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Co-occurrence of Sensory Over-responsivity with Obsessive-Compulsive Symptoms in Childhood and Early Adolescence

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Abstract

Objective: Sensory over-responsivity is characterized by challenges in integrating and responding to everyday sensory experiences (SOR). Obsessive Compulsive Disorder (OCD) is characterized by intrusive thoughts, ritualistic behaviors, and sensory phenomena. There is some evidence that individuals with co-occurring symptoms of SOR and OCD experience more severe anxiety than those with symptoms of OCD alone, but most studies employ small numbers of participants (typically with an OCD diagnosis) assessed at a single time point. Our two-fold objective was to replicate previous research showing an association between OCD symptoms and sensory over-responsivity symptoms concurrently, and to extend these analyses longitudinally in a large, birth-register based sample.

Method: Twins ($N=1,613$) and their primary caregivers participated in a multi-modal, multi-method, longitudinal study. Primary caregivers completed the Sensory Over-responsivity Inventory for their offspring at age 8 years and twins completed the Adult Sensory Profile at age 13 years. Parents completed the OCD module of the Diagnostic Interview Schedule for Children-IV when twins were age 8 years; twins completed the same module at age 13 years. Linear regression models tested for the concurrent and longitudinal associations between SOR and OCD controlling for socio-economic status.

Results: Concurrently, participants' likelihood of exhibiting OCD symptoms increased with each symptom of tactile or auditory over-responsivity both ages 8 years and 13 years ($OR=1.1-2.7$). However, sensory over-responsivity measured at age 8 years was unrelated to adolescent OCD symptoms at age 13 years and vice versa.

Conclusion: SOR symptoms, while significantly related to concurrent OCD symptoms, do not appear to precede OCD symptoms, suggesting that SOR symptoms may reflect another type of OCD sensory phenomenon rather than a comorbid condition.

Keywords

Sensory processing disorder; OCD; SOR; adolescence; middle childhood

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Sensory Processing Disorder (SPD) is characterized by an inability to integrate sensory information and respond appropriately. SOR typically manifests as exaggerated or prolonged negative behavioral responses to ordinary sensory stimuli¹. Although not currently recognized as such, some evidence suggests that SOR symptoms comprise a distinct disorder with prevalence rates ranging from 5–20%^{2,3}. Nevertheless, children with behavior problems, particularly anxiety disorders⁴ and autism spectrum disorder⁵, frequently report elevated levels of sensory over-responsivity. Conversely, children identified as at-risk for SOR have more behavior problems than children not at-risk^{3,6}.

Obsessive-Compulsive Disorder (OCD) is an anxiety disorder characterized by persistent and ritualistic behaviors that are performed in response to intrusive thoughts, images, or ideas. Lifetime prevalence for juvenile-onset (usually 9–12 years) is relatively low (1–2.5%)⁷. However, many more individuals experience subclinical obsessive-compulsive symptoms in the absence of a formal diagnosis. Among pediatric populations, 13–15% report at least one or more OCD symptoms^{8,9}. Having one or more OCD symptoms is associated with functional impairment and an increased risk for other behavior problems^{8,9}.

The archetypal depiction of OCD characterizes obsessions as the anxiety-provoking symptom and compulsions as the regulation of these obsessive symptoms. However, not all compulsions can be attributed to obsessions. As many as 30%–70% of OCD patients report that sensory phenomena (e.g. uncomfortable feelings regarding physical sensations) drive their compulsive rituals¹⁰. Children and adolescents are more likely than adults to report miscellaneous compulsions¹¹, which may include responses to sensory phenomena¹⁰. Among adults, sensory phenomena are associated with tic disorders, earlier age of onset, and poor treatment response¹². In addition, body-focused repetitive behaviors are related to a heightened awareness of somatic sensations¹³. Together these findings suggest that atypical sensory experiences may play an important role in understanding OCD.

