DISSERTATION

Examining the Relationship Between Sensory Phenomena, Sensory Processing, and Obsessive-compulsive Symptoms

by

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Abstract

There have been a large number of individuals with obsessive-compulsive disorder (OCD) who endorse compulsive behavior driven by internally generated sensory sensations, absent of feared consequences. These experiences, known as “feelings of incompleteness,” “not just right experiences,” and sensory phenomena, have been found to be highly prevalent within the disorder, and similar to traditional obsessions and compulsions, cause significant distress and impairment and interfere with social and occupational functioning. Internally-generated sensory sensations in OCD have been understudied in comparison to fear based obsessions and compulsions yet hold significant importance in the conceptualization of OCD and its treatment. Researchers have hypothesized a sensory-affective dysfunction which may underlie these experiences, which implicates potential dysfunction related to sensory processing. Some evidence suggests that individuals with OCD have altered experiences related to sensory processing, yet there have been limited studies examining the interplay between these domains. To addresses these gaps in the literature, the purpose of this study was to examine the relationship between altered sensory processing, sensory phenomena, and obsessive-compulsive symptoms within a large community sample. Bivariate correlations revealed that there were significant positive associations between sensory over-responsivity, sensory phenomena, and obsessive-compulsive symptoms. Sensory over-responsivity was predictive of obsessive-compulsive symptoms, and both facets of sensory phenomena “incompleteness” and “not just right experiences.” Sensory over-responsivity was also found to moderate the association between obsessive-compulsive symptoms and sensory phenomena; however, some findings were counter to the proposed hypotheses. Lastly, exploratory analyses displayed that facets of interoceptive sensibility were also associated with sensory over-responsivity, sensory

phenomena, and obsessive-compulsive symptoms. Taken together, findings from this study highlight that elevated sensory over-responsivity appear to be associated with obsessive-compulsive symptoms and impact its' relationship to sensory phenomena. Further research is needed to replicate and extend these findings within a clinical sample, however sensory over-responsivity may be a relevant area of research pertaining to the etiology of sensory phenomena symptoms present in OCD, and may inform neurobiological models of OCD more broadly.

Keywords: obsessive-compulsive disorder; sensory over-responsivity; sensory phenomena; incompleteness; not just right experiences; NJREs

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Chapter 1 – Introduction

Review of the literature

Obsessive-compulsive disorder

Obsessive-compulsive disorder (OCD) is characterized by the presence of obsessions and/or compulsions that cause significant distress or impairment (APA, 2013). Obsessions take the form of intrusive thoughts, images or urges that are ego dystonic and result in increased anxiety or distress. Compulsions are repetitive behaviors aimed at neutralizing or alleviating anxiety or distress caused by obsessive thoughts. Compulsions are typically an attempt to prevent a feared consequence from occurring, but can serve multiple functions (Starcevic et al., 2011). The lifetime prevalence of OCD is between 2-3% (Kessler et al., 2005; Ruscio et al., 2010), with the typical age of onset being at 19 years old (APA, 2013). Approximately 25% of individuals with OCD have an onset at the age of 14 years old or younger (APA, 2013). Typically, after onset, OCD is a chronic condition and waxes and wanes over time (APA, 2013; Visser et al., 2014). OCD can be incredibility debilitating (Markarian et al., 2010) and is ranked the 10th leading cause of disability worldwide (Ayuso-Mateos, 2000).

In the Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-V), OCD is no longer categorized under the umbrella of anxiety disorders (APA, 2000; APA, 2013). It has been reclassified under its own independent section labeled “Obsessive Compulsive and Related Disorders” (OCRD), and is now recognized as part of the spectrum of obsessive-compulsive (OC) disorders along with hoarding, trichotillomania, excoriation disorder, and body dysmorphic disorder. Commonalities amongst these disorders are obsessive preoccupations and repetitive behaviors (Krzanowska & Kuleta, 2017). These changes in the DSM represent an effort to more appropriately diagnostically classify this condition, yet the high heterogeneity of the disorder

represents a challenge for both clinicians and researchers (Dams et al., 2020; Lochner & Stein, 2003; Sica et al., 2016).

Conceptualizations of OCD

Models of OCD have traditionally emphasized the role of anxiety in the etiology and maintenance of the disorder (Coles & Ravid, 2016; Lack et al., 2015; Taylor et al., 2005). Prior to the development of contemporary cognitive behavioral models (CBT), conceptualization of OCD focused on conditioning models (Lovibond, 1993; Mowrer, 1960). Mowrer's (1960) Two Factor Theory (classical conditioning and operant conditioning) served as the initial model for the fear and maintenance of anxiety-related disorders (Rachman, 1971; Rachman & Hodgson, 1980; Teasdale, 1974). According to this model, an individual first learns to associate anxiety or discomfort with an originally neutral stimulus (unconditioned stimulus; US). Through classical conditioning, the US then becomes a conditioned anxiety stimulus (CS). Due to the CS evoking anxiety or discomfort, an individual is motivated to avoid and/or escape the CS. In the moment, this strategy is an effective method of anxiety reduction via negative reinforcement. However, this results in either avoiding the CS, or engaging in behaviors to remove the CS. Over time this behavioral cycle continues, which results in strengthening and maintaining avoidance and/or escape behaviors (Franklin & Foa, 2008), therefore contributing to the overall maintenance of anxiety related disorders and OCD.

Conditioning models have led to the development of one of the most efficacious treatments for OCD, exposure with response prevention (EX/RP) (Abramowitz et al., 2005; Foa & Kozak, 1996; Foa & McLean, 2016; Page & Hall, 1953; Page, 1955). This behavioral treatment consists of intentionally exposing oneself to feared stimuli, with refraining from engaging in compulsive behaviors (Foa et al., 2012). Although this treatment has been the gold

standard behavioral treatment for OCD, the conditioning model it is based on is insufficient in explaining certain aspects of OCD presentation. Conditioning models helped to explain ritualistic/compulsive behaviors related to OCD but lacked etiology of obsessions (Lack et al., 2015). Many patients have not endorsed a history of conditioning experience which would have led to specific obsessions. Additionally, conditioning models have failed to explain why OCD symptoms tend to change over time (Taylor et al., 2005). Given some of these limitations, clinical researchers began to consider alternative models of OCD, specifically examining the role of cognitions in the disorder.

Contemporary CBT models of OCD are based on Beck's (1976) Cognitive Specificity Model. The premise of this model is that psychopathology develops from different types of dysfunctional beliefs. One model that has served as a theoretical foundation of contemporary CBT approaches is that of Salkovskis (1985, 1989, 1996). This model is based on the premise that most individuals typically experience intrusive thoughts to some nature. Obsessions then develop as a result of an individual appraising those intrusive thoughts as threatening and for which they are personally responsible. These appraisals then result in anxiety and distress, of which the individual wants to alleviate, suppress, or remove, while simultaneously attempting to prevent the potential harmful thought from occurring. This ruminative cycle then results in compulsive behaviors.

Salkovskis (1985, 1989) continues to discuss the nature of compulsions, and that through negative reinforcement, compulsions result in immediate anxiety reduction by "removing" the unwanted thought. However, in an attempt to remove obsessions, this cycle actually results in increasing the frequency and distress of intrusive thoughts, and compulsions become excessive and persistent. Additionally, when individuals engage in compulsive behaviors, they fail to learn

that their appraisals of intrusive thoughts are unrealistic, and that having an intrusive thought does not lead to action and is not threatening (thought-action fusion; Shafran et al., 1996; Shafran & Rachman, 2004). Ultimately, compulsions maintain the intrusive thoughts and prevent new learning (Foa & Kozak, 1986; Foa & McNally, 1996). Taken together, belief and appraisal models coupled with conditioning models have led to contemporary CBT models and approaches to OCD and its treatment (Abramowitz et al., 2005; Taylor et al., 2005).

OCD Symptom Subgroups

Given that OCD is a highly heterogenous condition, clinicians and researchers have worked to identify the best method for categorizing symptoms into subgroups. Although the findings are mixed, there has been some consistency amongst researchers (Abramowitz et al., 2003; Bloch et al., 2008; McKay et al., 2004; Starcevic & Brakoulias, 2008; Williams et al., 2013) in categorizing the following subgroups: contamination obsessions, aggressive/harm obsessions, concern with symmetry or exactness, taboo thoughts, those who experience obsessions without overt compulsions (typically labeled “pure O”), and hoarding behaviors.

Contamination obsessions are typically associated with concern for dirt and germs, with accompanying compulsions centered around washing and cleaning behaviors. According to Rachman (2004), contamination be in the form of physical contact, where an individual encounter a feared stimulus that is perceived as threatening to their health in an in vivo setting. Additionally, individuals may experience mental contamination which is typically associated with feeling internally unclean, and is associated with feelings of shame and guilt. For example, one may have thoughts of particular words or phrases which may trigger a memory of a situation in which they felt violated or disgusted.

Harming obsessions and checking compulsions are experienced as an individual having intrusive thoughts of harming oneself or others or being responsible for something terrible happening, such as a fire or burglary. Typically, these thoughts are followed by checking behaviors, such as trying to be certain that harm was not caused, for example checking one's body to look for signs of blood or injury. Additionally, individuals may engage in avoidance behaviors such as refraining from using sharp objects around a loved one or refusing to cook someone's food out of the fear of accidently poisoning them (Goodman et al., 1989; McKay et al., 2010).

Concern with symmetry or exactness consists of individuals having the need for things to be ordered in a certain way or do something until it feels safe or "feels right." These obsessions at times can be accompanied by "magical thinking," in which an individual has the belief that if something is not arranged in an exact matter that it will result in a negative consequence to themselves or someone else. For example, one may have to arrange the books on a bookshelf until they are all symmetrical or else something terrible may happen to a family member. These beliefs may also be grandiose in nature, for example one may need to arrange items in their living room a certain way during a sports game or else their team will lose the game. Typically, the function of these compulsions is to increase the probability of a favorable outcome or to prevent a negative consequence from occurring (Moretz & McKay, 2009).

Under the umbrella of "taboo thoughts" falls an OCD subgroup which consists of sexual and religious obsessions. Individuals who experience sexual obsessions may have thoughts related to pedophilia, homosexuality or incest, which at times can be directed towards family members (Gordon, 2002). These thoughts often result in significant distress, accompanied by shame and/or guilt (Weingarden & Renshaw, 2015). Individuals who experience religious

obsessions, also known as scrupulosity, may have thoughts related to spirituality and morality, with an underlying fear of going against religious doctrine (Greenberg & Huppert, 2010; Siev et al., 2011). Within this subgroup of "taboo thoughts," such as fears of worshipping the devil or cursing God's name, compulsions are typically centered on a need to correct aversive or blasphemous thinking. There may be overt compulsions like checking for arousal around a feared stimulus (e.g., child, family member), or needing to pray in a certain order to counteract blasphemous thoughts. These obsessions can be incredibility distressing for patients, which may lead them to avoid being around family members or participate in religious activities.

Additionally, there is a subgroup of individuals with OCD who experience obsessions without overt compulsions ("pure O"). These individuals often engage in mental rituals to suppress or alleviate unwanted intrusive thoughts. Themes of these obsessions span across all subgroups, and can be related to sex, violence, harm, or scrupulosity (Clark et al., 2008; OCD Cognitions Working Group, 2005). These individuals tend to have an overestimated belief that experiencing an intrusive thought is dangerous and increases the likelihood of it behaviorally occurring (thought-action fusion; Shafran et al., 1996; Shafran & Rachman, 2004). They may also have the belief that having these thoughts speaks to their character and experience a perceived sense of responsibility for them (Frost & Steketee, 2002).

A final domain that has been present in OCD and now newly categorized as its own disorder (hoarding disorder; APA, 2013) is centered around hoarding behaviors. Within traditional OCD conceptualizations, hoarding has been associated with obsessional concerns of losing something or the possibility of needing a particular stimulus at a later time (Frost & Hartl, 1996). These thoughts then lead to hoarding compulsions, in which an individual accumulates a variety of items, and has difficulty discarding them regardless of meaning or value of the objects.

Given the various OC symptom subgroups, OCD's heterogeneity impacts treatment (Lochner & Stein, 2003 for a review). Individuals typically endorse symptoms from multiple subgroups, and symptoms may change over time (Besiroglu et al., 2007; Rufer et al., 2005). Additionally, there have been a large number of individuals with OCD, who endorse compulsive behavior absent of feared consequences (Tolin et al., 2001) driven by internally generated sensory sensations (Coles et al., 2003; de Alvarenga et al., 2012; Farhat et al., 2019; Ferrão et al., 2012; Starcevic et al., 2011). These findings have led researchers to examine alternative motivations that underlie compulsive behavior beyond harm avoidance (Belloch et al., 2016; Summerfeldt, 2004; Summerfeldt et al., 2014). Internally generated sensory sensations in OCD has been understudied in comparison to harm avoidance (Coles & Ravid, 2016), yet may be significant for the conceptualization of OCD and its treatment.

Sensory Experiences in OCD

Sensory experiences within OCD were first described by French psychiatrist Pierre Janet as *les sentiments d'incompletude*, translated from French as "the feeling of incompleteness" (Janet, 1903; see Pitman 1987 for full translation of Janet's publication). Since the time of Janet, researchers have used many terms to describe these sensory symptoms, such as a sense of "incompleteness" (Rasmussen & Eisen, 1992; Summerfeldt. 2004), "not just right experiences" (Coles et al., 2003), sensory phenomena (Miguel et al., 2000), and "just right" perceptions (Leckman et al.,1994). Although distinct, each of these terms is conceptually aiming to capture a similar clinical phenomenon that is highly prevalent within OCD (60-65%; Collins et al., 2021; Fornés-Romero & Belloch, 2017). Research has shown that these sensory perfections, sensations or urges precede repetitive behaviors, can be the primary presenting symptoms (de Alvarenga et al., 2012; Miguel et al., 1997), can occur absent of obsessions/intrusive thoughts or images

(Hazen, 2008; Prado et al., 2008), and at times can be more distressing than fear-based obsessions and compulsions (Ferrão et al., 2012). In this study, we will solely focus on incompleteness, not just right experiences, and sensory phenomena.

CBT conceptualization models of OCD lack a proposed mechanism that may drive compulsive behavior linked to these internally generated sensations. Current CBT models of OCD propose that OC symptoms are motivated by harm avoidance, here the emphasis is on dysfunctional beliefs and prevention of feared consequences (Frost & Skeetee 2002; Taylor et al., 2007). However, harm avoidance is insufficient in OCD conceptualizations, as there is a large number of OCD patients who fail to endorse these dysfunctional beliefs (Bragdon & Coles, 2017; Dams et al., 2020; Starcevic et al., 2011).

Given these findings, there has been growing attention to the distinction between compulsions done to avoid harm and those done to alleviate uncomfortable sensory sensations or feelings of incompleteness (Ecker & Gönner, 2008; Summerfeldt, 2004; Summerfeldt et al., 2014; Taylor, McKay, et al., 2014). OCD driven by internally generated sensory experiences would suggest that an individual engages in compulsions until they achieve an internal sensation of feeling “complete” or “just right,” in which a feared consequence is not identified. For example, a patient may wash their hands until it feels “just right” versus washing their hands to eliminate dirt or germs due to the fear of contamination. Here the emphasis is on the function of the behavior versus the content of the obsession (Starcevic et al., 2011; Summerfeldt et al., 2014). Harm avoidance and incompleteness have been found to be related yet distinct constructs, and frequently co-occur within patient groups (Ecker & Gönner, 2008; Summerfeldt et al., 2014).

