with monitoring coping styles are overly sensitive to others' emotional and physical states, as well as their own internal and external responses. They tend to demonstrate anxious attachment (Jerome & Liss, 2005). There is hope for children who do not have positive relationships with their parents, as there are other factors that affect their attachment styles, and they can overcome a disappointing past in order to pursue secure relationships in the future.

Attachment style and sensory processing. Though seemingly unrelated, attachment style can often correspond to particular patterns of sensory responsiveness. A study by Jerome and Liss (2005) administered the AASP, COPE Scale, and Experiences in Close Relationships Scale (ECR) to a group of 133 adults. Their analysis found that patterns of sensory avoidance (as a result of overresponsivity) correlated with avoidance in relationships ($r = .278$, $p < .05$). People who were overwhelmed by significant sensory stimulation may have been overwhelmed in social situations in general, where they have to see and interact with a variety of people at once. As a result, they often withdraw from others and have difficulty forming relationships. Sensory sensitivity usually occurs in conjunction with anxious relationship styles. Underresponsivity to sensory stimuli correlates to both relationship anxiety ($r = .248$, $p < .05$) and avoidance ($r = .224$, $p < .05$), as well as a coping style of denial and both mental and behavioral disengagement (Jerome & Liss, 2005). Finally, sensory seeking was related to secure attachment in relationships, as it had no significant correlation to either attachment anxiety or avoidance. Sensory seeking tendencies were reported in conjunction with several different coping strategies, both effective and ineffective (Jerome & Liss, 2005).

Individuals who seek out stimulation are more likely to seek out environments with many people around and activities going on. They tend to enjoy social situations and are comfortable with sensory stimulation and with developing relationships. Attachment styles are clearly influenced by early parental relationships, environmental factors, and patterns of sensory responsiveness (Liss, Timmel, Baxley, & Killingsworth, 2005).

Need for Research

Researchers have extensively studied sensory processing, ADHD, and relationship attachment. However, according to the American Occupational Therapy Association (2014), there are many areas that require continued research regarding sensory processing. The organization calls for research with sensory integration therapy in order to help clients complete daily tasks independently, process and respond to sensory stimuli appropriately, regulate their emotions, and effectively communicate and interact with other people. This is not the only need for more research. Further research on sensory processing would help psychologists and therapists in the debate between SPD and simply comorbidity of symptoms. Most sensory research has been done on children, as deficits are easily identified alongside other childhood developmental disorders. There is a great need for research on sensory responsivity throughout adolescence and adulthood. In addition, ADHD is primarily studied throughout the childhood years. The field of psychology focuses on the entire lifespan, and further research on ADHD in adulthood is a necessity. In order to further understand the relationships that sensory processing has with ADHD and relationship attachment, further studies should particularly focus on adult populations. These relationships have not yet

been explored among college students, and it is essential to examine multiple populations within adulthood while still determining whether SPD is its own clinical diagnosis.

Previous research clearly shows that sensory processing affects other areas of development. The purpose of this study is to test for relationships between sensory responsiveness and relationship attachment among college students, as well as group differences in sensory processing for college students with and without ADHD. Recent studies suggest a correlation between sensory processing and attachment styles, and have shown that sensory dysfunction or sensitivity is a key predictor of ADHD. The research will focus on the following questions: (1) How does sensory processing responsiveness relate to relationship anxiety and/or avoidance? (2) How do subscales within sensory responsiveness correlate with relationship anxiety and/or avoidance? (3) How does overall sensory responsiveness differ between individuals with and without an ADHD diagnosis? Though there is a lack of research in this area for adults, we predict that relationships and group differences between sensory responsiveness, ADHD, and attachment are similar to those discovered in children. The results will provide insight into the role of sensory processing in ADHD symptomology and adult relationship attachment, and these findings may have implications for therapists and others working with individuals who have ADHD or sensory processing differences.