The small number of studies examining the relationship between sensory over-responsivity and OCD symptoms find that, across the lifespan, sensory sensitivities co-occur with OCD symptoms. Hazen et al.¹⁴ examined a series of case studies to investigate how intolerance of ordinary sensory stimuli might drive compulsive behaviors in children diagnosed with OCD and/or Tourette's Syndrome (a related disorder with repetitive behaviors). Sensory-avoidance behaviors were the primary presenting symptoms in the absence of obsessive thoughts, suggesting that atypicalities in sensory processing and integration occur in at least a subset of OCD patients. Lewin et al.¹² extended Hazen's work by examining sensory over-responsivity in a sample of children ages 3–17 years diagnosed with OCD. SOR was relatively common, with 32.5% of participants experiencing tactile sensitivity, 20.3% visual or auditory sensitivity, and 20.5% gustatory/olfactory sensitivity. Sensory over-responsivity was nearly twice as prevalent among children (i.e., preschoolers) than adolescents. Rieke and Anderson¹⁵ confirmed that adults diagnosed with OCD scored higher than the Adolescent/Adult Sensory Profile published norms¹⁶ on sensory sensitivity and sensory avoidance. Sensory over-responsivity and OCD symptoms are moderately correlated in non-clinical populations as well^{17,18}. For example, Dar et al.¹⁷ reported that strong reactions to typical sensations were correlated with ritualism in a community based sample of young children.

Several studies report that children who have co-occurring symptoms of SOR and another disorder tend to score higher on both symptoms and measures of impairment than children who do not experience co-occurring symptoms^{3,6,19,20}. Similarly Ben-Sasson and Podoly¹⁸ reported that adults with co-occurring SOR and OCD symptoms have higher OC symptom scores than an OC-symptom-only group and higher SOR scores than an SOR-symptom-only group. Thus, the additional burden presented by sensory dysfunction appears to exacerbate comorbid conditions. In addition, SOR appears to be a trans-diagnostic feature associated not only with OCD but also ADHD²¹, anxiety⁶, and other clinical conditions²². Thus, studying OCD jointly with SOR may provide clues to common processes that OCD shares with other conditions.

These studies suggest that a subpopulation of individuals with OCD or who experience OCD symptoms are likely to also experience aversive reactions to everyday sensations. Moreover, these reactions may exacerbate existing OCD symptoms or otherwise be indicative of more general impairment. However, these studies are limited by small samples and in some cases non-systematic ascertainment. Moreover, previous studies are cross-sectional and do not address the potential temporal ordering in the development of SOR and OCD symptoms. The issue of temporal ordering is important because sensory over-responsivity symptoms are observed as early as infancy and toddlerhood²³, well before OCD symptoms typically manifest. Because SOR symptoms are associated with a range of disparate behavior problems, they may provide an early marker of neurological vulnerabilities²⁴. Alternatively, early onset sensory over-responsivity may lead to behaviors associated with distress⁵, such as hyper-vigilance to both external and internal sensations.

Hypotheses.

We examined the relationship between SOR and OCD symptoms in a large birth-record based sample of twins assessed at ages 8 and 13 years. We hypothesized that (1) SOR symptoms and OCD symptoms would be positively correlated with one another concurrently; and that (2) SOR symptoms in childhood would precede OCD symptoms in adolescence, owing to the possible early onset of SOR symptoms²⁵. We tested tactile and auditory sensitivity separately given the moderate inter-correlation between the two modalities and possible differential relationship with anxiety²⁵.

Methods

Participants.