Incompleteness

Incompleteness can be defined as a sense or feeling that one's actions, intentions or experiences have not been properly achieved, which results with an individual feeling "not just right" or a sense of imperfection (Summerfeldt, 2004). Incompleteness has been associated with perfectionism, but is considered a distinct construct (Coles et al., 2003; Moretz & McKay, 2009). When examining incompleteness in OCD, overt behavioral compulsions may look the same, but the internal motivating factors driving the behavior can vary. The emphasis is on the function of the behavior, highlighting that there appears to be two distinct motivational factors which drive compulsions (Summerfeldt, 2004; Summerfeldt et al., 2014).

Since the release of Summerfeldt's (2004) two factor motivational model of OCD, researchers have given attention to the role of incompleteness in the disorder. Using a large student sample, Pietrefesa and Coles (2009) sought to behaviorally distinguish between harm avoidance and incompleteness while engaging in various tasks likely to elicit precautionary behaviors (washing dirty dishes to prevent food poisoning, checking and sorting "hazardous" chemicals, proofreading college students resume being sent to employers) and feelings of incompleteness (arranging books on bookshelf, hanging pictures on a wall, sorting contents of recycling bin). Incompleteness and harm avoidance were measured by the Obsessive-Compulsive Trait Core Dimensions Questionnaire (Summerfeldt et al., 2001), a 20-item questionnaire which looks at harm avoidance and incompleteness. Researchers found that harm avoidance was moderately associated with anxiety/nervousness experienced while performing all tasks, and that harm avoidance predicted anxiety/nervousness ratings and desire to prevent harm. Conversely, incompleteness was moderately associated with discomfort/tension across all tasks and desire to perform the tasks perfectly. Incompleteness was also predictive of

discomfort/tension and desire to perform the tasks just right, unlinked to any feared consequence. These findings support the validity of distinguishing between harm avoidance and incompleteness, as they appear to be associated with different emotional responses.

Within a large clinical sample of OCD patients Ecker and Gönner (2008) examined at the relationship between incompleteness and OCD symptoms. Researchers found that on the Yale-Brown Obsessive-Compulsive Scale (YBOCS; Goodman et al., 1989), the gold standard OCD assessment measure, symptom severity had slightly stronger correlations with incompleteness (r = .48) than harm avoidance (r = .41). Additionally, incompleteness was more closely associated with symmetry/ordering symptoms, while obsessional thoughts were a predictor for harm avoidance. These results are in line with previous findings linking dysfunctional beliefs to harm avoidance (Frost & Steketee, 2002). Additional studies have found that incompleteness predicted ordering/symmetry symptoms beyond harm avoidance (Cervin et al., 2020; Lee & Wu, 2019; Sibrava et al., 2016) and was also associated with checking (Cougle et al., 2013) and contamination rituals (Lee & Wu, 2019; Mathes et al., 2019). This suggests that incompleteness may be related to all OCD subgroups but appears to be more relevant to certain symptoms versus others, highlighting the importance of addressing motivational factors in treatment.

A more recent study conducted by Sibrava and colleagues (2016) replicated and extended previous findings analyzing the relationship between incompleteness and other domains of functioning in a large sample of OCD patients. Their results found that ~22.8% of patients endorsed incompleteness symptoms, which were associated with greater OCD severity, greater comorbidity, poorer ratings of functioning, lower quality of life, and higher rated of unemployment and disability. These findings emphasize the clinical importance of feelings of

incompleteness, and the need to further understand underlying mechanisms which contribute to these experiences.

Not Just Right Experiences

"Not just right experiences" (NJREs) are conceptualized as an inner drive to reach a desired state of perfection and/or control, which results in a "not just right experience." "Not just right experiences" are related to incompleteness, and at times have been used interchangeably within the literature (Coles & Ravid, 2016; Fornés-Romero & Belloch, 2017). However, a more parsimonious explanation may be to conceptualize incompleteness as an underlying motivating factor driving compulsive behavior, and NJREs as the sensations triggered by the experience of not being able to achieve a "just right" state (Mathes et al., 2019). Incompleteness may be a trait-based factor that predisposes individuals to experience NJREs (Mathes et al., 2019). Some common examples of NJREs are having a sensation after dressing that part of clothes did not feel just right, placing a book on to a shelf and it not looking just right with other books, and when talking to someone, having the sensation that words did not sound just right. These experiences are typically measured by the Not Just Right Experiences Questionnaire-Revised (NJRE-Q-R; Coles et al., 2005).

"Not just right experiences" have been reported in the general population and by individuals with OCD (Coles et al., 2003; Sica et al., 2016). One study using an undergraduate sample found that 99% of participants reported experiencing at least one NJRE over this lifespan, with 95% of the sample experiencing one NJRE within the past week (Coles et al., 2003). In another study, Ghisi and colleagues (2010) found that 83% of the undergrads in their sample endorsed at least one NJRE in their lifetime, whereas 100% of their OCD sample

reported having at least one NJRE in their lifetime, with 50% of them having it within the past few hours.

Belloch and colleagues (2016) examined a large sample of undergrads and participants with OCD using the Not Just Right Experiences Questionnaire Revised, Obsessive-Compulsive Trait Core Dimensions Questionnaire, Yale Brown Obsessive-Compulsive Scale, and additional measures of OC symptoms, depression and anxiety. This study replicated previous findings that NJREs are common in the general population, with all participants reporting experiencing at least one "not just right experience" in their lifetime. Individuals in the OCD group reported experiencing more than one NJRE in their lifetime, and rating them as more frequent, intense, and distressing than the undergraduate group. Data was also divided into groups based on Obsessive Compulsive Inventory-Revised (OCI-R; Foa et al., 2002) scores, which consisted of those at low risk of OCD (below the median split OCI-R score of 14), at risk of OCD (above OCI-R score of 14), and diagnosed with OCD. Interestingly, those categorized as at risk of OCD and OCD patients did not differ on number of NJREs endorsed on the Not Just Right Experiences Questionnaire Revised. These findings suggest that NJREs may be a vulnerability factor for the development of OCD.

Studies have also developed experimental paradigms to test whether NJREs can be induced within clinical and nonclinical populations. Although slightly modified across studies, researchers have tried to capture NJREs across visual, auditory, and tactile sensory domains. Visual paradigms typically include messy or cluttered rooms, a disheveled bookshelf or rug area, a desk with drawers open, or crocked items on a wall or surface. Auditory paradigms include listening to music out of tune. Tactile paradigms include putting on a large article of clothing

(e.g., lab coat) and buttoning it asymmetrically or using a handwipe and wiping the back of one's non-dominant hand but not the other.

Undergraduate students who endorsed higher intensity of NJREs within the past month (high group) reported more discomfort than students who endorsed low intensity NJREs within the past month (low group) when tested in eight experimental paradigms designed to induce visual NJREs (Coles et al., 2005). The stimuli were divided into two groups, low and high intensity inducing NJREs, based on the assumption that some stimuli may elicit either higher or lower NJREs. For example, a disheveled bookshelf was presumed to be more likely to elicit a NJRE compared to a neatly arranged bookshelf. The high group had more discomfort than the low group on both high and low intensity NJRE inducing stimuli. The high group had higher mean scores than the low group on the urge to respond to the stimuli, yet these differences were not statistically significant. Additionally, feared consequences were rarely endorsed across both groups. These findings are consistent with previous research in support of the two-factor model of OCD distinguishing between compulsions done to reduce a sensation of not being just right and those done to avoid harm.

In a more recent study with a large group of undergraduate students, Summers and colleagues (2014) utilized a NJREs induction tasks via auditory, tactile and visual domains. Across all four tasks, discomfort and urge to counteract was strongly associated with self-report measures of NJREs measured via the Not Just Right Experiences Questionnaire Revised and Obsessive-Compulsive Trait Core Dimensions Questionnaire. Weaker and less consistent associations were found with task ratings and harm avoidance, which is in line with previous research showing that NJREs/incompleteness are distinct from harm avoidance (Ecker &

Gönner, 2008). Ordering and arranging compulsions were found to be most strongly associated with NJREs.

Previous literature has suggested a potential relationship between NJREs and perfectionism (Coles et al., 2003); however, the researchers did not find a significant relationship between perfectionism scores via the Multidimensional Perfectionism Scale (MPS; Frost et al., 1990) and task ratings after controlling for negative affect and pre task discomfort. Given the mixed findings, further research is needed to explore the relationship between NJREs and perfectionism.

In an effort to replicate and extend Summers and colleagues (2014) findings, Irwin and Jones (2017) added a "just right" condition to the study design and the construct of anxiety sensitivity in relation to NJREs. Researchers found that NJREs task rating (discomfort and urge to counteract) were positively associated with self-report measures of NJREs, OC symptoms, and anxiety sensitivity. However, contrary to Summers and colleagues' (2014) findings, the researchers found a positive association between maladaptive perfectionism, specifically concern over mistakes and doubts about actions, and ratings of discomfort and urge to counteract during the NJRE tasks. The researchers hypothesized that anxiety sensitivity would moderate the relationship between maladaptive perfectionism and NJREs task performance but failed to find support for hypothesis. This suggests that although perfectionism and NJREs may be related, they are distinct experiences, not influenced by the interaction of anxiety sensitivity, and have not been found to be associated across all perfectionism domains.

Additionally, a group of researchers developed and tested a novel NJREs induction paradigm which consisted of interruption on a short-term memory free recall task (Fornés-Romero & Belloch, 2017) across both clinical and non-clinical samples. Rationale for this novel

paradigm was that disruption of working memory processes may interfere with other mental processes, such as ordering, checking, etc., which would then elicit an internal uncomfortable feeling of incompleteness/NJRE. Nonclinical samples who were randomized into the induction condition reported significantly higher scores on the post task questionnaire than those not in the induction condition. This questionnaire assessed physical discomfort and the need to a behavior or to check repeatedly at the mandatory stop time. Given these ratings, the researchers felt confident that the paradigm was successful at inducing NJREs.

When applied to an OCD clinical population, researchers found that all patients reported experiencing more than one uncomfortable sensation while performing the induction task and immediately after. Physical discomfort and the need to a behavior or to check repeatedly at the mandatory stop time scores were significantly correlated with NJREs and incompleteness scores. The researchers also found weak associations between NJREs and the harm avoidance subscale, which continues to provide further support for the notion that compulsions related to incompleteness/NJREs are distinct than those related to harm avoidance. Interestingly, the investigators reported that some participants from the OCD group emailed them post task to describe compulsions they engaged in to "feel right" after completing the study. Despite the limitation of this study not implementing a control condition when examining the OCD group, these findings suggest that that incompleteness/NJREs may play an etiologic role in compulsive symptoms.

The researchers examined differences between both the OCD patients and nonclinical participants in the induction group, and found that OCD patients scored higher than the nonclinical group on all measures, except the number of NJREs endorsed, which showed no significant difference between groups. These findings suggest that the occurrence of NJREs may

not be problematic, as it may be the subjective experience of one's level of distress, urges to counteract, and overall reactions to the NJREs that appears to be problematic. Potentially, the severity versus frequency of a NJRE may be a vulnerability marker of NJREs. Taken together, these findings support that NJREs can be induced across both clinical and nonclinical samples and result in discomfort and urge to correct for or counteract the experience.

Multiple studies have examined NJREs and its relationship to other constructs and disorders. One study found that NJREs may serve as a transdiagnostic mechanism which occurs across various psychopathology such as OCD, generalized anxiety disorder, and clinical perfectionism (Fergus, 2014). However, there has been further evidence suggesting that NJREs are most closely associated to OCD than other disorders (Belloch et al., 2016b; Coles et al., 2005; Ghisi et al., 2010; Sica et al., 2015).

Additionally, there is evidence to support NJREs as a potential endophenotype of OCD. Sica and colleagues (2016) conducted a study examining the frequency and severity of NJREs in offspring of parents with OC symptoms (at-risk group) versus those without OC symptoms (no risk group) within a college student sample. Researchers found that the at-risk group reported higher scores on both NJREs frequency and severity, and that these differences remained significant after controlling for general distress (anxiety and depression) when compared to the no risk group. In the at-risk group, NJREs were associated with all OC domains measured by Obsessive Compulsive Inventory, which provides further evidence that incompleteness/NJREs potentially underlie most manifestations of OCD. Given these results, NJREs may qualify as an endophenotype for OCD due to its specificity within the disorder (Belloch et al., 2016b; Coles et al., 2005; Ghisi et al., 2010; Sica et al., 2015), prevalence in both clinical and nonclinical samples (state independence; Belloch et al., 2016; Coles et al., 2003; Fornés-Romero & Belloch,

2017; Sica et al., 2016), and increased frequency and severity in offspring of those who reported higher OC symptoms (familial association; Sica et al., 2016). However, further research is needed to examine the role of NJREs as a potential OCD endophenotype.

Sensory Phenomena

Lastly, in an effort to capture and synthesize the range of sensory experiences which precede repetitive behaviors, the term sensory phenomena has been used to describe uncomfortable and disturbing sensations, feelings or urges that can be experienced physically or mentally (Prado et al., 2008; Rosario-Campos et al., 2005). In addition to incompleteness and "not just right experiences," sensory phenomena include aversive physical sensations such as repetitive muscle tensing and contracting, built up energy sensations, as well such as sensations in the muscles, joints, skin, and viscera (Rosario-Campos et al., 2005), which have also been endorsed within OCD presentations (Shavitt et al., 2014). Sensory phenomena have primarily been studied in OCD and Tourette's Disorder (TD), and comorbid OCD/TD (Prado et al., 2008); however, researchers have found its presence across various forms of psychopathology and medical conditions (Rosario et al., 2017).

In relation to OCD, researchers have found that sensory phenomena are highly prevalent (~60-65%; Ferrão et al., 2012; Shavitt et al., 2014), associated with an earlier age of onset, and greater comorbidity with tic disorders (Ferrão et al., 2012; E. C. Miguel et al., 1997; Miguel et al., 2000; Shavitt et al., 2014). In line with traditional obsessions and compulsions, sensory phenomena symptoms have been found to cause significant distress and impairment, interfere with social and occupational functioning (Prado et al., 2008), and at times have been reported as more distressing than fear-based obsessions and compulsions (Ferrão et al., 2012). Sensory phenomena can be measured via the University of San Paolo Sensory Phenomena Scale

(Rosario-Campos et al., 2005; Rosario et al., 2009; Sampaio et al., 2014), which is designed as a semi structured interview that assesses frequency and severity across a full spectrum of sensory symptoms that precede repetitive behaviors. Given their high prevalence, it is recommended that clinicians assess for sensory phenomena symptoms and identify methods to target them in treatment.

Sensory Symptoms and OCD Treatment

Patients with OCD who are unable to articulate a feared consequence have been shown to have less post treatment improvement compared to those with feared consequences (Foa et al., 1995). Given these findings, it is unsurprising that individuals who experience prominent sensory symptoms within OCD have been found to not respond as well to EX/RP (Shavitt et al., 2014; Sibrava et al., 2016). There is little research to date specifically assessing for, targeting, and treating sensory symptoms in OCD (McKay, 2020; Schubert et al., 2016; Summerfeldt, 2007). Coles and Ravid (2016) conducted a study that examined the use of cognitive behavioral therapy (CBT) to treat "not just right experiences" (NJRE) in adults with OCD. Results found that CBT was associated with significant reductions in NJREs scores; however, the researchers stated that CBT was modified to address NJREs, which may be overlooked or missed within traditional treatment. Additionally, Mathes and colleagues (2019) examined the role of incompleteness/NJREs in behavioral treatment of contamination-based OCD. Researchers found that greater pretreatment discomfort to the NJRE behavioral task was associated with greater contamination symptoms post treatment and follow up. This highlights that the presence of NJRE symptoms within individuals who experience heightened OC symptoms related to contamination may impact and interfere with treatment and result in continued discomfort and distress post EX/RP.