Method

Participants

The study's participants were recruited through the use of convenience sampling at a large, private Christian university. While 377 people accessed the survey, 5 chose not to complete it and 2 were automatically prevented from completing it because they

were under 18 years old. The final study sample consisted of 370 adult volunteers, 32 (9%) of whom had an ADHD diagnosis. All adults age 18 and older were welcome to participate, regardless of gender, ethnic background, health status, or occupation. Due to the recruitment method, most participants were college students probably enrolled in at least one residential psychology course. The mean age of participants was 19.95 (*SD* = 3.14). The sample consisted of 149 (39.1%) freshmen, 93 (24.4%) sophomores, 70 (18.4%) juniors, and 57 (15.0%) seniors. Participants represented a range of ethnicities, where 87.1% identified as White, 2.6% as Asian, 2.9% as Black/African American, 2.9% as Hispanic, 0.3% as Pacific Islander/Native Hawaiian, and 1.3% as other. Approximately sixty percent of participants were single, 34.1% were in a relationship, 3.1% were married, and 1.8% were parents. The only requirement for involvement was that participants be over the age of 18 at the time of survey completion.[*]

Procedure

The goal of this study was to explore the correlations and group differences among sensory processing responsivity, ADHD, and relationship attachment. Participants were informed of the opportunity to participate in this study through the psychology department website at a large, private Christian university. The opportunity was posted on the psychology activities page, which is checked frequently by any student enrolled in a residential psychology course. In addition, professors were asked to direct their students to the psychology activities page for possible survey opportunities. Those who participated in the survey were eligible to receive one psychology activity credit fulfilling part of the requirements for residential psychology classes. Each survey was

[*] When the survey was entered into Qualtrics, the question asking participants' gender was inadvertently omitted. Historically, samples from psychology activity surveys have been predominantly female.

taken anonymously at the participants' convenience. Participants were allowed to withdraw from the study and stop answering questions at any time. All data were left anonymous in order to protect the integrity of the research and avoid the ability of the researchers to connect responses to individuals whom they might actually know.

Participants were first prompted to read an informed consent document outlining the purpose of the research and details of the survey, as well as information regarding the confidentiality and anonymity of results. Participants voluntarily responded to a series of self-report questions through an online Qualtrics survey. The survey began with a variety of demographics questions and then proceeded to the Sensory Perception Quotient and Experiences in Close Relationships – Global/General Attachment Scale. There were a total of 52 questions. Instructions were provided at the start of each new category of questions. Data collection and analysis took place in January and February of the Spring 2016 semester. The research was considered cross-sectional, as data collection took place once and results were compared according to categories of sensory responsiveness.

Measures

Demographics. After completing general demographics questions (race, age, classification in school, etc.), participants were asked if they had ever received an ADHD diagnosis. They were further asked to classify that diagnosis according to ADHD, ADHD-Predominantly Inattentive, ADHD-Predominantly Hyperactive/Impulsive, ADHD-Combined, or ADD. Options for both ADHD-Predominantly Inattentive and ADD were offered since the ADD label is still used, even in scholarly sources (e.g., Conner, 2012), despite being removed from the DSM in 1994.

Sensory processing. The Sensory Perception Quotient (SPQ) was used to measure participants' sensory processing responsivity. Developed by Tavassoli et al. (2014), the SPQ was designed to measure basic sensory processing and sensitivity "with no reference to affective response" (p. 30). This self-report scale examined individual differences in sensory perception across different populations. Participants used the short version, which consists of 35 questions measuring hypersensitivity and hyposensitivity to sensory stimuli (for example, 'I would be able to distinguish different people by their smell'; see Appendix A for full set of items). Responses were given on a Likert scale from 0-3, with 0 indicating "strongly agree" and 3 indicating "strongly disagree" (Tavassoli et al., 2014, p. 31). Hyposensitive items were reverse-coded. Item responses were totaled so that a low score on the SPQ indicated a low sensory threshold and high levels of sensory reactivity. Scale items measured specific functions of each of the five main senses: hearing, sight, smell, taste, and touch (Tavassoli et al., 2014). Scores could range from 0 to 105, and in the current study, they ranged from 16 to 80 (M = 46.05, SD = 10.75).