Participants were drawn from the Wisconsin Twin Project, a statewide, birth register-based twin sample that was mildly enriched for internalizing and externalizing symptoms¹. Families were invited to participate in a study of temperament and behavior problems when twins were age 8 years ($N=1,613$; 49% female) and an adolescent follow-up study at

¹At age 7 years, mothers completed the Health and Behavior Questionnaire (Essex et al, 2002) for each child. Children who scored higher than 1.5 standard deviations on any behavior problem scale (overanxiousness, separation anxiety, depression, conduct disorder, attention deficit hyperactivity disorder and oppositional defiance disorder) were eligible for an in-depth study at age 8 year, as were children who scored below the mean on all behavior problems scales. Unselected cotwins of eligible participants were enrolled and participated in all aspects of the subsequent study as well.

approximately age 13 years ($N=1,046$; 50.6% female). Participants who did not complete the adolescent follow-up did not differ in race, ethnicity, SES, gender, or mean SOR and OCD symptoms at age 8 years. On average, mothers and fathers had 15.3 and 14.7 years of education, respectively, corresponding to some technical or college level training. Median family income, reported categorically, corresponded to \$50,000 to \$60,000. Ninety percent of caregivers identified their offspring as white, 3.2% as African-American, 0.7% as Hispanic, and 6.1% as mixed race or other. The University of Wisconsin Institutional Review Board approved this study. Parents provided consent, and adolescents assent, for their participation, and all participants were paid. Parents completed phone and in-person interviews and questionnaire packets for each of their offspring separately when twins were ages 8 and 13 years. Each twin completed phone interviews and questionnaires at age 13 years. A full description of study procedures is provided in Schmidt et al.²⁶.

Sensory Over-responsivity.

At age 8 years ($M = 7.8$; $SD = 0.83$), trained interviewers obtained primary caregiver (98% mothers) reports of tactile and auditory over-responsivity symptoms for each of her twins ($n = 910$)² using the Sensory Over-Responsivity Inventory (SensOR)²⁷. Thirty items relate to discomfort with tactile sensations (i.e. contact with substances or surfaces, grooming activities). Twenty-two items relate to discomfort with auditory sensations (i.e. irritating noises, loud places). Caregivers indicated whether the child was 'bothered' by each experience (0 = no, 1 = yes). We created two scales by summing over all 31 tactile items and 23 auditory items separately. The tactile and auditory subscales both had good reliability estimates (Chronbach's $\alpha = .83$ and $.84$, respectively), which are consistent with published reliabilities²⁷. Participants were defined as at-risk for having a sensory processing disorder if they had 4+ symptoms of auditory over-responsivity and/or 8+ symptoms of tactile over-responsivity.

At age 13 years ($M = 13.3$; $SD = 1.39$), trained interviewers administered a subset of items from the Adolescent/Adult Sensory Profile (AASP)¹⁶ that targeted tactile and auditory over-responsivity of each twin ($n = 889$); members of a twin pair were assessed during separate phone interviews. Participants reported on their own sensory over-responsivity on a scale from 1 (*almost never*) to 5 (*almost always*); high scores indicated greater sensory sensitivity. We averaged across 13 items related to tactile over-responsivity and 11 items related to auditory over-responsivity. Reliability was adequate for the auditory scale ($\alpha = .71$), but low for the tactile scale ($\alpha = .58$), likely owing to a broader range of sensory experiences in this scale. Because we used a subset of the AASP, we were unable to use the published norms to identify participants at-risk for having a sensory processing disorder.

Obsessive-Compulsive Symptoms.

Trained interviewers administered the Diagnostic Interview Schedule for Children²⁸ (DISC-IV) to primary caregivers at age 8 years. Caregivers completed the DISC for each twin separately ($n = 1600$). Each adolescent twin completed the DISC interview at age 13 years

²Sensory items were added after the start of the study. Children who participated before the sensOR was added are older, come from lower income families, and are less likely to be non-white, but do not differ on gender, or OCD symptom presence.

($n = 1,045$). The DISC is a widely used structured interview with good psychometric properties²⁸. Respondents indicated whether symptoms were (1) or were not (0) characteristic of their child (or themselves). The DISC scoring algorithm provides both symptom counts and diagnoses for anxiety, mood, and externalizing disorders³.