A meta-analysis examining the efficacy of OCD treatment for incompleteness found eleven studies which directly addressed incompleteness in treatment (Schwartz, 2018). Those which assessed for and targeted incompleteness as part of the treatment protocol reported a reduction in incompleteness symptoms, however many researchers did not formally address, measure, or tailor treatment to specifically target these symptoms. These findings suggest that incompleteness may be amenable to treatment if assessed for and incorporated into CBT or EX/RP treatment plans. If the two-factor motivational model of OCD symptoms were to be widely adopted, clinicians and researchers would be trained to assess for, identify, and target incompleteness in current OCD treatments and treatment development research.

Overall, there is a need to further examine sensory experiences in OCD as they are highly prevalent, yet poorly understood, identified, and targeted in treatment. Researchers have hypothesized a sensory-affective dysfunction which may underlie these experiences (Bragdon & Coles, 2017; Ferrão et al., 2012; Irwin & Jones, 2017; Summerfeldt, 2004; Summerfeldt et al., 2014). Feelings of incompleteness/"not just right experiences" may be seen as a deficit in the ability to use emotional experience and sensory feedback to guide behavior, which may implicate dysfunction related to sensory processing (Ben-Sasson et al., 2017; Ben-Sasson & Podoly, 2020; Collins et al., 2021; Summerfeldt et al., 2014). Few studies have looked at the relationship between potential sensory dysfunction and OCD. Given the above proposed hypotheses, further examining the interplay between these domains and OCD may assist in gaining a better understanding of the potential mechanisms and etiological factors of these sensory driven compulsions. Given the conceptual overlap amongst these constructs, and their use interchangeably within the literature (Coles & Ravid, 2016; Fornés-Romero & Belloch, 2017), they will be referred to as a single cluster of sensory sensations.

Sensory Processing and OCD

Research suggests that individuals with OCD have altered experiences related to sensory processing (Grimaldi & Stern, 2017). Sensory processing is operationalized as one's ability to register and regulate sensory information and generate responses to sensory input (Harrison et al., 2019; Humphry, 2002; Schauder & Bennetto, 2016).

Dar and colleagues (2012) examined the relationship between sensory processing, childhood ritualism, and OC symptoms in a large community sample, and found that recollected and current taste/smell and tactile sensitivity was significantly correlated with OC symptom severity measured by Obsessive Compulsive Inventory-Revised. Specifically in clinical populations, Lewin and colleagues (2015) found that compared to healthy controls, children and adolescents with OCD endorsed higher scores across all sensory modalities via the Short Sensory Profile (Dunn, 1999), and the level of responsivity was positively correlated with severity of both compulsions and impairment. These findings display that altered sensory processing patterns appear to be present within childhood and adolescence and are associated with OC symptoms. Atypical sensory experiences in childhood may also serve as a risk factor in the development of OCD (Hazen et al., 2008; Levit-Binnun et al., 2013; Summerfeldt, 2004), however further research is needed to examine that relationship.

Similarly, within an adult sample of participants with OCD, Rieke and Anderson (2009) found that patients scored higher than general population for low registration, sensory sensitivity, and sensation avoiding patterns, and scored lower than general population on sensation seeking via the Adolescent/Adult Sensory Profile (Brown et al., 2001). This suggests that individuals with OCD may have delayed or even missed responses to stimuli (low registration), experience discomfort and difficulty ignoring sensory stimuli (sensory sensitivity), or may experience

sensory stimuli as overwhelming and try to limit or avoid exposure to it (sensory avoidant). Taken together, these results suggest that individuals with OCD may attend to and process sensory information differently than the general population, and that these sensory patterns appear may be associated with OC symptom frequency and severity.

Recently, there has been specific emphasis on the role of sensory over-responsivity in relation to OCD. Sensory over-responsivity is defined as a heightened detection of subtle sensory differences, and exaggerated or prolonged reactions to these externally generated sensations (Ben-Sasson et al., 2017; Ben-Sasson & Podoly, 2017; Miller et al., 2007; Miller & Schaaf, 2008). Sensory Perception Quotient (SPQ; Tavassoli et al., 2014) has been designed to capture hyper and hyposensitivity related to daily functioning across all five sensory modalities. These aspects of sensory sensitivity have been categorized as part of the presentation of sensory over-responsivity (Ben-Sasson & Podoly, 2017). Two findings using the SPQ-short with a non-clinical sample found a positive relationship between SPQ scores and self-reported OC symptoms severity via the Obsessive-Compulsive Inventory-R (Ben-Sasson et al., 2017; Ben-Sasson & Podoly, 2017). Additionally, sensory over-responsivity has been hypothesized to be related to the presence of "not just right experiences" in OCD (Ben-Sasson et al., 2017; Ben-Sasson & Podoly, 2017, 2020), yet further evidence is needed to establish that relationship. Deficits in sensory processing, specifically sensory sensitivity, sensory habituation, and sensory over-responsivity may potentially be risk factors for the development of OCD, and specifically the presence of "not just right experiences" observed within the disorder (Ben-Sasson & Podoly, 2020).

Other studies have tried to capture the relationship between sensory over-responsivity and OCD more broadly. In a large internet based sample, individuals who endorsed more tactile

and auditory over-responsivity also endorsed greater number of OC symptoms (Taylor, Conelea, et al., 2014). However, sensory over-responsivity was assessed by two true/false items developed by the research team (tactile intolerance: "I am very bothered by certain tactile sensations, such as clothing textures or tightness; substances that feel stick, greasy or wet, or activities like haircuts or cutting my nails"; auditory intolerance: "I am very bothered by certain auditory sensations, such as the sound of alarms, sirens, appliances, or background noises like people talking or ticking clocks") versus a specific measure of sensory processing. In a longitudinal study looking at the relationship between sensory over-responsivity and OCD in children and adolescents, participants' likelihood of exhibiting OCD symptoms increased with each symptom of tactile or auditory over-responsivity at 8 and 13 years old (Van Hulle et al., 2019). Lastly, a critical review of exteroceptive abnormalities in childhood/adolescent OCD found support for the notion that sensory abnormalities are common in children with anxiety disorders and OCD, yet there are limitations to the current body of research, which prevents firm conclusions from being made (Houghton et al., 2020). Further research is needed to establish the role of sensory over-responsivity in relation to OCD, and the potential role it plays in sensory symptoms.

Misophonia

Misophonia, a highly negative emotional response and autonomic arousal triggered by specific sounds (Jastreboff & Jastreboff, 2002), may be conceptualized as a form of auditory over-responsivity (Brout et al., 2018). Misophonia can lead to significant distress and disability (Schroder et al., 2013) and some case studies there have been reports of co-occurrence of OCD with misphonia (Edelstein et al., 2013; Ferreira et al., 2013; Webber et al., 2014). Similar to compulsions in OCD, individuals with misophonia often engage in rituals to try to alleviate uncomfortable sensations or feelings triggered by these specific sounds (Webber et al., 2014; Wu

et al., 2014). One study found that misophonia was positively correlated with self-reported OC symptoms via the Obsessive-Compulsive Inventory-Revised in a large non-clinical sample of college undergraduates (Wu et al., 2014). However, McKay and colleagues (2018) used profile analysis to identify psychology features that distinguish those with and without misophonia symptoms in a community sample, and failed to find a relationship between misophonia, OCD and related disorders. Given these mixed results, further research is needed to understand the potential relationship between OCD and misophonia.

Neurophysiological and Neuroimaging Findings

Neurophysiological and neuroimaging findings have provided further evidence of sensory deficits in individuals with OCD. At the neurophysiological level, individuals with OCD have displayed deficits in sensory motor gating. Sensory motor gating is an inhibitory process by which the brain filters out unnecessary information from the environment (Hoenig et al., 2005; Houghton et al., 2020). Studies have indicated that individuals with OCD have trouble with gating out/filtering sensory information from environmental stimuli (Ahmari et al., 2012; Hashimoto et al., 2008; Hoenig et al., 2005; Korostenskaja et al., 2013; Rossi et al., 2005) however the findings are mixed (De Leeuw et al., 2010; Pittenger et al., 2016; Steinman et al., 2016). Potential deficits in sensory motor gating may explain the presence of compulsions, specifically those driven by sensory sensations.

Brain imaging findings have displayed altered sensory processing in OCD. Pittenger and colleagues (2016) conducted a study examining sensory motor gating in patients with OCD and healthy controls using positron emission tomography. The researchers found that in participants with OCD, brain regions typically not associated with sensory functioning, such as the medial temporal lobe and the orbitofrontal cortex, were performing sensory processing tasks. These

preliminary findings suggest neural reorganization of sensory circuitry in individuals with OCD. Additionally, an functional magnetic resonance imaging study conducted by Berlin and colleages (2018) found abnormalities in neural activation related to olfactory processing in OCD. Specifically, the researchers found abnormal functioning in the insula related to processing the valence associated with both pleasant and unpleasant odors, indicating dysfunction in neural networks related to sensory processing. Taken together, these findings support the notion that individuals with OCD may experience a deficit in sensory gating and processing at the neurophysiological and neural level. These deficits in sensory gating may explain the higher prevalence of low neurological sensory threshold patterns and sensory over-responsivity (Grimaldi & Stern, 2017).

Rationale for the Current Study

Despite the fact that increasing research supports alterations in sensory processes in OCD, these traits and factors are underrepresented in theoretical models of OCD that guide evidence-based treatments (Bragdon & Coles, 2017; Coles & Ravid, 2016). Expanding upon this research within the context of OCD is imperative, as it may provide critical evidence identifying underlying mechanisms and etiological factors that may influence compulsive behavior, specifically compulsions driven by internally generated sensory sensations. OCD is a highly heterogenous and debilitating condition (Markarian et al., 2010), of which approximately 20-30% of individuals prematurely drop out of behavioral treatment (Abramowitz, 2006). Of those who do complete cognitive behavioral treatment, a substantial number do not report clinically significant reductions in symptoms (Hezel & Simpson, 2019), leaving many individuals still suffering. Broadening our knowledge of sensory phenomena and potential factors which

influence these symptoms may allow researchers and clinicians to expand upon their conceptualization of OCD and its treatment and inform novel, effective interventions.

The purpose of this study was to bridge this gap by examining the association between sensory over-responsivity, sensory phenomena, and obsessive-compulsive symptoms in the general population. Studying these variables in a nonclinical sample is relevant for several reasons (see Taylor, McKay, et al., 2014, Appendix A for a comprehensive review supporting the use of nonclinical samples for studying obsessive-compulsive phenomena). OC symptoms, subclinical OCD, and sensory phenomena have both been endorsed independently within a large portion of the general population over the course of their lifetime (Coles et al., 2003; Ghisi et al., 2010; Ruscio et al., 2010). Classifying nonclinical samples in terms of "caseness" has also displayed a high prevalence of clinically significant OC phenomena within the general population. "Caseness" refers to individuals who endorse clinically significant symptoms who may or may not meet full diagnostic criteria for a particular disorder. Participants endorsing a four or higher on the Obsessions Subscale of the Obsessive-Compulsive Inventory Revised are likely to experience clinically significant obsessive-compulsive phenomena (Foa et al., 2002). Utilizing the cutoff score of four on the Obsessive-Compulsive Inventory Revised Obsessions Subscale has served as the marker for classifying "caseness" in previous studies with nonclinical samples (Siev et al., 2010; Taylor et al., 2010, 2014). Across these studies, results ranged between 22-40% of nonclinical participants meeting "caseness" criteria (Siev et al., 2010; Taylor et al., 2010, 2014), displaying that clinically significant OC phenomena is common within the general population, and a high likelihood of these phenomena being endorsed within a community sample.

Further, taxometric research has found that OC symptoms appear to occur on a continuum versus categorically (Haslam et al., 2005; Olatunji et al., 2008). This suggest that those within the community experience milder variations of what is seen in clinical populations (Sica et al., 2016) indicating their relevance in the study of OC phenomena. Lastly, no study to date has examined the relationship between this set of variables within a community sample. This can not only lead to further information regarding OC symptoms and sensory phenomena but can provide novel insight into the prevalence of sensory dysfunction more broadly and its unique relationship to these phenomena. Given this rationale, a community sample was therefore deemed an appropriate group for the nature of this study.

Hypotheses

1. There will be a positive association between OC symptoms measured via the Obsessive Compulsive Inventory-Revised (OCI-R), Obsessive Compulsive Trait Core Dimensions Questionnaire (OQ-TCDQ; across both harm avoidance and incompleteness subscales) and current Not Just Right Experiences Questionnaire Revised (NJRE-Q-R), therefore establishing the relationship between OC symptoms and various sensory symptoms.
2. There will be a positive relationship between incompleteness scores on the OC-TCDQ and NJRE-R-Q, specifically that incompleteness scores will be predictive of the number of, frequency and severity of current “not just right experiences.”
3. There will be a relationship between OC symptoms and sensory over-responsivity, specifically higher scores on the Sensory Perception Quotient will be predictive of greater OC symptoms.
4. There will be a positive relationship between altered sensory processing and incompleteness scores, specifically higher scores on the Sensory Perception Quotient will

be predictive of incompleteness and current "not just right experiences" frequency. This will examine previous hypotheses in the literature suggesting sensory dysfunction related to incompleteness in OCD (Bragdon & Coles, 2017; Ferrão et al., 2012; Summerfeldt, 2004; Summerfeldt et al., 2014).

5. The relationship between OC symptoms and sensory phenomena (incompleteness/ "not just right experiences") will be moderated by sensory over-responsivity scores via the Sensory Perception Questionnaire. Specifically, higher levels of sensory over-responsivity will strengthen the association between OC symptoms and sensory phenomena (incompleteness and "not just right experiences").

Research question. Interoceptive deficits have been found across several psychiatric disorders (Khalsa & Lapidus, 2016; Khalsa et al., 2018) with some studies suggesting interoceptive deficits within OCD (Eng, et al., 2020; Schulten et al., 2019; Stern, 2014; Yoris et al., 2017). Interoception can be examined multiple ways via interoceptive accuracy, sensibility and awareness. For the purposes of this study, examining interoceptive sensibility, the subjective assessment of one's internal bodily state across daily life (Khalsa et al., 2018; Mehling et al., 2018; Trevisan et al., 2019), may provide clinically relevant information regarding ones individualized personal experience of how they attend to their internal body sensations. These findings may provide further insight into sensory phenomena symptoms, as they have been described as internally generated sensations. It is of interest to explore the relationships between interoceptive sensibility, sensory phenomena, sensory over-responsivity, and OC symptoms. Given the limited findings in the literature, this research question was exploratory in nature and directionality of these relationships were unable to be determined a priori.

Chapter 2 – Method

Participants

A power analysis conducted in G*Power (Faul et al., 2007) indicated that a sample size of 485 participants would provide adequate power (80%) to detect a small effect size ($f^2 = 0.02$, alpha = .05) for the planned analyses. Research on online studies suggests that about 10% of data is often eliminated from main analyses due to data quality or missingness (Barends & de Vries, 2019). To account for this, the proposed sample size for the study was increased to 535 to increase the likelihood that the main analyses had adequate statistical power.

