Olfactory Identification, Odor Hedonics, and Atypical Behaviors
Julianne Cary, Joseph LaFrance, Sara Costello, and Emily R. Bovier*
State University of New York at Oswego

ABSTRACT. Smell identification deficits have been found to coincide with diagnoses of schizophrenia and anxiety disorders. This study aimed to determine if olfactory functioning (in terms of smell identification and subjective experiences) differed depending on self-reported atypical behaviors in a subclinical sample. In Part 1, participants (N= 183) completed self-report questionnaires pertaining to atypical behavior and social interaction. Participants who were recruited for Part 2 (N= 59) completed additional measures of smell identification, odor hedonics, and an emotion recognition task. A one-way Analysis of Variance showed no significant difference in smell accuracy, pleasantness, or intensity ratings of odorants across groups. However, subjective ratings of irritation for the negative odorant significantly differed across groups (F = 3.05, p = .04, d = .13). These findings suggest that subjective perceptual experiences may be more informative than identification accuracy, especially if olfactory measures could be used as a sensory marker of early signs of clinical symptoms or to provide insight into possible underlying neurological and sensory deficits.

Keywords: olfactory functioning, atypical behavior, smell identification, odor hedonics, schizotypy

Sensory function can be a useful tool for understanding individual differences in behavior and brain functioning. In addition, olfactory processing may provide information about the functions of neural structures that are in part responsible for atypical behaviors. Previous studies have reported that smell identification deficits are common among individuals diagnosed with schizophrenia, anxiety, and neurodegenerative disorders (Clepece, Reich, Gossler, Kornhuber, & Thueraif, 2012; Havlíček et al., 2012). Typically, these deficits often coincide with negative symptoms (e.g., blunted affect, anhedonia and social withdrawal; Havlíček et al., 2012). The purpose of the current project was to determine if individual differences in olfactory ability differed depending on self-reported atypical behaviors in a subclinical population. Information from this study could be used to develop a behavioral assessment battery to characterize individuals at risk for the development of schizophrenia, anxiety or neurodegenerative disorders and monitor preventative measures or treatment approaches. Participant groups were entirely subclinical as studying a subclinical population may identify risk factors for developing certain disorders and allow for a better understanding of the progression of the illness.

Most individuals in the general population have the ability to access normative olfactory functions, unless there is a presence of an olfaction or gustation related deficit (Havlíček et al., 2012). Sense of smell is arguably one of the most essential functions that humans experience. Humans use their sense of smell to detect threats in their environment, choose romantic partners, and in food assessment (Havlíček et al., 2012). Olfactory functioning can be deconstructed into distinct...
Cary, LaFrance, Costello, and Bovier | Olfaction and Atypical Behaviors

The test continues until seven reversals, when the threshold is computed as the mean dilution steps of the last four reversals (Hummel et al., 1997).

Objective and subjective components of olfactory processing can occur as separate processes. For example, an individual may have the ability to detect and discriminate between odorants, but may have deficits in odorant identification. Similarly, two individuals who have the same objective ability to identify odorants, may have different ratings of subjective pleasantness of the same odorants. Olfactory identification encompasses a variety of functions (i.e., the ability to not only detect a scent, but also to identify it and distinguish it from other scents, while incorporating odor memory). In addition, a large component of processing olfactory stimuli occurs at the neural level. Understanding the neurological basis of olfaction provides justification for why this particular sensory system may function differently in individuals with clinical symptoms.

Olfactory perception has been found to activate the regions of the brain responsible for emotional processing: the amygdala, hippocampus, and the orbitofrontal cortex (OFC). Findings by Schiffman (1974) suggest that olfactory perception directly activates amygdala neurons in some cases, and then activated the OFC. Qureshy et al. (2000) found through PET scans that the regions activated during olfactory identification are the right anterior cingulate gyrus, left insula, OFC, and the left anterolateral cerebellum, whereas during olfactory discrimination the bilateral cerebellar regions were activated (Havlíček et al., 2012; Krusemark et al., 2013; Qureshy et al., 2000). Thus, it is possible that there may be a relationship among olfactory deficits and atypical behavior because these regions are also affected by several psychiatric disorders (i.e., schizophrenia, anxiety disorders, neurodegenerative disorders; Auster, Cohen, Callaway, & Brown, 2014; Doty et al. 1983; Havlíček et al. 2012). In addition, Doty et al. (1983) emphasized the fact that olfactory deficits commonly occur as a result of accidents (i.e. mild traumatic brain injury) and aging. Due to the frequency of olfactory identification deficits coinciding with diagnoses of mental illnesses, this occurrence is likely an indicator of underlying neurological dysfunction.