The number of participants who met criteria for an OCD diagnosis, $n=8$ (0.5%) at age 8 years and $n=13$ (1.2%) at age 13 years, closely matched previously reported prevalence rates for children and adolescents⁷. However, because the numbers of diagnoses were quite low, we focused on OCD symptom counts (Figure 1, Supplemental Digital Content 1). At age 8 years, 13% of participants exhibited at least one OCD symptom; at age 13 years, 45% of participants endorsed at least one OCD symptom. Because of the highly skewed distribution of symptoms, we dichotomized OCD symptoms into presence vs. absence, where presence was defined as 1 or more symptoms at age 8 years ($n=215$, 13%), and 3 or more symptoms ($n=92$, 8%) at age 13 years. These thresholds align with previously published symptom prevalence rates⁹.

To determine if these cut-points represented a meaningful level of behavior problems, we examined parent ratings of impairment to self and family. At both ages, caregivers completed a the Health and Behavior Questionnaire (HBQ)²⁹, which asks caregivers to rate their offspring's behavior problems (not including OCD symptoms), and the extent to which those behaviors negatively impact the family or the target child. Children whose parents endorsed one or more OCD symptoms at age 8 years scored higher than children with no symptoms on both the family and target child impairment measures. Likewise, adolescents who scored 3 or more symptoms were rated higher on both impairment measures than adolescents who had no symptoms or adolescents who endorsed 1–2 symptoms. Adolescents who endorsed 1–2 symptoms of OCD were indistinguishable from the no symptom group. Details are provided in Supplemental Table 1.

Data Analytic Plan.

We used SPSS 24 (IBM Corp) to conduct all statistical analyses. We conducted logistic regressions, controlling for clustering within family, to assess whether tactile or auditory sensitivity predicted presence of OCD symptoms, as defined above, concurrently and/or longitudinally. Prior to logistic regression we used chi-square analyses and t-tests to determine if gender, zygosity, or SES were related to presence of OCD symptoms.

Results

OCD symptom presence was only modestly stable over time ($\chi^2 = 4.4$, $p = .04$); 20% of children who exhibited OCD symptoms at age 8 years continued to report engaging in OCD behaviors at age 13 years. Adolescents reported more OCD symptoms at age 13 years ($M = 0.80$, $SD = 1.1$) than caregivers reported at age 8 years ($M = 0.17$, $SD = 0.48$, $t(1044) = 20.0$, Cohen's $d = .74$). Nearly 1 in 5 participants who did not exhibit OCD symptoms at age 8 years went on to report three or more OCD symptoms at age 13 years.

³The following DISC modules were administered at both ages: GAD, SAD, social phobia, OCD, agoraphobia, panic disorder, ODD, CD, ADHD. An eating disorders module was added to the adolescent interview.

In describing their 8-year-old children, caregivers endorsed relatively few sensory items ($M = 2.9$, $SD = 2.23$ tactile; $M = 1.4$, $SD = 2.20$ auditory) at this age. Adolescent SOR symptom ratings were normally distributed for both SOR subtypes with averages corresponding to rating sensations as bothersome between “seldom” and “occasionally” (tactile $M = 2.4$, $SD = 0.58$ tactile; auditory $M = 2.6$, $SD = 0.59$). The tactile and auditory scales were moderately correlated at age 8 years ($r = .45$, $p < .001$) and age 13 years ($r = .47$, $p < .001$). Parent reported SOR was not significantly correlated with adolescent self-reported SOR ($r = .08$, $p = .07$ for the tactile scale; $r = .07$, $p = .12$ for the auditory scale).

Covariates:

Gender, age and zygosity were not significantly related to scores on any of the sensory or OCD measures; therefore, results are based on the full sample. SES was lower in families of children with OCD symptom presence at age 8 years ($t(1477) = 2.0$, $p = .04$) and at age 13 years ($t(982) = 3.2$, $p < .001$). We included SES as a covariate in all subsequent analyses.