The SPQ was originally developed in a Cambridge University study by Tavassoli et al. (2014) to compare sensory responsiveness in adults with and without Autism Spectrum Disorders (ASD). Each of the 35 item responses varied considerably so that patterns of responsivity could be distinguished and compared among groups of participants. Items targeting hypersensitivity and hyposensitivity were included so as to prevent bias in item focus and responses (Tavassoli et al., 2014). Subscale items were created in order to target the main receptors for each of the senses. Concurrent validity was examined by comparing the SPQ with the SensOR, a self-report scale that measured

sensory overresponsivity, where high scores represented high sensory sensitivity. Participants' total short SPQ scores corresponded to total SensOR scores, r = -.20, p = .0001 (Tavassoli et al., 2014). The short SPQ was determined to have high internal reliability, with a Cronbach's alpha of 0.93. In the current study, alpha for the total SPQ was 0.837. Alphas for individual subscales were as follows: α = 0.659 for smell, α = 0.491 for vision, α = 0.395 for taste, α = 0.510 for hearing, and α = 0.716 for touch. Young adults with autism had significantly different scores than those without on the total SPQ and every subscale but smell.

Attachment: Anxiety and avoidance. The Experiences in Close Relationships-Global/General Attachment Scale (Fraley, 2015) was used to measure participants' general relationship attachment styles. This 9-question self-report scale was adapted from the ECR-Relationship Structures Scale, which originally asked the same 9 questions in regards to relationships with a mother, father, romantic interest, and best friend (Fraley, 2015). The Global update simply generalized the ECR-RS's nine items to encompass all types of relationships (for example, "It helps to turn to people in times of need"; see Appendix A for all ECR-General items). Each item is scored on a Likert scale from 1-7, with 1 indicating "strongly disagree" and 7 indicating "strongly agree" (Fraley, 2015). Items 1-6 targeted avoidant relationship patterns, while items 7-9 targeted anxious relationship patterns. The first four avoidant responses were reverse-coded. Avoidance items measured "discomfort with being close to and depending upon others" and include dismissive and fearful behaviors (Smith, Msetfi, & Golding, 2010, p. 328). Anxiety items measured fear of rejection and abandonment of others and included behaviors such as worrying about relationships and an overwhelming desire to please people. Low

scores on avoidant and anxious items indicate more secure relationship attachment. Possible scores can range from 1-7 for each subscale.

The ECR-Global/General Attachment Scale was developed by Dr. Chris Fraley at the University of Illinois. The scale can be used for people of all ages and was not created for a specific population (Fraley, 2015). Average Cronbach's alpha values for reliability of avoidance and anxiety items range from $\alpha = .81$ to .92, and average test-retest reliability ranges from .80 to .95 (Fraley, Vicary, Brumbaugh, & Roisman, 2011). Alpha was 0.901 for anxiety and 0.862 for avoidance.

Results

All survey data were analyzed through the use of SPSS Statistics 23 software. Data appeared to be normally distributed, as each scale and subscale had skewness scores between -1.163 and 1.058. Means, standard deviations, reliability coefficients for each scale and subscale have been listed in Table 1.

Table 1

Descriptive Statistics for SPQ and ECR-General Scores in a Sample of College Students

Scale	Mean	Standard Deviation	Possible Range	Cronbach's alpha
Total SPQ	46.04	10.75	0-105	.837
SPQ smell	13.60	3.83	0-30	.659
SPQ vision	8.95	2.62	0-18	.491
SPQ taste	4.61	1.83	0-12	.395
SPQ hearing	6.94	2.43	0-15	.510
SPQ touch	12.21	3.91	0-30	.716
ECR avoidance	3.53	1.32	1-7	.862
ECR anxiety	4.24	1.79	1-7	.901

Analysis of bivariate correlations between total SPQ score and ECR subscales of anxiety and avoidance addressed the first research question (see Table 2). The mean

relationship anxiety score in this sample was 4.24 with a standard deviation of 1.79 and the mean relationship avoidance score was 3.53 with a standard deviation of 1.32. SPQ scores were significantly correlated with relationship anxiety (r = -.119, p = .023), indicating that a low sensory threshold and high sensory sensitivity were associated with high relationship anxiety. In contrast, SPQ scores were not significantly correlated with relationship avoidance (r = -.082, p = .119).