Previous literature has found anxiety to be significantly related to olfactory functioning (Clepce et al., 2012). For example, past studies have established that increased anxiety reactions occur following the presentation of, what are deemed as, fearful odorants (Albrecht et al., 2010; Clepe...
et al., 2012). Albrecht et al. (2010) presented women participants with sweat from a fearful man. Anxiety was measured using the State-Trait Anxiety Inventory X (Spielberger, Gorsuch, & Lashene, 1970), a questionnaire containing items related to stress response, and through physiological recordings such as blood pressure and heart rate measurements. When compared to controls who were presented neutral sweat, the women who were presented the fear-induced sweat showed a heightened anxiety response (Albrecht et al., 2010). Clepece et al. (2012) tested the theory that anxiety is correlated to deficits in olfactory identification through an extended version of the Sniffin’ Sticks identification test. This study used participants with diagnosed cases of various types of anxiety disorders (generalized anxiety disorder, social phobia, panic disorder, agoraphobia) and healthy control participants. Researchers found that the anxiety group performed significantly worse on the discrimination task than the control group, although there were no group differences in identification and threshold (Clepece et al., 2012).

Smell identification tests have also served as a vulnerability marker for schizophrenia spectrum disorders (Auster et al., 2014). Specifically, studies using the UPSIT have found that up to 80% of patients with schizophrenia in their studies exhibit these deficits (Auster et al., 2014). Contrasted with the rates of olfactory identification deficits reported among the general population, which is less than 15%, it is apparent that these deficits may be related to schizophrenia (Doty et al., 1984). Due to the heterogeneous nature of schizophrenia, symptoms are typically categorized into symptom domains. The positive symptom domain includes hallucinations, delusions, and disorganized thoughts and speech while the negative symptom domain includes avolition and blunted affect (Ishizuka et al., 2010).

It is a well-established finding that negative and disorganized symptoms are associated with reduced smell identification accuracy, lessened sensitivity, and lower ratings of subjective pleasantness experience when compared to positive symptom group performance and controls (Auster et al., 2014; Brewer et al., 2005; Ishizuka et al., 2010). It has also been established that negative symptoms are specifically related to the first episode of psychosis (Auster et al., 2014). Due to the relationship between negative symptoms and smell identification deficits, it is possible that smell identification deficits may be specifically related to an increased risk of psychosis. Negative symptoms including avolition, anhedonia, and blunted affect are also similar to symptoms of Asperger’s syndrome and anxiety disorders, both of which also have been known coincide with olfactory identification deficits (Suzuki, Critchley, Rowe, Howlin, & Murphy, 2003). Individuals with schizophrenia, Asperger’s syndrome, and anxiety disorders have been known to present significantly lower scores on hedonic evaluations of odors as well (Auster et al., 2014; Cieslak et al., 2015; Ishizuka et al., 2010; Krusemark et al., 2013; Suzuki et al., 2003).

Previous literature has established that individuals with schizophrenia often have deficits in social cognition (Brown & Cohen, 2010; Cieslak et al., 2015; Fonseca-Pedrero, Paíño-Piñeiro, Lemos-Giráldez, Villazón-García, & Muñiz, 2009; Gica, Poyraz, & Gulec, 2019). Social cognition has been defined as the ability to make sense of other’s behaviors and to understand other’s beliefs and intentions (Gica et al., 2019). Social cognition also encompasses social perception, interpretation, and processing (Brown & Cohen, 2010). It is also a well-established finding that individuals with schizophrenia perform worse on emotion recognition tasks (ERTs). Gica et al. (2019) used the Cambridge Neuropsychological Test Automated Battery (CANTAB) ERT (Cambridge Cognition, 2019) to determine how successful patients with schizophrenia are on ERTs. This task requires the participant to identify feelings from presentations of facial expressions on a computer or electronic device. Six basic emotions (sadness, happiness, fear, anger, disgust, or surprise) are shown throughout the 180 trials. The authors found that, compared to healthy controls, patients with schizophrenia performed worse on the ERT. Specifically, patients had the most difficulty recognizing the negative emotions, such as fear and disgust (Gica et al., 2019). Further, individuals with schizotypy have also performed worse on ERTs. Brown and Cohen (2010) used the Schizotypal Personality Questionnaire (SPQ; Raine, 1991) to determine the relationship between individuals with schizotypy and their performance on ERTs. The results show that individuals with schizotypy have impaired facial emotion recognition abilities. Because individuals with schizotypy are likely at an increased risk of developing schizophrenia, results from this study suggest that deficits in emotion recognition ability may serve as an indication of risk for development of a disorder such as schizophrenia (Brown & Cohen, 2010).