Hypothesis 1.

Results of the logistic regressions are shown in Table 1. At age 8 years, the odds of parents reporting any OCD symptoms increased by 1.11 (95%CI: 1.05–1.15) with every increase in concurrent symptoms of tactile SOR and by 1.17 (95%CI: 1.07–1.28) with every increase in auditory SOR symptoms. In a model that included both as predictors, tactile and auditory SOR independently contributed to OCD symptom presence (OR=1.07, $p = .01$ tactile, OR=1.11, $p = .05$ auditory). A small but significant number children fell in the OCD present and SOR at-risk groups (3%; $\chi^2 = 13.5$, $p < .001$). However, 80% of children identified as at-risk for SOR showed no OCD symptoms.

At age 13 years, the odds of being in the OCD present group increased by 2.35 (95%CI: 1.61–3.44) with every unit increase in self-reported tactile SOR and by 2.72 (95%CI: 1.90–3.91) for every unit increase in auditory SOR. As before, tactile and auditory SOR independently contributed to OCD symptom presence when both were included as predictors (OR=1.06, $p = .03$ tactile; OR=1.42, $p < .001$ auditory).

Hypothesis 2.

SOR symptoms at age 8 years did not predict age 13 years OCD symptom presence (OR = 1.01, $p = .64$ for tactile symptoms, and OR=.99, $p = .91$ for auditory symptoms). Similarly, OCD symptom presence at age 8 years did not predict SOR symptoms at age 13 years ($b = -.03$, $p = .55$ for tactile symptoms, and $b = .02$, $p = .74$ for auditory symptoms).

Post-hoc analyses.

At age 8 years, 43% of participants in the OCD present group qualified for at least one DISC diagnosis compared with 19% of children without OCD symptoms; 32% of adolescents in the OCD present group qualified for a DISC diagnosis compared to 9% of adolescents with 2 or fewer OCD symptoms. Within each age, SOR continued to significantly predict OCD presence after controlling for a diagnosis of a comorbid disorder (Table 1, Supplemental Digital Content 1).

Discussion

We examined the relationship between adverse reactions to daily tactile and auditory sensations and the presence of OCD symptoms at two ages. Lifetime prevalence rates in our study were consistent with other community-based samples of children and adolescents; ^{8,23,24} however, we did not analyze OCD diagnoses, owing to low incidence. The proportion of children who were rated by parents as exhibiting at least one OCD symptom (13%) was close to that reported by Fullana et al.⁹ (8%) in similarly aged community-based samples. In contrast, the number of adolescents endorsing at least one OCD symptom was much higher than expected. Imposing a higher threshold on adolescents (at least 3 OCD symptoms) resulted in a more realistic proportion of adolescents in the OCD present

Although previous evidence of a direct relationship between SOR and OCD symptoms was sparse, we anticipated finding a positive association within age. We also expected to find a longitudinal association between childhood SOR symptoms and adolescent OCD symptoms. The first of these hypotheses was supported, with internal replication because we used different raters and different assessments of SOR at ages 8 and 13 years. At age 8 years, parents of children with one or more OCD symptoms endorsed more symptoms of auditory and tactile SOR than children without OCD symptoms, and a small but significant number of children with at least one symptom of OCD were identified as at-risk for SOR. At age 13 years, adolescents who reported three or more OCD symptoms also rated themselves as having more negative reactions to tactile and auditory sensations than adolescents with two or fewer OCD symptoms. Most children at-risk for SOR did not experience any OCD symptoms. Thus, sensory dysfunction may serve as a non-specific risk factor for a variety of behavior problems³.

The longitudinal hypothesis was not supported. Parent reported SOR symptoms at age 8 years did not predict self-reported OCD symptoms at age 13 years. Although we did not anticipate that OCD would predict later SOR symptoms, we nevertheless tested for that possibility. The results were also non-significant.