Participants were recruited through Prolific Academic. Prolific is an online subject recruitment platform similar to that of Amazon's MTurk; however, the platform is designed by researchers specifically for the purpose of conducting research (Palan & Schitter, 2018). Participants via the Prolific platform are explicitly informed that they are recruited to participate in research and undergo pre-screening questionaries independent of any research studies. Given that this information is collected prior to participating in a study, participants are unable to change their demographic information to align with a particular study which helps to ensure data integrity. Prolific has been shown to be comparable to Amazon's MTurk (Peer et al., 2017), with the addition of specific guidelines to ensure data quality and minimum fixed payment rates per unit of time required to complete an experiment. This gives researchers the option to filter participants based on specific study criteria.

To be included in the study, participants had to speak English, live in the United States, and be 18 years of age and older. Overall, 543 participants completed this survey. Of these, 12 participants' responses were rejected following failed attention checks, while an additional 12 were eliminated due to missing data. Therefore, final analyses reflect the responses of 519 participants. No participants were excluded from study analyses due to responses falling three or

more standard deviations above the mean on study questionnaires. Participants' demographic information can be found in Table 1.

Table 1

Descriptive Statistics

Variable	**(n=519)**		
Gender		Mental Health Dx*	
Male	290 (55.9%)	Yes	156 (30.1%)
Female	224 (43.2%)	No	362 (69.7%)
Other	5 (1%)	Psychotherapy*	
Race		Yes	78 (15%)
White	358 (69%)	No	440 (84.8%)
Black	55 (10.6%)	Psychotropic Meds**	
Hispanic/Latinx	28 (5.4%)	Yes	55 (10.6%)
Asian/Asian-American	60 (11.6%)	No	462 (89%)
Multiracial	13 (2.5%)		
Other	5 (1%)		
Employment			
Full Time	317 (61.1%)		
Part Time	61 (11.8%)		
Per diem	8 (1.5%)		
Unemployed	63 (12.1%)		
Student	38 (7.3%)		
Retired	22 (4.2%)		
Unable to work	10 (1.9%)		
Education			
Some H.S.	3 (.6%)		
H.S. Grad	43 (8.3%)		
Some College	95 (18.3%)		
Associates	38 (7.3%)		
Bachelors	180 (34.7%)		
Masters	120 (23.1%)		
Doctoral	15 (2.9%)		
Professional (MD, JD)	13 (2.5%)		
Trade/Vocational	12 (2.3%)		
Geographic Location			
Northeast	138 (26.6%)		
Southern	169 (32.6%)		
Mid-West	108 (20.8%)		
Western	103 (19.8%)		
Alaska	1 (0.2%)		

Note. Dx = diagnosis; * = missing data from one participant; ** = missing data from two participants.

Of the 519 participants who qualified, there were slightly more individuals who identified as males (~56%) than females, with a small percentage identifying as other. Participants' ages ranged from 18–82 (M = 36.49, SD = 12.13). Regarding racial and ethnic identities, the majority of participants identified as White. Most participants endorsed working full-time. Regarding education, approximately one-third of the sample reported having earned a bachelor's degree and one-quarter endorsed having earned a master's degree; the remaining participants reported education varying from some high school to a doctoral or professional (M.D., J.D.) degree. Participants' geographic location varied across the United States, with one-third of participants currently living in the south.

Regarding mental health conditions, one-third of the sample endorsed having a diagnosed mental health condition, primarily depression and anxiety, though most did not endorse participating in psychotherapy. Lastly, a small portion of the sample endorsed currently taking psychotropic medications, primarily antidepressants, with data missing from two participants.

Design and Measures

This study is a cross sectional design with participants from the general population. All participants received the same measures.

Demographics and Mental Health History. Information such as participants' age, race, gender, location in the U.S., employment status, and level of education was collected. Participants were asked to indicate whether they have or have had a diagnosed mental health illness/condition, and if so, what is/was the diagnosis, if they were currently or have recently participated in psychotherapy, and if so, length of involvement in therapy, and if they were taking psychiatric medications, and if so, what is/are the name(s) of the current medication(s). The full demographic questionnaire can be found at Appendix A.

Incompleteness. Feelings of incompleteness were measured using the Obsessive-Compulsive Trait Core Dimensions Questionnaire (OC-TCDQ; Summerfelt et al., 2001). The OC-TCDQ is a 20-item measure assessing two constructs thought to motivate obsessions and compulsions: harm avoidance and incompleteness (Appendix B). Items are rated on a 5-point Likert scale from 1 (*never applies to me*) to 5 (*always applies to me*) and are scored as individual subscale scores. In nonclinical samples, the harm avoidance and incompleteness subscales have shown high internal reliability (Cronbach's $\alpha = 0.89$ and 0.88, respectively; Summerfeldt et al., 2014). Confirmatory factor analysis has shown support for the two-factor structure in nonclinical student samples (Pietrefesa & Coles, 2008) and nonclinical general samples (Summerfeldt et al., 2014). These findings support the separability and distinctness of these two constructs, which are measured as two separate subscales. Evidence of convergent validity has also been obtained (Coles et al., 2005). In this sample, the harm avoidance and incompleteness subscales showed high internal reliability (Cronbach's $\alpha = 0.91$ and 0.90, respectively).

Not Just Right Experiences. To assess for the presence of "not just right experiences," the Not Just Right Experiences Questionnaire Revised (NJRE-Q-R) (Coles et al., 2003) was used (Appendix C). The NJRE-Q-R is a 19-item total measure of "not just right experiences" (NJRE). Participants first rate whether or not ten NJRE experiences have occurred within the past month. If a NJRE occurred within the past month, it is labeled under NJRE current (NJRE-C). Any NJREs reported prior to the past month are labeled as NJRE past (NJRE-P). The most recent NJRE is then identified and rated on an eight-item severity scale (NJRE-S), which assesses frequency, intensity, immediate distress, delayed distress, rumination, urge to respond, and sense of responsibility on a 7-point Likert scale of 1 (*absent*) to 7 (*extreme*). Scores on the severity scale range from eight to 56. The NJRE-Q- R has shown adequate internal reliability

(Cronbach's α = 0.79) and good convergent validity with other features of OCD (*r*s ranging from 0.44 to 0.60 (Coles et al., 2003). Discriminant validity has also been shown through weaker correlations with symptoms of non-OCD psychopathology (*r*s ranging from 0.21 to 0.45; Coles et al., 2003). In this sample, the NJRE-Q-R showed high internal reliability (Cronbach's α = 0.83).

Obsessive-Compulsive Symptoms. Obsessive-compulsive symptoms were measured via the Obsessive-Compulsive Inventory Revised (OCI-R; Foa et al., 2002) (Appendix D). The OCI-R is an 18-item measure of OC symptoms designed for use with clinical and nonclinical samples. Items are rated on a 5-point Likert scale of 0 (*not at all*) to 4 (*extremely*), with higher scores indicating greater symptom severity. The recommended clinical cut off score is 21, which may indicate the presence of OCD. The OCI-R yields a total score as well as six subscale scores (checking, hoarding, neutralizing, obsessing, ordering, and washing). Among clinical and nonclinical samples, internal reliability is high within four of the six subscales (Cronbach's α = 0.34 to 0.90) and very high for total scores (Cronbach's α = 0.81 to 0.93) (Taylor, McKay, et al., 2014). Test-retest reliability also been shown to be strong for both total and subscale scores for OC samples (*r*s = 0.74 to 0.91) and nonclinical samples (*r*s = 0.57 to 0.87) (Taylor et al., 2014). OCI-R scores have demonstrated good convergent validity with other widely used measures of OC symptoms (*r*s = 0.53 to 0.85) and discriminant validity from measures assessing symptoms of depression (Foa et al. 2002; Sica et al., 2009). High internal reliability has also been demonstrated for the OCI-R in online administration format (Cronbach's α = 0.94; Coles et al., 2007). In this sample, the OCI-R showed high internal reliability for total scores (Cronbach's α = 0.93).

Sensory Over-Responsivity. Sensory over-responsivity was measured by the Sensory Perception Questionnaire Short Version (SPQ; Tavassoli et al., 2014) (Appendix E). The SPQ is a 35-item measure which examines hyper- and hyposensitivity across all five sensory modalities. This measure is focused on detection and/or discrimination of sensory experiences. The SPQ short version has 30 items which describe hypersensivity and 5 which describe hyposensitivity. Items are assessed by a 4-point Likert scale from 0 (*strongly disagree*) to 3 (*strongly agree*). The SPQ has high internal reliability (Cronbach's $\alpha = .93$) good concurrent validity (Tavassoli et al., 2014). Similar to previous studies utilizing this measure (Ben-Sasson et al., 2017; Ben-Sasson & Podoly, 2017, 2020), hyposensitivity items will be reverse scored so that overall higher scores indicate higher sensitivity. In this sample, the SPQ showed high internal reliability (Cronbach's $\alpha = 0.92$).

Interoceptive sensibility. Interoceptive sensibility was measured by The Multidimensional Assessment of Interoceptive Awareness Version 2 (MAIA-2; Mehling et al., 2018) (Appendix F). The MAIA-2 includes 32 questions assessing 8 dimensions of interoceptive sensibility identified through factor analysis: (1) tendency to notice or become aware of body sensations, (2) tendency to not distract oneself from sensations of pain or discomfort, (3) tendency to not worry about or experience emotional distress in response to sensations of pain or discomfort, (4) ability to sustain and control attention to body sensations, (5) awareness of the link between emotion and body sensations, (6) ability to regulate negative emotion through attention to body sensations, (7) tendency to listen to body sensations for insight into emotion and guide behavior, and (8) tendency to experience the body as safe and trustworthy. Items are rated on a 6-point Likert scale ranging from 0 (*never*) to 5 (*always*). This MAIA-2 has displayed construct validity with other measures of body awareness, mindfulness, and emotion regulation

(Mehling et al., 2012; Mehling, 2016). Internal reliability for the eight subscales is high and ranges between Cronbach's α = 0.64 to 0.83 (Mehling et al., 2018). In this sample, the MAIA-2 showed high internal reliability for total scores (Cronbach's α = 0.92).

Procedure

The study was posted on Prolific and made available in batches of 15-30. This allowed the researcher to examine data quality, accept or discard data in a timely fashion, and determine remaining number of participants needed for the proposed sample size. Once the study was public, participants from Prolific who met study criteria and were interested were directed to a link for the study survey designed in Qualtrics. Participants were first prompted to read the IRB approved consent form (Appendix G). They were informed that they would be compensated $4.28 for completion of the study. This payment was predetermined by Prolific who provided a fixed rate per unit of time. Participants were also informed that they would not be compensated if they failed one or more of the data quality checks placed randomly throughout the survey. These check items consisted of manipulation questions, click counts per page, time spent on each question, and time spent on each page. These data quality checks have been implemented in previous research and recommended for use in online data collection (Buchanan & Scofield, 2018; Oppenheimer et al., 2009).

Once participants consented and agreed to move forward, they were prompted to begin filling out the study survey. The study took approximately 25-30 minutes to complete. Once participants reached the end of the study, they were given a randomly generated code and asked to enter it back into Prolific. Participants were informed that entering this code back into Prolific indicated completion of the study and was needed for final compensation.

Statistical Analyses

A series of correlations were implemented to examine the specific associations amongst variables for Hypotheses 1-4. For Hypotheses regarding the likelihood of one variable predicting the value of a second variable hierarchical regression was conducted (Hypotheses 2-4). To assess whether sensory over-responsivity moderated the association between OC symptoms and sensory phenomena (Hypothesis 5) the PROCESS macro (Hayes, 2018) in SPSS was used. PROCESS is a modeling tool that has been widely used within the social sciences and has been selected due to its ability to detect interactions and main effects of the variables being tested. To examine differences across demographic variables (gender, race, education), an analysis of variance was conducted. To examine the association between age and study variables, a bivariate correlation was conducted.

Chapter 3 - Results

Descriptive Statistics and Group Differences

Means and standard deviations for the primary variables of interest can be found in Table 2. A similar pattern of results were found compared to previous studies using community samples (Ben-Sasson et al., 2017; Taylor et al., 2014). However, for current "not just right experiences" (NJREs), participants in this sample endorsed fewer items than in prior literature ($M = 1.84$, $SD = 2.33$ compared to $M = 3.4$, $SD = 2.4$; Taylor et al., 2014).

An analysis of variance (ANOVA) was conducted to determine whether there were differences in study variables (i.e., incompleteness, NJREs, OC symptoms, and sensory over-responsivity) across demographic groups (i.e., gender, race, education). There was a statistically significant difference between genders on the incompleteness $F(2, 516) = 3.14$, $p = .04$, current NJREs frequency, $F(2, 516) = 7.64$, $p = .001$, and sensory over-responsivity $F(2, 516) = 4.22$, $p = .01$, in which females endorsed higher scores across all three variables. There was a

statistically significant difference between racial groups on sensory over-responsivity $F(5, 513) = 4.86$, $p = .001$. Lastly, there was a statistically significant difference between levels of education and OC symptoms, $F(8, 510) = 2.26$, $p = .02$, and sensory over-responsivity $F(8, 510) = 2.05$, $p = .04$. Age was significantly negatively correlated with harm avoidance ($r = -.18$), incompleteness ($r = -.11$), current NJREs frequency ($r = -.11$), and OC symptoms ($r = -.18$).

Table 2

Descriptive Statistics of Self-Report Measures

Measure	*M*	*SD*
OCI-R	17.47	14.40
INC	23.74	9.17
HA	22.68	9.56
NJRE-C	1.84	2.33
NJRE-P	3.12	2.59
NJRE-S	31.71	9.03
SPQ	54.44	15.26

Note. OCI-R = Obsessive-Compulsive Inventory Revised, clinical cut off score = 21; INC = Incompleteness subscale of the Obsessive Compulsive Trait-Core Dimensions Questionnaire; HA = Harm Avoidance subscale of the Obsessive Compulsive Trait-Core Dimensions Questionnaire; NJRE-C = Not Just Right Experiences Questionnaire Revised, current frequency; NJRE-P = Not Just Right Experiences Questionnaire Revised, past frequency; NJRE-S = Not Just Right Experiences Questionnaire Revised, severity scale; SPQ = Sensory Perception Questionnaire Short Form; higher scores indicate increased symptom endorsement across all measures.

Hypothesis 1

To address Hypothesis 1, examining the association between OC symptoms, incompleteness, and NJREs, a bivariate correlation was conducted (Table 3). It was hypothesized that there would be a positive association between OC symptoms measured via the Obsessive-Compulsive Inventory-Revised (OCI-R), Obsessive Compulsive Trait Core Dimensions

Questionnaire (OQ-TCDQ) across both harm avoidance and incompleteness subscales, and current NJREs measured via the Not Just Right Experiences Questionnaire Revised (NJRE-Q-R). Findings indicated that there was a significant positive correlation between OC symptoms and incompleteness $r(517) = .72$ $p < .001$, harm avoidance $r(517) = .67$ $p < .001$, and current NJREs $r(517) = .57$ $p < .001$.

Table 3

Pearson product bivariate correlations between study variables

Variable	**1.**	**2.**	**3.**	**4.**	**5.**
1. OCI-R	-				
2. INC	.72**	-			
3. HA	.67**	.77**	-		
4. NJRE-C	.57**	.56**	.47**	-	
5. SPQ	.45**	.38**	.33**	.33**	-

Note. OCI-R = Obsessive-Compulsive Inventory Revised; INC = Incompleteness subscale of the Obsessive-Compulsive Trait-Core Dimensions Questionnaire; HA = Harm Avoidance subscale of the Obsessive Compulsive Trait-Core Dimensions Questionnaire; NJRE-C = Not Just Right Experiences Questionnaire Revised, current frequency; SPQ = Sensory Perception Questionnaire Short Form.
* $p < .05$; ** $p < .01$ (2-tailed).