Table 2

Bivariate Correlations Between SPQ and ECR Subscales

Correlations

		AVOIDANCE	ANXIETY	SPQTotal	SPQsmell	SPQvision	SPQtaste	SPQhearing	SPQtouch
AVOIDANCE	Pearson Correlation	1	.179**	-.082	-.034	-.131*	.006	-.089	-.050
	Sig. (2-tailed)		.001	.119	.525	.013	.905	.091	.346
	N	368	368	367	359	360	357	363	357
ANXIETY	Pearson Correlation	.179**	1	-.119*	-.066	-.183**	-.028	-.026	-.093
	Sig. (2-tailed)	.001		.023	.213	.000	.595	.622	.080
	N	368	368	367	359	360	357	363	357
SPQTotal	Pearson Correlation	-.082	-.119*	1	.740**	.700**	.600**	.713**	.803**
	Sig. (2-tailed)	.119	.023		.000	.000	.000	.000	.000
	N	367	367	367	359	360	357	363	357
SPQsmell	Pearson Correlation	-.034	-.066	.740**	1	.373**	.359**	.386**	.409**
	Sig. (2-tailed)	.525	.213	.000		.000	.000	.000	.000
	N	359	359	359	359	354	353	356	350
SPQvision	Pearson Correlation	-.131*	-.183**	.700**	.373**	1	.315**	.430**	.454**
	Sig. (2-tailed)	.013	.000	.000	.000		.000	.000	.000
	N	360	360	360	354	360	352	358	351
SPQtaste	Pearson Correlation	.006	-.028	.600**	.359**	.315**	1	.344**	.399**
	Sig. (2-tailed)	.905	.595	.000	.000	.000		.000	.000
	N	357	357	357	353	352	357	354	349
SPQhearing	Pearson Correlation	-.089	-.026	.713**	.386**	.430**	.344**	1	.500**
	Sig. (2-tailed)	.091	.622	.000	.000	.000	.000		.000
	N	363	363	363	356	358	354	363	354
SPQtouch	Pearson Correlation	-.050	-.093	.803**	.409**	.454**	.399**	.500**	1
	Sig. (2-tailed)	.346	.080	.000	.000	.000	.000	.000	
	N	357	357	357	350	351	349	354	357

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Bivariate correlations were also measured between the five SPQ subscales (smell, vision, taste, hearing, and touch) and the ECR subscales of anxiety and avoidance (see Table 2). Vision (M = 8.95, SD = 2.62) was the only SPQ subscale significantly correlated with the ECR subscales. Vision scores were negatively correlated with

relationship anxiety (r = -.183, p < .001) and relationship avoidance scores (r = -.131, p = .013). Low scores on the SPQ's vision items (i.e., a low threshold and high sensory sensitivity) may indicate higher likelihood of anxiety or avoidance in relationships.

Finally, an independent samples *t*-test was run to test for mean differences in overall sensory responsiveness between individuals with and without ADHD (see Figure 1). The mean of total SPQ scores for college students with an ADHD diagnosis was 43.406, (SD = 10.922) while the mean of total SPQ scores for college students without an ADHD diagnosis was 46.293 (SD = 10.716). The difference was not significant (t(365) = -1.453, p = .147, d = -.27).