Collectively, these findings suggest that among the subset of children with OCD symptoms, SOR symptoms may be an extension of OCD sensory phenomena rather than a separate, comorbid condition. There are several mechanisms by which OCD and SOR may co-occur. Some individuals diagnosed with OCD reported engaging in obsessive-compulsive behaviors in response to or in conjunction with physical discomfort localized to a specific body part¹⁰. Heightened sensitivity to these internal bodily sensations (e.g. muscle tension) may be accompanied by heightened sensitivity to external sensations as well. In addition, core features of OCD and sensory over-responsivity are hypothesized to arise from deficits in sensorimotor integration^{32,33}. Thus, similar neurological conditions could also give rise to symptoms of both SOR and OCD. Finally, OCD³⁴ and SOR²³ symptoms are both moderately heritability, and SOR symptoms share genetic influences with internalizing symptoms³. Thus, overlapping genetic risk factors may contribute to the development of both OCD and SOR symptoms.

We allowed for the possibility that sensitivity to tactile and auditory stimuli may be differentially related to OCD symptoms, but the evidence did not suggest that one type of SOR was a better predictor of OCD symptom presence than the other. In fact, both appeared to contribute independently and equally to the outcome. We were unable to assess other types of sensory dysfunction (including motor dysfunction); however, Lewin et al.¹² reported heightened sensitivity across the sensory modalities including taste and smell, suggesting that OCD is related to general sensory dysfunction.

Despite our relatively large sample, very few individuals reported or were observed engaging in OCD-related behaviors, which prevented us from examining OCD symptom subtypes. Although The DISC-IV interview provides symptom counts, its intended purpose was as a diagnostic screening tool²⁸. Thus, the DISC-IV might not be a robust measure for the specific identification of OCD symptoms. However, our findings mirror Alvarenga et al.⁸, who also found that having at least one symptom of OCD was related to functional impairment during childhood. In addition, our sample was largely Causasian and broadly middle class, and thus findings may not generalize to other populations. SOR symptoms are vastly over-represented among children from disadvantaged backgrounds³⁵. Adolescents reported more OCD symptoms than parents and parent-rated SOR symptoms were uncorrelated with adolescent-rated SOR symptoms. Ideally, both parents and children would provide information on OCD and SOR symptoms at the two ages, allowing us to disentangle rater effects from true developmental changes. Changing measures of SOR across the two ages, which was necessary to be developmentally appropriate, did, however, dampen our ability to detect any temporal ordering or infer causality.

Ours is the first large-sample study of typically developing children to confirm a positive relationship between sensory over-responsivity and OCD symptoms. Although we did not find a significant longitudinal association, sensory issues may exacerbate or maintain existing OCD symptoms during a period when many anxiety problems have their onset³⁶. Understanding the mechanisms underlying co-occurring sensory dysfunction and OCD symptoms could provide insight into the neurobiology underlying each.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1.

Relationship between SOR and *concurrent* OCD symptoms.

		Age 8 OCD–present				Age 13 OCD–present			
		β	<i>p</i>	<i>OR</i>	<i>CI</i>	β	<i>p</i>	<i>OR</i>	<i>CI</i>
Model 1.									
SES		–0.18	.25	0.83	0.61–1.14	SES		0.58	0.39–0.84
Tactile SOR		0.10	<.001	1.11	1.05–1.15	Tactile SOR		2.35	1.61–3.44
Model 2.									
SES		–0.17	.30	0.84	0.60–1.17	SES		0.56	0.38–0.83
Auditory SOR		0.14	.001	1.17	1.07–1.28	Auditory SOR		2.72	1.90–3.91

Note: OCD–present refers to 1+ obsessive-compulsive symptom at age 8 year or 3+ obsessive compulsive symptoms at age 13 years; OR = odds ratio, CI = 95% confidence interval. At age 8, parents completed the Sensory Over-responsivity Inventory; at age 13 adolescents completed items from the Adult/Adolescent Sensory Profile