Hypothesis 2

To address Hypothesis 2, examining the association between incompleteness and NJREs, a bivariate correlation was conducted (Table 3). It was hypothesized that there would be a significant positive association between incompleteness and current NJREs, and that incompleteness would be predictive of current NJREs and severity. There was a significant moderate positive correlation between incompleteness and current NJREs, $r(517) = .56$ $p < .001$. A hierarchical multiple regression was conducted to determine whether incompleteness predicted current NJREs frequency (Table 4) and severity (Table 5) when controlling for demographics.

After controlling for age and gender, incompleteness was statistically significant in predicting current NJREs frequency, $F(1, 515) = 225.12$, $p < .001$, Adjusted $R^2 = .33$ for the overall model; and severity, $F(1, 280) = 103.53$, $p < .001$, Adjusted $R^2 = .28$ for the overall model.

Table 4

Hierarchical Regression Examining Incompleteness on Current "Not Just Right Experiences"

Predictor	*B*	*SE B*	β	*t*
Step 1				
Age	-0.02	0.01	-0.11*	-2.62
Gender	0.76	0.20	0.17**	3.90
Step 2				
Age	-0.01	0.42	-0.05	-1.39
Gender	0.51	0.01	0.11*	3.10
Incompleteness	0.14	0.16	0.55**	15.00

Note. Data in this table is representative of variables that were analyzed in a hierarchical regression utilizing the current "Not Just Right Experiences" Questionnaire Revised (NJRE-Q-R) frequency score. The NJRE-Q-R current frequency score is the sum of the measure's first ten items, which indicate if a specific NJRE experience has occurred within the past month.
* $p < .05$. ** $p < .001$.

Table 5

Hierarchical Regression Examining Incompleteness on Current "Not Just Right Experiences"

Severity

Predictor	*B*	*SE B*	β	*t*
Step 1				
Age	-0.10	0.04	-0.14*	-2.41
Gender	0.89	1.02	0.05	0.87
Step 2				
Age	-0.06	0.04	-0.08	-1.46
Gender	0.63	0.88	0.04	0.72
Incompleteness	0.55	0.05	0.52**	10.18

Note. Data in this table is representative of variables that were analyzed in a hierarchical regression utilizing the "Not Just Right Experiences" Questionnaire Revised (NJRE-Q-R) severity score. The NJRE-Q-R severity score is the sum of items 12-19 on the measure that rate the severity of the most recent NJRE on a seven-point Likert scale. Higher scores indicate greater severity.
* $p < .05$. ** $p < .001$.

Hypothesis 3

To address Hypothesis 3, examining the association between OC symptoms and sensory over-responsivity, a bivariate correlation was used (Table 3). It was hypothesized that there would be a significant positive association between OC symptoms and sensory over-responsivity. There was a significant moderate positive correlation between OC symptoms and sensory over-responsivity, $r(517) = .46$ $p < .001$. A hierarchical multiple regression was conducted to determine whether sensory over-responsivity would be predictive of OC symptoms after controlling for demographics (Table 6). After controlling for age and education, sensory over-responsivity was a statistically significant predictor of OC symptoms, $F(1, 515) = 144.98$, $p < .001$, Adjusted $R^2 = .24$ for the overall model.

Table 6

Hierarchical Regression Examining Sensory Over-Responsivity on Obsessive-Compulsive Symptoms

Predictor	*B*	*SE B*	β	*t*
Step 1				
Age	-0.22	0.05	-0.19**	-4.28
Gender	0.33	1.20	0.01	0.28
Step 2				
Age	-0.22	0.05	-0.19**	-4.92
Gender	-1.17	1.07	-0.04	-1.09
SOR	0.40	0.36	0.46**	12.02

Note. SOR = Sensory Over-Responsivity; Data in this table is representative of variables that were analyzed in a hierarchical regression utilizing the Obsessive-Compulsive Inventory Revised (OCI-R), which is the sum of the measure's 18 items.
* $p < .05$. ** $p < .001$.

Hypothesis 4

To address Hypothesis 4, examining the associations between sensory over-responsivity, incompleteness, and current NJREs, a bivariate correlation was conducted (Table 3). It was hypothesized that there would be a significant positive association between sensory over-

responsivity, incompleteness, and current NJREs, and that sensory over-responsivity would be predictive of both incompleteness and current NJREs. There was a significant moderate positive correlation between both sensory over-responsivity and incompleteness $r(517) = .39$, $p < .001$, and current NJREs, $r(517) = .34$, $p < .001$. A hierarchical multiple regression was conducted to determine whether sensory over-responsivity would predict incompleteness (Table 7) and current NJREs frequency (Table 8) when controlling for demographics. After controlling for age and gender, sensory over-responsivity was statistically significant in predicting incompleteness, $F(1, 515) = 88.69$, $p < .001$, Adjusted $R^2 = .16$ for the overall model, and current NJREs frequency, $F(1, 515) = 61.51$, $p < .001$, Adjusted $R^2 = .14$ for the overall model.

Table 7

Hierarchical Regression Examining Sensory Over-Responsivity on Incompleteness

Predictor	*B*	*SE B*	β	*t*
Step 1				
Age	-0.09	0.03	-0.12*	-2.64
Gender	1.82	0.77	0.10*	2.36
Step 2				
Age	-0.09	0.03	-0.12*	-2.92
Gender	1.04	0.72	0.06	1.44
SOR	0.23	0.02	0.38**	9.41

Note. SOR = Sensory Over-Responsivity. Data in this table is representative of variables that were analyzed in a hierarchical regression utilizing the Obsessive-Compulsive Trait-Core Dimensions Questionnaire Incompleteness subscale, which is the sum of the measure's 10 items corresponding to this subscale.
* $p < .05$. ** $p < .001$.

Table 8

Hierarchical Regression Examining Sensory Over-Responsivity on Current "Not Just Right Experiences"

Predictor	*B*	*SE B*	β	*t*
Step 1				
Age	-0.02	0.01	-0.11*	-2.62
Gender	0.76	0.20	0.17**	3.90
Step 2				
Age	-0.02	0.01	-0.12*	-2.82
Gender	0.59	0.19	0.13*	3.18
SOR	0.05	0.01	0.32**	7.84

Note. SOR = Sensory Over-Responsivity; Data in this table is representative of variables that were analyzed in a hierarchical regression utilizing the current "Not Just Right Experiences" Questionnaire Revised (NJRE-Q-R) frequency score. The NJRE-Q-R current frequency score is the sum of the measure's first ten items, which indicate if a specific NJRE experience has occurred within the past month.
* $p < .05$. ** $p < .001$.

Hypothesis 5

To analyze the proposed interaction model in Hypothesis 5 (i.e., determining whether levels of sensory over-responsivity would moderate the relationship between OC symptoms and sensory phenomena), the PROCESS macro (Hayes, 2018) for SPSS was used. It was hypothesized that higher levels of sensory over-responsivity would strengthen the association between OC symptoms and both incompleteness and current NJREs.

Incompleteness. The overall model, including OC symptoms, sensory over-responsivity, and the interaction (OC symptoms × sensory over-responsivity), was statistically significant in predicting incompleteness $F(3, 515) = 200.54$, $p < .001$, $R^2 = .54$ (Table 9). There was a significant main effect of OC symptoms $b = 0.46$, $t(515) = 20.72$, $p < .001$ on incompleteness. A main effect of sensory over-responsivity on incompleteness was approaching significance $b = 0.04$, $t(515) = 1.90$, $p = .06$. However, the main effects were qualified by a statistically significant interaction, $b = -0.005$, $t(515) = -3.74$, $p < .001$ (Figure 1). Simple slopes analyses

revealed that as sensory over-responsivity increased, the effect of OC symptoms on incompleteness weakened (Table 10). When probing the interaction by setting sensory over-responsivity at -1, 0, and +1 *SD* from the mean, all effects were statistically significant, though the magnitude of the effect decreased. For low sensory over-responsivity (-1 *SD*), OC symptoms, $b = .53$, $t(515) = 16.42$, $p < .001$. For average sensory over-responsivity (0 *SD*), OC symptoms, $b = .46$, $t(515) = 20.66$, $p < .001$. For high sensory over-responsivity (+1 *SD*), OC symptoms, $b = .40$, $t(515) = 16.18$, $p < .001$. For the maximum value of the sensory over-responsivity in the dataset (Max = 99), OC symptoms, $b = 0.40$, $t(515) = 4.63$, $p < .001$.

Table 9

Interaction OC Symptoms x Sensory Over-Responsivity on Incompleteness

	B	*SE*	*t*	*p*	95% CI	
Predictors					Lower	Upper
OC symptoms	0.46	0.02	20.72	<.001	0.42	0.51
SOR	0.04	0.02	1.90	0.06	-0.001	0.08
OC × SOR	-0.005	0.001	-3.74	<.001	-0.007	-0.002

Note. OC = obsessive-compulsive; SOR = Sensory Over-Responsivity; OC x SOR is the interaction effect between the recorded scores. Data in this table is representative of variables that were analyzed in an interaction model utilizing the Obsessive-Compulsive Trait-Core Dimensions Questionnaire Incompleteness subscale, which is the sum of the measure's 10 items corresponding to this subscale.

Table 10

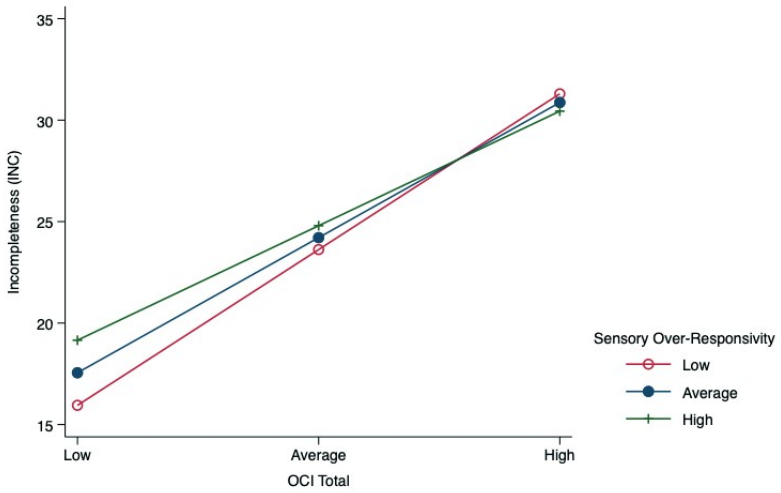
Simple Slopes for Interaction OC Symptoms x Sensory Over-Responsivity on Incompleteness

	B	*SE*	*t*	*p*	95% CI	
SPQ Levels					Lower	Upper
Low (-1 *SD*)	0.53	0.03	16.42	<.001	0.47	0.59
Average (0 *SD*)	0.46	0.02	20.66	<.001	0.42	0.51
High (+1 *SD*)	0.40	0.02	16.18	<.001	0.35	0.44

Note. SPQ= Sensory Perception Questionnaire- Short Form; SPQ scores were set at -1, 0, and +1 standard deviation from the mean to probe the interaction.

Figure 1

Obsessive-Compulsive Symptoms and Incompleteness by Sensory Over-Responsivity



Note. Moderating effect of sensory over-responsivity between obsessive-compulsive symptoms and incompleteness.

"Not Just Right Experiences." The overall model including OC symptoms, sensory over-responsivity, and the interaction (OC symptoms × sensory over-responsivity), was statistically significant in predicting current NJREs when controlling for past NJREs $F(4, 514) = 88.36$, $p < .001$, $R^2 = .41$ (Table 11). Due to past NJREs having a significant positive association with OC total scores, $r(517) = .44$ $p < .001$, it was controlled for in the model. There was a significant main effect of OC symptoms on current NJREs, $b = 0.06$, $t(514) = 9.29$, $p = < .001$. Sensory over-responsivity was not a significant predictor of current NJREs, $b = 0.01$, $t(514) = 1.76$, $p = .07$. However, there was a statistically significant interaction between OC symptoms and sensory over-responsivity when controlling for previous NJREs, $b = 0.001$, $t(514) = -3.14$, $p < .001$ (Figure 2). Simple slopes analyses revealed that as sensory over-responsivity increased, the effect of OC symptoms on current NJREs strengthened (Table 12). When probing the interaction by setting sensory over-responsivity at -1, 0, and +1 *SD* from the mean, all effects were statistically significant, and the magnitude of the effect increased. For low sensory over-

responsivity (-1 *SD*), OC symptoms $b = 0.05$, $t(514) = 4.81$, $p < .001$. For average sensory over-responsivity (0 *SD*), OC symptoms, $b = 0.06$, $t(514) = 9.14$, $p < .001$. For high sensory over-responsivity (+1 *SD*), OC symptoms $b = 0.08$, $t(514) = 11.21$, $p < .001$.

Table 11

Interaction OC Symptoms x Sensory Over-Responsivity on Current "Not Just Right Experiences"

	B	*SE*	*t*	*p*	95% CI	
Predictors					Lower	Upper
OC symptoms	0.06	0.01	9.29	<.001	0.05	0.08
SOR	0.01	0.01	1.76	0.08	-0.001	0.02
NJRE-P	0.26	0.03	7.44	<.001	0.19	0.32
OC × SOR	0.001	0.0004	3.14	<.001	0.0004	0.002

Note. OC = obsessive-compulsive; SOR = Sensory Over-Responsivity; NJRE-P = "not just right experiences" endorsed prior to one month ago; OC x SOR is the interaction effect between the recorded scores. Data in this table is representative of variables that were analyzed in a hierarchical regression utilizing the current "Not Just Right Experiences" Questionnaire Revised (NJRE-Q-R) frequency score. The NJRE-Q-R current frequency score is the sum of the measure's first ten items, which indicate if a specific NJRE experience has occurred within the past month.

Table 12

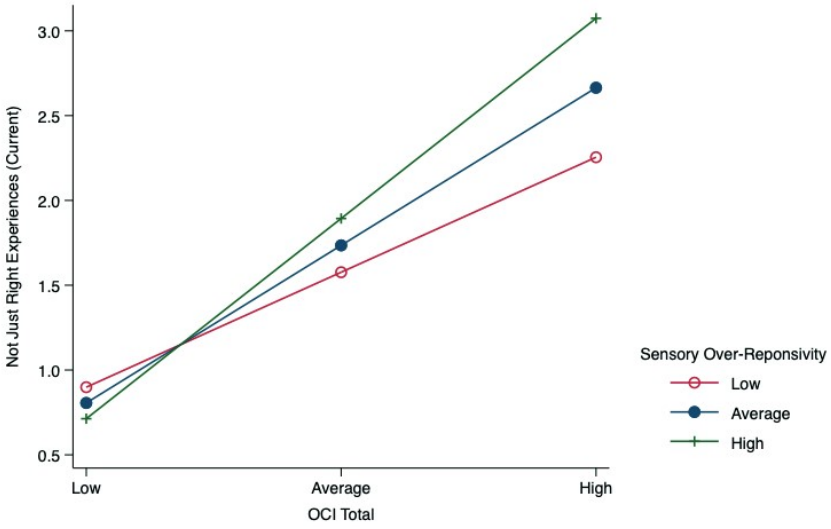
Simple Slopes for Interaction OC Symptoms x Sensory Over-Responsivity on Current "Not Just Right Experiences"

	B	*SE*	*t*	*p*	95% CI	
SPQ Levels					Lower	Upper
Low (-1 *SD*)	0.05	0.01	4.81	<.001	0.03	0.07
Average (0 *SD*)	0.06	0.01	9.14	<.001	0.05	0.08
High (+1 *SD*)	0.08	0.01	11.21	<.001	0.07	0.10

Note. SPQ= Sensory Perception Questionnaire- Short Form; SPQ scores were set at -1, 0, and +1 standard deviation from the mean to probe the interaction.