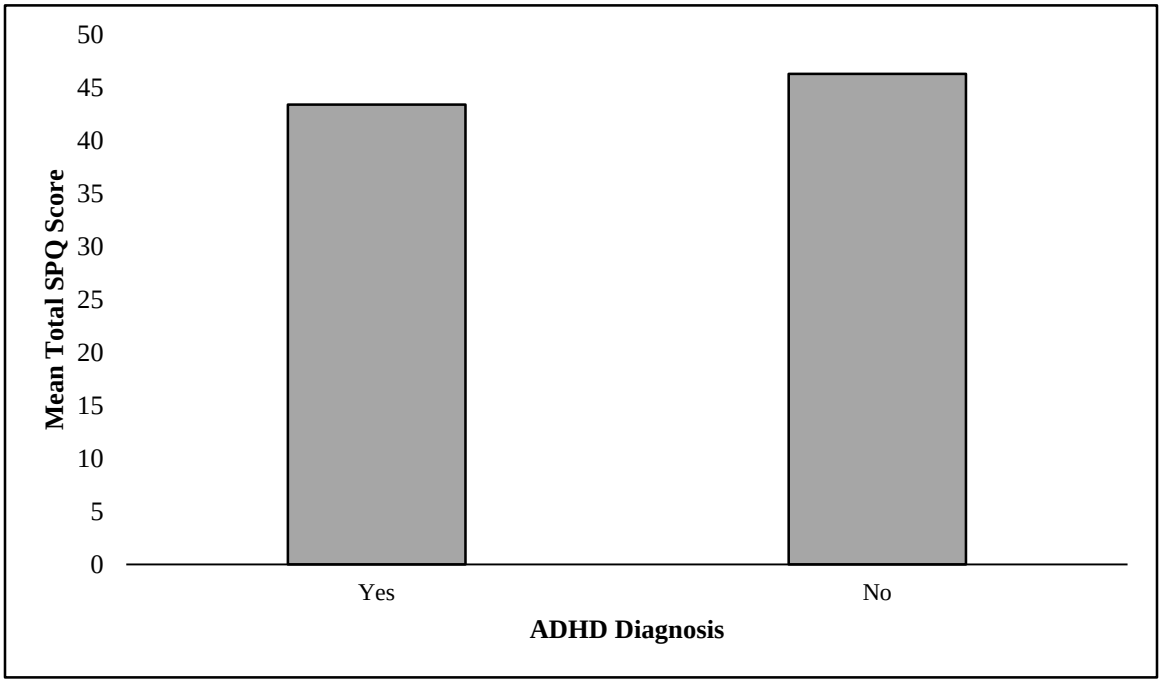

Figure 1. Bar graph of mean total SPQ scores among college students with and without ADHD.

Discussion

The purpose of this study was to address the following research questions: (1) How does overall sensory responsiveness correlate with relationship anxiety and/or

avoidance? (2) How do subscales within sensory responsiveness correlate with relationship anxiety and/or avoidance? (3) How does overall sensory responsiveness differ between individuals with and without an ADHD diagnosis? Sensory responsiveness was measured using the Sensory Perception Quotient (SPQ), and relationship attachment was measured with the Experiences in Close Relationships-General/Global measure (ECR-General).

Research suggests a significant negative correlation between total SPQ scores and relationship anxiety. People who exhibit high sensory reactivity are more likely to experience anxiety in relationships than those with low to normal reactivity. In addition, the current study found preliminary support for links between visual sensory sensitivity and attachment. It is plausible that those who are sensitive to sensory stimuli may be oversensitive to environmental factors in general and may naturally be more likely to worry about details in relationships that would not concern the average individual. Results of the current study are consistent with those from previous research. Jerome and Liss (2005) found that sensory sensitivity was significantly correlated with relationship anxiety. People displaying this type of behavior are described to be sensitive to stress, but do not do anything to target or redirect that stress (Jerome & Liss, 2005).

Though the researcher predicted a difference in sensory processing patterns among groups with and without ADHD, the results indicate otherwise. There was no significant difference in overall sensory responsiveness detected in college students with and without ADHD. Therefore, sensory processing deficits may only be a symptom in specific cases of ADHD. However, these findings must be considered carefully, as research by Mazor-Karsenty et al. (2015), Sanz-Cervera et al. (2015), and Jung et al.

(2014) found processing deficits in adults and children with ADHD, particularly for visual and auditory stimuli. The abundance of studies detecting a significant difference in sensory processing among ADHD and non-ADHD indicate a need for further research in this area.