Figure 2

Obsessive-Compulsive Symptoms and "Not Just Right Experiences" by Sensory Over-Responsivity



Note. Moderating effect of sensory over-responsivity between obsessive-compulsive symptoms and current "not just right experiences" after controlling for past "not just right experiences."

Research Question

To address the exploratory research question examining the association between interoceptive sensibility, OC symptoms, sensory phenomena, and sensory over-responsivity, a bivariate correlation was conducted (Table 13). Given multiple correlations conducted, a stringent *p* value of .001 was used to determine significance. Relevant findings indicated that there were significant correlations between facets of sensory phenomena (incompleteness and NJREs), sensory over-responsivity, and interoceptive sensibility. Specifically, there was a significant positive association between Incompleteness subscale on the Obsessive-Compulsive Trait-Core Dimensions Questionnaire and the Noticing, Emotional Awareness, and Body Listening subscales on the Multidimensional Assessment of Interoceptive Awareness-2 (MAIA-2). There was a significant negative association between Incompleteness and the Not Distracting,

Not Worrying, and Trusting subscales. There was a significant positive correlation between current NJREs and the Noticing and Emotional Awareness subscales. There was a significant negative association between current NJREs and the Not Distracting, Not Worrying, Body Listening and Trusting subscales. There was a significant positive correlation between sensory over-responsivity and the Noticing, Attention Regulation, Emotional Awareness, Self-Regulation, and Body Listening subscales. There was a significant negative correlation between sensory over-responsivity and the Not Distracting and Not Worrying subscales. Increased distraction and worrying over unpleasant body sessions were indicated by lower scores on the Not Distracting and Not Worrying subscales.

Table 13

Pearson product bivariate correlations between MAIA-2 subscales, OC symptoms, sensory phenomena, & sensory over-responsivity

Variable	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
1. Noticing	-												
2. Not Distracting	-.21**	-											
3. Not Worrying	-.10**	.08	-										
4. Attention Reg	.53**	-.09*	.24**	-									
5. Emotion Reg	.53**	-.12**	-.08	.59**	-								
6. Self-Reg	.41**	.05	.25**	.65**	.61**	-							
7. Body Listening	.49**	.03	.01	.61**	.72**	.65**	-						
8. Trusting	.31**	.070	.27**	.50**	.38**	.58**	.52**	-					
9. HA	.16**	-.29**	-.42**	-.04	.19**	-.14**	.06	-.23**	-				
10. INC	.28**	-.30**	-.40**	.08	.28**	.02	.16**	-.14**	.78**	-			
11. OCI-R	.25**	-.25**	-.30**	.09*	.19**	.02	.17**	-.14**	.67**	.72**	-		
12. NJRE-C	.28**	-30**	-.25**	.07	.18**	-.03	.10*	-.11*	.47**	.57**	.58**	-	
13. SPQ	.40**	-.18**	-.13**	.30**	.34**	.19**	.25**	.05	.33**	.39**	.46**	.33**	-

Note. Variables 1-8 are all subscales on the Multidimensional Assessment of Interoceptive Awareness-2 (MAIA-2); HA = Harm Avoidance subscale of the Obsessive-Compulsive Trait-Core Dimensions Questionnaire; INC = Incompleteness subscale of the Obsessive Compulsive Trait-Core Dimensions Questionnaire; OCI-R = Obsessive-Compulsive Inventory Revised; NJRE-C = Not Just Right Experiences Questionnaire Revised, current frequency; SPQ = Sensory Perception Questionnaire Short Form. * $p < .05$; ** $p < .01$ (2-tailed).

Chapter 4 – Discussion

Sensory phenomena are a highly prevalent, yet poorly understood cluster of symptoms present within OCD. The purpose of this study was to examine factors that may be associated sensory phenomena, such as sensory over-responsivity, and to determine if specific levels of sensory over-responsivity may impact the relationship between OC symptoms and sensory phenomena more broadly. In this study, incompleteness and "not just right experiences" (NJREs) were the facets of sensory phenomena explored.

Participant Characteristics

Within this community sample, females endorsed experiencing greater incompleteness, NJRES, and sensory over-responsivity than males. Recent metanalysis have found that worldwide women are at a 1.6 times greater risk of developing OCD than men (Fawcett et al., 2020), which is in line with previous National Institute of Mental Health prevalence rates of OCD (NIMH, 2004). Although there were no significant differences in OC symptoms by gender in this sample, given that incompleteness and NJREs are conceptualized as facets of OCD (Apa et al., 2021; Belloch et al., 2016b; Coles et al., 2005; Ghisi et al., 2010; Sica et al., 2015), it appears that women may be more likely than men to endorse this specific cluster of symptoms. This may be due to hormonal factors, as onset of OCD symptoms in women have been found to be associated with a major hormonal event such as menarche or childbirth (Guglielmi et al., 2014), however researchers are continuing to examine this line of work.

Within this sample, age was negatively correlated with OC symptoms, incompleteness, and NJREs. This is in line with previous literature which has shown that younger adults are 1.4 times more likely to be diagnosed with lifetime OCD than older adults (Baxter et al., 2013; Fawcett et al., 2020). This may be due to methodological and/or psychological factors. From a

methodological perspective, cross sectional studies may have cohort effects, specifically capturing data from individuals within a specific generational period where the cultural context may influence mental health (Byers et al., 2010; Satre et al., 2006). Additionally, stigma may play a role with older adults being less likely to report symptoms (Baxter et al., 2013). Lastly, from a psychological perspective, research has shown that across all mental health conditions adults tend to report less mental health symptoms then younger individuals (Gum et al., 2009). Potentially, as an individual gets older, they attain more coping skills or habituation to stressful life events, which may make them less likely to report symptoms associated with a mental health diagnosis (Gum et al., 2009; Jorm, 2000).

Data collection for this study occurred from January to March 2021 during the COVID-19 pandemic, which may have impacted the sample demographics and participant responses. A greater number of individuals may have been accessing online research platforms due to being in quarantine or potentially seeking additional monetary funds due to employment concerns. However, descriptive statistics across study measures were similar to those previously performed using an online general population sample (Ben-Sasson et al., 2017; Taylor et al., 2014), despite the sample endorsing a higher educational level compared to previous literature (Ben-Sasson et al., 2017).

Hypothesis 1

In line with the first hypothesis, there was a significant positive association between OC symptoms, incompleteness, and NJREs. These findings are in line with previous research which have found moderate to strong correlations between facets of sensory phenomena such as incompleteness and NJREs to OC symptoms (Sica et al., 2016; Taylor et al., 2014). These findings provide further evidence indicating the association between sensory phenomena and OC

symptoms. Interestingly, there was a stronger association between OC symptoms and incompleteness than current NJREs frequency. This may be due to incompleteness being an underlying trait and motivational factor driving OC symptoms (Bragdon & Coles, 2017; Ecker et al., 2008; Summerfeldt, 2004; Summerfeldt et al., 2014), and NJREs suspected to be a behavioral outcome of this underlying trait (Mathes et al., 2019). However, some research has suggested that NJREs may be an endophenotype of OCD (Sica et al., 2016), yet findings are mixed (Apa et al., 2021).

Despite using similar methodologies, this samples' endorsement of current NJREs was low compared to the previous literature (Taylor et al., 2014) which may be due to gender differences in the sample, and may have impacted the strength of the association. Additionally, current NJREs measured in this study reflected upon the past month. When examining the association of previous NJREs and OC symptoms a moderate association was found, which was contrary to prior research (Coles et al., 2005), highlighting that previous experienced NJREs may also be related to OC symptoms. Future research should continue to explore the association between endorsement of previous NRJEs and OC symptoms, and longitudinally track the development of symptoms over time. Lastly, examining the prevalence of the NJREs in addition to the severity of these experiences would assist in providing information regarding if distress or impairment is associated with OC symptoms. Previous research has found that is not just the frequency of NJREs that may be related to OC symptoms but more so the severity (Coles et al., 2005; Sica et al., 2015). This highlights that potentially the distress or discomfort related to having a NJREs may lead to the potential urge to counteract or neutralize the experience, leading to compulsive behavior (Fornés-Romero & Belloch, 2017).

Hypothesis 2

Support was found for the second hypothesis which found a significant positive correlation between incompleteness and NJREs, which is in line with previous research (Taylor et al., study 1; Coles et al., 2005). Given that both incompleteness and NJREs are represented under the umbrella of sensory phenomena (Ferrao et al., 2012; Rosario-Campos et al., 2005; Rosario et al., 2009; Sampaio et al., 2014), it would have been expected for them to be correlated. Previous literature has also suggested that incompleteness may be a predisposing factor/trait in the likelihood of one having a NJRE (Mathes et al., 2019). In line with study hypotheses, incompleteness was significant in predicting both current NJREs frequency and severity. In the first model, after accounting for incompleteness and age, there remained a significant difference between gender on current NJREs frequency and severity. This suggests that women endorse more NJREs regardless of age or feelings of incompleteness, and endorse these NJREs as more distressing. This may be due to women being more in tuned to bodily sensations than men. Some research has found support for this notion, specifically that women have a stronger attention to perceive interoceptive information and notice bodily sensations compared to men (Grabauskaite et al., 2017; Longarzo et al., 2021). Findings from this study may also be associated to women's increased likelihood of developing OCD than men (Fawcett et al., 2020), and specifically in this sample women endorsing greater facets OC symptoms such as NJREs and incompleteness. Despite these findings, future research should continue to examine these constructs and replicate and extend findings to clinical populations.

Hypothesis 3

Findings were also in line with the third hypothesis which found a significant positive association between OC symptoms and sensory over-responsivity. Previous literature has found

sensory sensitivities and intolerances in individuals with OCD compared to the general population (Collins et al., 2021; Grimaldi & Stern, 2017). These findings provide further evidence suggesting that those who endorse elevated experiences of sensory over-responsivity, specifically just noticeable differences, may also experience increased OC traits. Within a large community sample, researchers have also found a significant positive association between sensory over-responsivity and OC symptoms (Ben-Sasson & Podoly, 2017), and in an undergrad sample sensory over-responsivity was also found to be positively correlated with both OC symptom frequency and distress (Ben-Sasson et al., 2017).

Future studies examining sensory processing and OCD may want to consider examining the Sensory Perception Questionnaire with additional self-report measures of adult sensory processing such as the Adolescent/Adult Sensory Profile (Brown et al., 2001). The Adolescent/Adult Sensory Profile is a commonly used self-report measure based on Dunn's (2001) model of sensory processing which measures the interaction of one's "neurological threshold" and "behavioral response" to frequently encountered sensory stimuli. Utilizing both of these assessments would allow researchers to capture a broad range of sensory experiences and individuals' self-reported behavioral responses to those encounters. Additionally, these self-report measures may be paired with behavioral paradigms capturing *in vivo* behavioral responses to encountering specific sensory stimuli, in addition to measuring level of distress or discomfort and urge to counteract after encountering those sensory experiences. Future studies should also explore if specific OC symptom dimensions correlate with certain domains of exteroceptive sensory modalities assessed across these measures.

It was also of interest to further examine if increased sensory over-responsivity, or sensory intolerances in general, may be a predisposing factor to the development of OCD. Some

research has shown that atypical sensory experiences in childhood may serve as a risk factor in the development of OCD (Hazen et al., 2008; Levit-Binnun et al., 2013; Summerfeldt, 2004). A critical review of sensory abnormalities in childhood/adolescent OCD found support for sensory dysfunction in children with anxiety disorders and OCD (Houghton et al., 2020). A longitudinal study examining the association between sensory over-responsivity and OC symptoms in twins also found that childhood sensory over-responsivity was associated with increased OC symptoms in adolescence (Van Hulle et al., 2019). In this online community sample, findings indicated that increased sensory over-responsivity was predictive of OC symptom severity. Within the model, age remained significant which suggests as one gets older OC symptoms on average decrease after accounting for gender and sensory over-responsivity. This is in line with previous findings indicating an inverse relationship between age and OC symptoms (Fawcett et al., 2020).

Given the cross-sectional nature of this study, findings should be interpreted with caution. Longitudinal designs measuring both OC symptoms and sensory over-responsivity over time may provide evidence into determining a causal relationship amongst these concepts. Future studies should also include additional variables that are traditionally associated with the construct of sensory over-responsivity, such as measures examining symptoms related to autism spectrum disorders (APA, 2013; Chamak et al., 2008; Kern et al., 2006), to determine if there are additional factors to consider and account for when examining the relationship amongst these variables. Additionally, across studies, there are nuances in operationalizing and measuring sensory over-responsivity via self-report measures in children, adolescents, adults, and adults responding for their children's' symptom presentations. Providing a more standardized assessment may help to better clarify and study this phenomenon. Given that examining sensory over-responsivity and OC symptoms is a more recent area of research, further studies are needed

to form more definitive conclusions regarding the developmental relationship between these variables.

Hypothesis 4

As hypothesized, there was a significant positive association between sensory over-responsivity, incompleteness, and NJREs. These findings extend previous data which have found a significant association between sensory over-responsivity and OC symptoms (Collins et al., 2021; Rieke & Anderson, 2009), to now focusing on a specific cluster of OC symptoms, sensory phenomena. To date, this is the first study to examine these constructs using these specific assessment measures. Relatedly, a previous study found a significant positive association between sensory over-responsivity and NJREs, however NJREs were measured behaviorally and not using the NJRE-Q-R (Ben-Sassion et al., 2017). In this previous study, the researchers' found associations between certain sensory modalities on the Sensory Perception Questionnaire and specific modalities of NJRE stimuli, however the Sensory Perception Questionnaire total scores were not found to be significantly correlated with urge to counteract exposure to NJRE stimuli (Ben-Sassion et al., 2017). Future research should aim replicate these findings within a clinical sample, in addition to examining current and past NJREs and severity level, and how that may be related to sensory over-responsivity.

To date, no study has looked at the association between sensory over-responsivity and incompleteness using the Sensory Perception Questionnaire. Findings from this study suggest that individuals who experience greater sensory over-responsivity also endorse more incompleteness, which has been found to be a unique underlying motivating factor in OCD in addition to harm avoidance (Ecker & Gönner, 2008; Summerfeldt et al., 2014). Interestingly, sensory over-responsivity was also significantly positively correlated with harm avoidance,

which may suggest that sensory over-responsivity may associated with OC symptoms more broadly across both harm avoidance and incompleteness. This is in line with the findings from earlier hypotheses indicating that sensory over-responsivity was significantly positively associated with OC symptoms more broadly measured via the Obsessive-Compulsive Inventory Revised. Historically, harm avoidance has been seen as an underlying motivation factor in OCD (Coles & Ravid, 2016; Lack et al., 2015; Taylor et al., 2005), with these findings expanding that sensory over-responsivity may be associated with the full spectrum of OCD motivators and symptom domains.

It was expected that individuals with elevated sensory over-responsivity would endorse elevated incompleteness. However, due to positive association between sensory over-responsivity and harm avoidance, this may also suggest that these individuals may be more likely to interpret these sensory experiences as threatening, potentially displaying an interaction of both sensory and cognitive components within OCD. Future research should examine the interplay of both cognitive and sensory domains within clinical samples, which may provide further information regarding etiological factors related to OCD.