Limitations

While this study was important in increasing the research base for sensory processing in adults, it had a restricted sample. Due to recruitment methods, the majority of participants were white, single, Christian university students within the range of 18 to 21 years of age. While a few middle-aged to older adults participated, the population was fairly limited as far as demographics. Results may have been influenced by the characteristics of the sample and may not generalize to a larger population of adults. Studies measuring similar constructs should be performed on larger samples of adults from a variety of backgrounds.

The survey was administered online, and the researchers were unable to control conditions of the testing environment. Participants took the survey at a different times and places, so differing circumstances may have affected their ability to think through the test items and answer accurately. Disruptions in the surrounding environment or internal stressors and emotions may have been a distraction for some individuals. Participants' responses also may have been biased, as the test was made up of self-report items. People may have answered in order to make themselves look better, or could have had trouble answering truthfully for themselves.

In addition, 32 participants were diagnosed with ADHD, which is a small subset. Some participants may have had ADHD but had never been given a diagnosis. The

symptoms may simply have never been caught by a doctor. Therefore, their results may have created an error in the data set. Due to how small the sample was of students with ADHD, their results may not have accurately represented the general population of students with ADHD and may have led to inaccuracies in correlations. In addition, internal consistency reliability was low for the SPQ subscales. Finally, the ECR Scale used in this survey focused on relationships in general. The accuracy of responses could have increased if questions had asked about specific categories of relationships.

Implications and Opportunities for Further Research

The results of this research are important for understanding sensory processing differences. Though sensory processing deficits often exist alongside a variety of developmental or intellectual disabilities, every individual displays different characteristics. This study implies that general sensory processing responsivity may be linked to patterns of relationship attachment, but may not differ between individuals with and without ADHD. Therefore, a person with difficulty interpreting and responding to sensory information may simply have a sensory issue without an ADHD diagnosis. Individuals with ADHD who do display sensory deficits may be experiencing those deficits outside of their diagnosis.

Studies like this one should be replicated in a variety of populations in order to determine the external validity of its results. There is a call for new research with samples of adults, as the majority of sensory and ADHD research has been performed with children and adolescents. Further research needs to examine sensory processing responsivity in relation to other deficits as well. Sensory responsivity may be significantly correlated to other characteristics of atypical development. Therefore,

sensory processing patterns should also be studied alongside a variety of psychological symptoms and diagnoses in order to get a well-rounded picture of the other factors that may be involved.

Conclusion

This study used a self-report online questionnaire made up of the SPQ and ECR-General Scale in order to assess sensory processing patterns and relationship attachment in college students with and without ADHD. Results indicated a significant negative correlation between total SPQ scores and relationship anxiety, as well as vision subscale scores with relationship anxiety and avoidance. Results did not indicate a difference in total SPQ scores between students with and without ADHD. This study involved many limitations and must be replicated among different populations to ensure its validity. However, its implications are important to consider as the field continues to research and understand differences in sensory processing and possible impacts on development. Future research should compare sensory processing and attachment patterns among larger groups with ADHD and among more heterogeneous samples.

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Appendix A

Survey Questions

1. Are you 18 years of age or older?
2. Please enter your age:
3. Ethnic group/race:
   Asian
   Black/African American
   Hispanic
   White
   American Indian/Alaskan Native
   Pacific Islander/Native Hawaiian
   Other
4. Are you a parent? Yes or no
5. Year/Classification: Freshman, Sophomore, Junior, Senior
6. Have you ever received one of the following diagnoses (ADHD-Combined, ADHD-Inattentive, ADHD-Hyperactive/Impulsive, or ADD)? Yes or no
   a. If yes, please select your diagnosis
      i. ADHD – Combined
      ii. ADHD-Inattentive
      iii. ADHD-Hyperactive/Impulsive
      iv. ADD
7. Are you currently in an exclusive romantic (dating/marital) relationship?
   Yes, I am married
   Yes, I am dating someone
   No

Sensory Perception Quotient

(The original scale and research can be accessed online at the following URL: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4005907/pdf/2040-2392-5-29.pdf)

Experiences in Close Relationships Scale – Global/General Attachment

(The original scale and research can be accessed online at the following URL: http://internal.psychology.illinois.edu/~rcfraley/measures/relstructures.htm)