Researchers have also hypothesized that the sensory phenomena symptoms (incompleteness and NJREs) present in OCD may be in part due to deficits in sensory processing (Ben-Sasson et al., 2017; Ben-Sasson & Podoly, 2020; Collins et al., 2021; Summerfeldt et al., 2014). When implementing regression analyses to determine if sensory over-responsivity was predictive of incompleteness and current NJREs, both models were significant. Specifically regarding incompleteness, age remained significant suggesting that as one ages incompleteness symptoms decrease on average after accounting for gender and sensory over-responsivity. These

findings are in line with previous literature regarding age and OC symptoms (Fawcett et al., 2020).

Regarding current NJRE frequency, both demographic variables of age and gender remained significant. Females endorsed greater NJREs when controlling for age and sensory over-responsivity. This may be due to the previously noted findings suggesting that females may be more in tuned to bodily sensations than males (Grabaukaite et al., 2017; Longarzo et al., 2021). Additionally, overall current NJREs were low in this sample, which may suggest that a true representation of these phenomena within the community wasn't accurately captured.

The effect of sensory over-responsivity on NJREs also decreased with age and remained significant after controlling for gender. Within the literature, sensory processing is traditionally explored in relation to younger individuals, with less work exploring these concepts into adulthood (Tavassoli et al., 2014). However, as individuals age, they may potentially habituate to sensory experiences and fail to detect them. These findings provide some initial evidence supporting the association between these variables; however, given the novelty and infancy of work done in this area, in addition to cross sectional data, further research is needed to examine the predictive nature of these constructs. Longitudinal studies measuring both OC symptoms and sensory over-responsivity should include the assessment of sensory phenomena as well. However, given that many of our current sensory phenomena measures are for adults, researchers need to create and validate assessments for NJREs and incompleteness symptom presentations in children and adolescents.

Hypothesis 5

Lastly, the proposed interaction model resulted in some unexpected findings. To the author's knowledge, this is the first study to examine sensory over-responsivity as a potential moderator between OC symptoms and sensory phenomena.

Incompleteness. Although there was a significant interaction of sensory over-responsivity by OC symptoms on incompleteness, the directionality of the hypothesis was counter to the proposed model. Findings indicated that as sensory over-responsivity increased the effect of OC symptoms on incompleteness weakened, highlighting that levels of sensory over-responsivity inversely influence the association between OC symptoms and incompleteness. At elevated levels of sensory over-responsivity, it appears that one may be less likely to endorse feelings of incompleteness, counter to the proposed hypothesis. Potentially at these elevated levels, one may be more focused on experiences they are encountering in their environment and not internally generation sensations like incompleteness. Given that sensory phenomena broadly are understudied and relatively newer area of investigation, further research is needed to determine if incompleteness is a sensory, cognitive, or affective experience, or an interaction of these domains. Exploring these concepts from a neuroimaging perspective may also provide further clarity in understanding the neural correlates of incompleteness, which may assist in better interpreting this finding.

"Not Just Right Experiences." When examining the interaction of sensory over-responsivity by OC symptoms on NJREs, results were in line with study hypotheses finding that as sensory over-responsivity increased, the effect of OC symptoms on current NJREs strengthened. At higher levels of sensory over-responsivity one would expect to have more OC symptoms and NJREs, strengthening the association between OC symptoms and NJREs. Items measured on the NJRE-Q-R highlight internal sensory experiences across various sensory

domains, in a similar fashion that the Sensory Perception Questionnaire assesses sensory over-responsivity across various sensory domains. Given that the Sensory Perception Questionnaire measures subtle differences and hypersensitivity to a sensory experience, those with elevated sensory over-responsivity would be expected to encounter a sensory experience and notice experiences that feel "not just right." Within the context of OC symptoms, sensory over-responsivity may be more likely to prompt NJREs reaction to external stimuli than an internal feeling of being "incomplete." Future studies should replicate and expand upon these findings in a clinical sample, in addition to coupling these self-report measures with physiological paradigms exploring sensory responsiveness to exteroceptive stimuli.

Taken together, findings from both interaction models may also suggest that incompleteness and NJRE are not related in the same way as previously proposed. Sensory over-responsivity may be more likely to have an impact on sensory phenomena symptoms centered on interactions with external environmental stimuli, such as NJREs, than factors of internal feelings of incompleteness. There may also be additional variables not accounted for that may influence this relationship, such as alexithymia. Alexithymia defined as the inability to identify, describe, interpret, and process emotional information (Sifneos et al., 1977; Taylor & Bagby, 2004), has historically been associated with deficits in interoceptive processes (Murphy et al., 2018; Trevisan et al., 2019). However, recent research has found that sensory processing sensitivity was predictive of alexithymia beyond interoceptive accuracy (Jakobson & Rigby, 2021). Potentially incompleteness is a form of alexithymia, in which an individual can't identify and label specific emotional states they are experiencing. More research is needed to further examine these constructs and replicate these findings within a clinical sample.

Research Question

In addition to examining the exteroceptive sensory experiences, it was of interest to also explore the association between interoception, OC symptoms, sensory phenomena, and sensory over-responsivity. Interoception is the process by which one is able to detect and interpret physiological signals generated from within the body, across both conscious and unconscious levels (Feinstein et al., 2018). Although traditional conceptualizations of interoception have focused on sensations from visceral organs (i.e. heart, lungs, stomach), a broader conceptualization of interoception proposed by (Craig, 2002, 2003) includes internal sensations from the entire body, including skin, muscles, joints and teeth, in addition to the viscera. Additionally, interoception plays an important role in emotion and cognition (Barrett et al., 2004; Critchley & Garfinkel, 2017; Herbert & Pollatos, 2012), and interoceptive deficits have been found across several psychiatric disorders (Khalsa & Lapidus, 2016; (Khalsa et al., 2018) with some studies suggesting interoceptive deficits within OCD (Bragdon et al., 2021; Stern, 2014). Interoception has be measured across various methods (Schandry, 1981; Whitehead et al., 1977) and labeled differently depending on if examining objective versus subjective methods.

Specifically for this study, interoceptive sensibility, the subjective assessment of one's internal bodily state across daily life (Khalsa et al., 2018; Mehling et al., 2018; Trevisan et al., 2019), was measured using self-report via the Multidimensional Assessment of Interoceptive Awareness Version 2 (Mehling et al., 2018). Examining interoceptive sensibility via self-report, can allow for clinicians and researchers to obtain clinically relevant information regarding ones individualized personal experience of how they attend to their internal body sensations. Both adaptative and maladaptive factors related to interoceptive sensibility can be examined via the Multidimensional Assessment of Interoceptive Awareness Version 2.

Data from this sample resulted in some interesting findings. Noticing sensations in the body was positively associated with OC symptoms, incompleteness, current NJREs, and sensory over-responsivity. Being most strongly correlated with sensory over-responsivity, these findings highlight the association between individuals noticing both internal and external experiences associated with ones' body. Maladaptive subscales of "not distracting" and "not worrying" were negatively correlated with OC symptoms, incompleteness, current NJREs, and sensory over-responsivity. Increased distraction and worrying over unpleasant body sessions were indicated by lower scores on this subscale, displaying that increases in these states were associated with the above-mentioned constructs. This may suggest that those with elevated OC symptoms and sensory phenomena may tend to notice them more, may be worried and distressed by these experiences, and may want to distract from them. Interestingly, body trusting was significantly negatively associated with OC symptoms, incompleteness, and current NJREs. Although the associations were weak, it may suggest that those who experience these symptoms have decreased trust in their body sensations, which may influence how they respond and react to these experiences and level of distress they cause.

These findings provide preliminary evidence suggesting further examination of the relationship between interoceptive processes in OCD, specifically in relation to sensory phenomena and sensory processing more broadly. Given that ~60-65% of individuals with OCD experience sensory phenomena (Ferrão et al., 2012), it can be hypothesized that potential increased awareness or attention to body sensations may contribute to sensory experiences reported within the disorder (Bragdon et al., 2021). One study found a positive association between symmetry/ordering/NJREs OC symptom dimensions and increased awareness of internal sensations and "noticing" measured via the Multidimensional Assessment of

Interoceptive Awareness Version 2 (Eng et al., 2020). Research has also shown that individuals with OCD have overactive monitoring of external stimuli (Endrass & Ullsperger, 2014; Gehring et al., 2000), and given the suspected interoceptive deficits in OCD patients, it is hypothesized that they would also experience overactive monitoring of internal sensations, specifically bodily states (Song et al., 2011). These findings highlight that deficits in interoceptive processes may play a role in sensory experiences reported within OCD.

While interoception has been more traditionally examined via interoceptive accuracy using a heartbeat perception task, considered an "objective" measure of interoception (Garfinkel & Critchley, 2013; Wiens et al., 2000), it neglects the full experience of interoception, specifically the clinically relevant subjective experience of an individuals' interoceptive awareness (Mehling et al., 2018). Further examining one's interoceptive sensibility, their subjective experiences of internal physical sensations in their body, may help to provide further insight into these sensory symptoms so highly prevalent in OCD. To date, no study has explored the potential co-occurrence of altered exteroception and interoception in relation to sensory phenomena and OC symptoms. Potentially, OCD may be associated with underlying deficits in both exteroceptive and interoceptive processes. These factors may interact and be associated with sensory phenomena symptoms seen in OCD, and OCD more broadly. Research should further examine these constructs within clinical samples, using physiological, neuroimaging, and behavioral assessments to gain a more comprehensive understanding of these experiences.

Conclusion

To the author's knowledge, this is the first study to date to examine the associations between sensory over-responsivity, OC symptoms, and sensory phenomena in a large online community sample. These findings provide preliminary evidence linking these constructs, which

supports future research examining sensory over-responsivity as an etiological factor accounting for sensory phenomena symptoms seen in OCD, or OCD more broadly. Additionally, these findings provide further evidence highlighting the presence of sensory phenomena in association with OC symptoms, which may diagnostically influence how OCD is assessed, and if an additional cluster of sensory based symptoms should be included in the diagnosis.

The Obsessive-Compulsive Inventory Revised used to measure OC symptoms in this study doesn't specifically capture incompleteness and NJREs. This highlights that when using this measure, clinicians and researchers may fall short in capturing the full presentation of OCD symptoms. Future studies may replace this measure with the Dimensional Obsessive-Compulsive Scale (Abramowitz et al., 2010), as it may more fully represent OC dimensions and includes some facets of "just right" phenomena. Furthermore, assessment of sensory phenomena should be incorporated in standard OCD evaluations, as it contains valuable information regarding symptomatology and could inform treatment approaches. Clinicians may then incorporate these phenomena on an exposure hierarchy, and design exposures targeting them. However, further research is needed to empirically test if sensory phenomena respond to exposure and response prevention in the same way that fear-based obsessions and compulsions do, or if novel treatment approaches are warranted.

Despite the study's large sample size and novelty of examining these constructs concurrently, findings need to be replicated in a clinical sample of individuals with OCD. Additionally, expanding upon exploring these phenomena within the context of other repetitive behavior disorders and common co-morbid conditions such as tic disorders (Prado et al., 2008) and eating disorders (Altman & Shankman, 2009), may provide further information regarding the presentation of sensory phenomena and how they may impact other forms of psychopathology

more broadly. Given that sensory phenomena have also been found to be highly prevalence within tic disorders and OCD/tic disorders comorbid presentations (Prado et al., 2008), future research may also consider examining deficits in sensory processing within these populations to determine its transdiagnostic relevance.

Given that this study was performed online and consisted of cross-sectional data, future work is needed to measure these constructs over multiple data points to determine causal factors, while also using more enhanced research methods. Physiological, neural, and behavioral measures, coupled with clinician administered interviews, would allow researchers to gain a more in depth understanding of the association and interaction of these phenomena, which may influence neurobiological models of OCD. Future work in this domain may also contribute to further enhancing our evidenced based interventions, and provide opportunities to develop more precise and tailored treatment approaches for those suffering from OCD.

Lastly, the study of sensory over-responsivity is incredibly nuanced and operationally not well defined within the literature. Previous studies have used subscales from the Adolescent/Adult Sensory Profile to operationalize and measure sensory over-responsivity (Ben-Sasson & Podoly, 2020; Collins et al., 2020), while others have used the Sensory Perception Questionnaire (Ben-Sasson et al., 2017, Ben-Sasson & Podoly, 2017; Tavassoli et al., 2014), and additional measures as well (Schoen et al., 2008). Further research is needed to explore and define sensory over-responsivity, in addition to using physiological, neural, and behavioral data to provide further evidence on how sensory over-responsivity manifests within individuals.

Taken together, elevated sensory over-responsivity appears to be associated with OC symptoms and impacts sensory phenomena. Further research is needed to determine if sensory over-responsivity may developmentally affect and/or be a trait marker for OCD, and its influence

on sensory phenomena symptoms seen within the disorder. Overall, sensory dysfunction in relation to clinical phenomena is understudied yet highly prevalent within the context of psychiatric disorders (Harrison et al., 2019). In addition to OCD, future work should examine the role of sensory processing within psychopathology more broadly, which may assist in improving etiological models and interventions for mental health disorders.

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Appendices

Appendix A: Demographics Questionnaire

What is your age?

What race do you identify with?

- White
- Black/African American
- Hispanic/Latino
- Asian
- Multiracial
- Other

What gender do you identify with?

- Female
- Male
- Other

Where in the United States are you located?

- North East
- Southern
- Mid-West
- Western
- Alaska

What is your employment status?

- Full time employee
- Part time employee
- Per diem
- Unemployed
- Student
- Retired
- Unable to work

What is the highest education level you've achieved?

- Some High School, but did not graduate
- High School Graduate (including GED)
- Trade/Vocational School
- Some college, but no degree
- Associates Degree
- Bachelor's Degree
- Master's Degree
- Doctoral Degree
- Professional Degree (JD, MD)

Do you have, or have you had, a diagnosed mental health illness/condition? (Yes/No)
If so, what is/was the diagnosis?

Are you currently, or have you recently, participated in psychotherapy? (Yes/No)
If so, what is/was the length of involvement in therapy?

Do you currently take any psychotropic medications? (Yes/No)
If so, what is/are the name(s) of the current medication(s)?

Appendix B: Obsessive-Compulsive Trait Core Dimensions Questionnaire

Please read each statement and decide how the statement applies to how you typically think, feel, and act.

- If the statement **never** applies, circle **N**.
- If the statement **rarely** applies, circle **R**.
- If the statement **sometimes** applies, circle **S**.
- If the statement **frequently** applies, circle **F**.
- If the statement **always** applies, circle **A**

Give your own opinion of yourself. Be sure to answer every statement. Erase completely any answer you wish to change. Begin with the first statement and respond to every statement.

		Never	Rarely	Sometimes	Frequently	Always
1.	I get a sense of apprehension, as though something bad might happen or may have already happened.	N	R	S	F	A
2.	I feel I must do things in a "set way", though I might have difficulty putting that set way into words.	N	R	S	F	A
3.	Even if harm is very unlikely, I feel the need to prevent it at any cost.	N	R	S	F	A
4.	I am bothered by the sense that things are imperfect (such as belongings, ideas, or tasks to be done).	N	R	S	F	A
5.	There are things that I am afraid might happen if I don't take certain steps to prevent them.	N	R	S	F	A
6.	I must do things in a certain way or I will not feel right.	N	R	S	F	A
7.	I get the impression that things are more threatening to me than to other people.	N	R	S	F	A
8.	I feel driven to re-do or prolong activities or tasks until they feel "just right".	N	R	S	F	A
9.	There are specific things around me that could cause harm to me or to people I care about.	N	R	S	F	A
10.	Routine activities take me longer than they should because they don't seem perfectly completed.	N	R	S	F	A
11.	There are certain consequences that I am more afraid of than most people.	N	R	S	F	A
12.	I waste a lot of time trying to get things "just right".	N	R	S	F	A
13.	It seems like I am "on the lookout" for the dangers in situations.	N	R	S	F	A

Please continue on next page …

As on the previous page, please read each statement and decide how the statement applies to how you <u>typically</u> think, feel, and act.

		Never	Rarely	Sometimes	Frequently	Always
14.	There is nothing like the feeling I have when something is finally satisfactorily completed.	N	R	S	F	A
15.	I have fears that I wish I could ignore, but can't.	N	R	S	F	A
16.	I am very particular about how things must appear or be done.	N	R	S	F	A
17.	I cannot help but think about bad things that might happen.	N	R	S	F	A
18.	It takes a long time for me to feel certain about things.	N	R	S	F	A
19.	Situations or things seem so scary that I wish I could avoid them altogether.	N	R	S	F	A
20.	I know I've done something right when I get a certain feeling inside.	N	R	S	F	A

Appendix C: "Not Just Right Experiences" Questionnaire- Revised

Subject ID _____ Date _____

"Not Just Right Experiences" Questionnaire

Part I

"Not Just Right Experiences" are defined as "times when you have the subjective sense that something isn't just as it should be." An example of this could be an unsettled feeling because something in you, or in your perception of the world, is not right.

Below are examples of some "not just right experiences" (NJRE). Please indicate whether you have had any of these experiences, and if they were in the past, or if you're currently experiencing them (this month). If you have had a NJRE both in the past (longer than 1 month ago) and currently (within the prior month), please check off both boxes.

Examples of "Not Just Right Experiences"	NO	PAST (date)	Current (this month)	Age of onset
1. I have had the sensation after getting dressed that parts of my clothes (tags, collars, pant legs, etc.) didn't feel just right.				
2. When placing a book back onto a shelf, I have had the sensation that it did not look just right with the other books.				
3. When locking the door to my house, I have had the sensation that the feel of the lock locking wasn't just right.				
4. I have had the sensation while folding my clothes that they did not look the way folded clothes should look.				
5. I have had the sensation while writing something down that the words did not look just how I wanted them to look.				
6. When talking to people, I have had the sensation that my words did not sound just right.				
7. I have had the sensation while organizing my desk that my papers, and other things didn't look just right.				
8. When putting a bill or letter into a mailbox, I have had the sensation that the way I placed the envelope in the mailbox and closed the door didn't feel just right.				
9. After washing my hands once, I have had the sensation that they did not feel just the way clean hands are supposed to feel.				
10. When hanging a picture on the wall, I have had the sensation that it did not look just right.				
If you have any other "Not Just Right Experiences" that are not written above, please write them here:				

For citation: Coles, M.E., Frost, R.O., Heimberg, R.G., & Rheaume, J. (2003). "Not just right experiences": perfectionism, obsessive-compulsive features and general psychopathology. *Behaviour Research and Therapy, 41,* 681-700.

Subject ID _____ Date _____

Part II
For this section, please refer back to the list of current "Not Just Right Experiences" located on the previous page. If you do not have any current NJREs, STOP HERE.

Which current "Not Just Right Experience" occurs most frequently, AND when did it last occur (ex: from within the past few hours to within past month):

_____
_____
_____
_____
_____

Part III
Please answer the following questions focusing on the particular current "Not Just Right Experience" endorsed in the previous question.

1) How frequently do you experience this NJRE? (With 1 indicating Never, and 7 indicating More than once a day)

Never						More than once a day
1	2	3	4	5	6	7

2) How intense is this NJRE? (With 1 indicating Not Intense, and 7 indicating Extremely Intense)

Not Intense						Extremely Intense
1	2	3	4	5	6	7

3) On a day you experience this NJRE, to what degree does this NJRE bother you or cause you distress AT THE TIME? (With 1 indicating No Distress, and 7 indicating Extreme Distress)

No Distress						Extreme Distress
1	2	3	4	5	6	7

For citation: Coles, M.E., Frost, R.O., Heimberg, R.G., & Rheaume, J. (2003). "Not just right experiences": perfectionism, obsessive-compulsive features and general psychopathology. *Behaviour Research and Therapy, 41,* 681-700.

Subject ID _____ Date _____

4) To what degree does this NJRE bother you or cause you distress LATER THAT SAME DAY? (With 1 indicating No Distress, and 7 indicating Extreme Distress)

No Distress Extreme Distress

1 2 3 4 5 6 7

5) To what extent do you feel that you couldn't get this NJRE out of your mind? (With 1 indicating Extremely Easy to get out of my mind and 7 indicating Extremely Difficult to get out of my mind?)

Extremely Easy Extremely Difficult

1 2 3 4 5 6 7

6) To what extent do you have an urge to do something about this NJRE? (With 1 indicating No Urge, and 7 indicating a Strong Urge)

No Urge Strong Urge

1 2 3 4 5 6 7

7) To what extent do you feel that it is your responsibility to do something about this NJRE? (With 1 indicating No Responsibility, and 7 indicating Strong Responsibility)

No Responsibility Strong Responsibility

1 2 3 4 5 6 7

8) To what extent do you feel that this NJRE is mental, physical, or both? (With 1 indicating All Mental, 4 indicating Both, and 7 indicating All Physical)

Mental Both Physical

1 2 3 4 5 6 7

For citation: Coles, M.E., Frost, R.O., Heimberg, R.G., & Rheaume, J. (2003). "Not just right experiences": perfectionism, obsessive-compulsive features and general psychopathology. *Behaviour Research and Therapy, 41,* 681-700.

Appendix D: Obsessive-Compulsive Inventory Revised

OCI-R

The following statements refer to experiences that many people have in their everyday lives. Circle the number that best describes **HOW MUCH** that experience has **DISTRESSED or BOTHERED you during the PAST MONTH.** The numbers refer to the following verbal labels:

0 Not at all	1 A little	2 Moderately	3 A lot	4 Extremely

1.	I have saved up so many things that they get in the way.	0 1 2 3 4
2.	I check things more often than necessary.	0 1 2 3 4
3.	I get upset if objects are not arranged properly.	0 1 2 3 4
4.	I feel compelled to count while I am doing things.	0 1 2 3 4
5.	I find it difficult to touch an object when I know it has been touched by strangers or certain people.	0 1 2 3 4
6.	I find it difficult to control my own thoughts.	0 1 2 3 4
7.	I collect things I don't need.	0 1 2 3 4
8.	I repeatedly check doors, windows, drawers, etc.	0 1 2 3 4
9.	I get upset if others change the way I have arranged things.	0 1 2 3 4
10.	I feel I have to repeat certain numbers.	0 1 2 3 4
11.	I sometimes have to wash or clean myself simply because I feel contaminated.	0 1 2 3 4
12.	I am upset by unpleasant thoughts that come into my mind against my will.	0 1 2 3 4
13.	I avoid throwing things away because I am afraid I might need them later.	0 1 2 3 4
14.	I repeatedly check gas and water taps and light switches after turning them off.	0 1 2 3 4
15.	I need things to be arranged in a particular way.	0 1 2 3 4
16.	I feel that there are good and bad numbers.	0 1 2 3 4
17.	I wash my hands more often and longer than necessary.	0 1 2 3 4
18.	I frequently get nasty thoughts and have difficulty in getting rid of them.	0 1 2 3 4

Appendix E: Sensory Perception Questionnaire Short Verision

The Sensory Perception Questionnaire (SPQ)

Name: _____ Sex: _____

Date of birth: _____ Email address: _____

Please try to answer the following items by ticking the appropriate box. Please try to answer as honestly as possible.

		Strongly Agree	**Agree**	**Disagree**	**Strongly Disagree**
1	I can recognize different people by the way they smell.				
2	I would be able to tell if a strawberry was ripe just by smelling it.				
3	I would notice right away that it got brighter if a dimmer control switch moved up one notch.				
4	I would notice right away if someone added 5 drops of lemon juice to my cup of water.				
5	I would be able to hear the sound of a leaf blown by the wind on a quiet street.				
6	I would be able to taste the difference between two brands of salty potato chips/crisps.				
7	I would *not* be able to feel the label at the back of my shirt even if I thought about it.				
8	I can hear electricity humming in the walls.				
9	I notice the flickering of a desktop computer even when it is working properly.				
10	I would be able to notice a small change (e.g. 1 degree) in the temperature of the weather.				
11	I would be able to feel a small (e.g. one millimetre) paper cut in my skin.				
12	I would be able to tell the weight difference between two different coin sizes on the palm of my hand with my eyes closed.				
13	I could *not* distinguish a familiar person and a stranger by their smell.				
14	I could *not* tell if bread was stale purely by its smell.				
15	I would be able to hear the sound of a vacuum cleaner from any room in a two-storey building.				
16	I would be able to feel the elastic holding up my socks if I stop and thought about it.				
17	I would be able to taste the difference between apparently identical pieces of candy.				
18	I notice the weight and pressure of a hat on my head.				
19	I would feel if a single hair touched the back of my hand.				

20	If I was walking along, I would be able to feel a passing truck's vibrations even if my eyes were closed.				
21	I would be able to smell the smallest gas leak from anywhere in the house.				
22	I *wouldn't* notice if someone changed their perfume, by smell alone.				
23	I can't go out in bright sunlight without sunglasses.				
24	I would be able to feel a change in the temperature of a cup of coffee after it had sat for 1 minute.				
25	I would be the first to hear if there was a fly in the room.				
26	If I look at a pile of blue sweaters in a shop that are meant to be identical, I would be able to see differences between them.				
27	I would be able to smell the difference between most men and women.				
28	I would be able to hear each note in a chord even if there were 10 notes.				
29	I close curtains to avoid bright lights.				
30	I would be able to distinguish two brands of coffee by their smell, even with my eyes closed.				
31	I can see dust particles in the air in most environments.				
32	I *wouldn't* be able to taste the difference between two brands of tomato sauce if they had different concentrations of salt.				
33	I would be able to smell the smallest amount of burning from anywhere in the house.				
34	If my mobile phone was vibrating in my pocket I would be quick to sense it.				
35	I would detect a new smell in my house instantly before anyone else.				

Appendix F: Multidimensional Assessment of Interoceptive Awareness Version 2

Below you will find a list of statements. Please indicate how often each statement applies to you generally in daily life.

.	Circle one number on each line					
	Never					Always
1. When I am tense I notice where the tension is located in my body.	0	1	2	3	4	5
2. I notice when I am uncomfortable in my body.	0	1	2	3	4	5
3. I notice where in my body I am comfortable.	0	1	2	3	4	5
4. I notice changes in my breathing, such as whether it slows down or speeds up.	0	1	2	3	4	5
5. I ignore physical tension or discomfort until they become more severe.	0	1	2	3	4	5
6. I distract myself from sensations of discomfort.	0	1	2	3	4	5
7. When I feel pain or discomfort, I try to power through it.	0	1	2	3	4	5
8. I try to ignore pain	0	1	2	3	4	5
9. I push feelings of discomfort away by focusing on something	0	1	2	3	4	5
10. When I feel unpleasant body sensations, I occupy myself with something else so I don't have to feel them.	0	1	2	3	4	5
11. When I feel physical pain, I become upset.	0	1	2	3	4	5
12. I start to worry that something is wrong if I feel any discomfort.	0	1	2	3	4	5
13. I can notice an unpleasant body sensation without worrying about it.	0	1	2	3	4	5
14. I can stay calm and not worry when I have feelings of discomfort or pain.	0	1	2	3	4	5
15. When I am in discomfort or pain I can't get it out of my mind	0	1	2	3	4	5
16. I can pay attention to my breath without being distracted by things happening around me.	0	1	2	3	4	5
17. I can maintain awareness of my inner bodily sensations even when there is a lot going on around me.	0	1	2	3	4	5
18. When I am in conversation with someone, I can pay attention to my posture.	0	1	2	3	4	5

How often does each statement apply to you generally in daily life? Circle one number on each line

	Never					Always
19. I can return awareness to my body if I am distracted.	0	1	2	3	4	5
20. I can refocus my attention from thinking to sensing my body.	0	1	2	3	4	5
21. I can maintain awareness of my whole body even when a part of me is in pain or discomfort.	0	1	2	3	4	5
22. I am able to consciously focus on my body as a whole.	0	1	2	3	4	5
23. I notice how my body changes when I am angry.	0	1	2	3	4	5
24. When something is wrong in my life I can feel it in my body.	0	1	2	3	4	5
25. I notice that my body feels different after a peaceful experience.	0	1	2	3	4	5
26. I notice that my breathing becomes free and easy when I feel comfortable.	0	1	2	3	4	5
27. I notice how my body changes when I feel happy / joyful.	0	1	2	3	4	5
28. When I feel overwhelmed I can find a calm place inside.	0	1	2	3	4	5
29. When I bring awareness to my body I feel a sense of calm.	0	1	2	3	4	5
30. I can use my breath to reduce tension.	0	1	2	3	4	5
31. When I am caught up in thoughts, I can calm my mind by focusing on my body/breathing.	0	1	2	3	4	5
32. I listen for information from my body about my emotional state.	0	1	2	3	4	5
33. When I am upset, I take time to explore how my body feels.	0	1	2	3	4	5
34. I listen to my body to inform me about what to do.	0	1	2	3	4	5
35. I am at home in my body.	0	1	2	3	4	5
36. I feel my body is a safe place.	0	1	2	3	4	5
37. I trust my body sensations.	0	1	2	3	4	5

Appendix G: Informed Consent

Hofstra University
Hempstead, NY
Department of Psychology

Fall 2020

The following research study is seeking individuals to complete a series of online questionnaires related to sensory experiences and mental health. Eligible participants do not need to be experiencing symptoms of any specific mental health condition. This study is part of a doctoral program requirement being conducted in the Phobia and Trauma Clinic at Hofstra University, Department of Psychology, by Stephanie J. Grimaldi, M.A., under the supervision of Dr. Mitchell L. Schare, Ph.D., ABPP.

As a participant, you will be asked to provide basic demographic information and answer a series of questionnaires using a Likert scale response system (i.e., 0 = *never applies to me*, 1 = *sometimes applies to me*, etc.). Questions will consist of items related to sensory experiences and symptoms associated with various mental health conditions.

Eligible participants include adults, ages 18 and older, who live in the United States, and are proficient in English. The study will take approximately 25-30 minutes to complete, and participants will be compensated $4.28 for their full participation. To ensure the integrity of this research, data quality checks have been placed randomly throughout the study. Participants will not be compensated if they fail one or more data quality checks. Additionally, if the survey is terminated before completion, or if responses do not correspond to the eligibility requirements listed in this consent, you will not receive compensation for the study.

Your participation is voluntary, and you may withdraw from the study at any time and for any reason. The risks involved in this study are minimal. There is little or no direct benefit to you for participating. However, your participation may help us understand more about the relationship between sensory experiences and mental health.

Your responses and any information related to your participation will be kept completely confidential. Only members of our research lab will have access to it. Any published data will be completely de-identified and will constitute aggregate data rather than individual data.

Your participation in this study is greatly appreciated. If you have questions regarding the study, or to report a research related problem, you may contact the PI at sgrimaldi1@pride.hofstra.edu. Additionally, Dr. Mitchell Schare, Director of the Phobia & Trauma Clinic can be contacted at Mitchell.L.Schare@hofstra.edu or 516-463-5009.

Stephanie J. Grimaldi, M.A.
Principal Investigator

This research has been reviewed by the Institutional Review Board of Hofstra University.

Click one of the two responses:

_____ I have read and understand the information given above and agree to participate in this study.

_____ I do not agree to participate in this study and/or recognize that I am not eligible.