The relationship between atypical behaviors...
and olfactory deficits may suggest that forms of olfactory functioning (i.e., olfactory identification, odor hedonics) can serve as markers for characterizing individual differences in behavior. This project aimed to determine if objective and subjective measures of olfactory functioning differed across groups of participants with varying degrees of self-reported atypical behavior. To achieve this aim, we conducted a two-part study: Part 1 was designed to test for correlations among self-report assessments of atypical behavior and Part 2 was designed to test for group differences in olfactory functioning.

Part 1 of our study consisted of self-report questionnaires measuring behavioral inhibition/activation (The Behavioral Inhibition/Behavioral Activation Scale, BIS/BAS; Carver & White, 1994), social interaction anxiety (Social Interaction Anxiety Scale, SIAS; Mattick & Clarke, 1998), and behaviors related to schizotypy (Schizotypal Personality Questionnaire – Brief, SPQ-B; Fonseca-Pedrero et al., 2009). These measures were chosen based on their psychometric properties, relevance to our study, and availability at our institution. Specifically, the SIAS was chosen to measure participants’ self-reported experiences of anxiety during social interaction because increased social anxiety commonly coincides with diagnoses of schizophrenia and schizotypy (Clepce et al., 2012; Havlíček et al., 2012). Similarly, the BIS/BAS was chosen to measure self-reported instances of behavioral approach and avoidance in participants. The SPQ-B was chosen as the measure of atypical behavior in this study due to its frequent use in current literature and its ability to measure atypical behaviors in subclinical populations. We hypothesized that scores on the SPQ-B would significantly correlate with scores on the BIS/BAS and SIAS.

Part 2 of our study recruited participants based on their total score on the SPQ-B to complete measures of olfactory functioning. The UPSIT was chosen as our measure of smell identification based on its validation in current literature and the ease of administration. Furthermore, the array of odorants presented in the UPSIT enabled us to include an additional measure of subjective reactions to different types of odorants (compared to other olfactory assessments such as Sniffin’ Sticks, which measure thresholds to one odorant). Another major benefit of the UPSIT is the ease of use, which allows for rapid and accurate assessment of olfactory functioning in clinics and laboratories. We chose to group participants by their total scores to create three groups: a low-scoring group, a high-scoring group, and a group that scored in the middle range. The cutoff scores for the groups (detailed in the Method section) were chosen specifically to recruit participants in the extremes given that we had limited number of UPSITs.

Previous literature has established that performance on subjective and objective olfactory measures may be related to differing levels of atypical behavior (Auster et al., 2014; Brewer et al., 2005; Clepce et al., 2012; Havlíček et al., 2012; Ishizuka et al., 2010). Specifically, those who score low on the SPQ-B endorse a low amount or absence of atypical behaviors, while those who score high on the SPQ-B endorse a great amount of atypical behaviors. Both of these extremes have been found to coincide with deficits in olfactory functioning, especially when compared to those who score in the middle group, which is meant to represent an average performance (Clepce et al., 2012; Doty et al., 1984; Havlíček et al., 2012).

Therefore, we hypothesized that participants who scored either very low or very high on the SPQ-B would have significantly different scores on olfactory functioning (subjective and objective measures) than those participants who scored in the middle range. Finally, as an exploratory component of the study, we had participants complete a computer-based emotion recognition task (given the connections between olfactory and emotional processing; Krusemark et al., 2013) to determine if participants differed in emotion recognition accuracy based on their atypical behavior (SPQ-B) scores.

Method

Participants

Participants were undergraduate students enrolled in psychology classes and were offered extra credit for participation. Part 1 of the study recruited participants to complete self-report questionnaires related to behaviors. Participants were then asked to participate in the second part of the study based on their scores on the SPQ-B. Part 2 involved a smell identification test, odor hedonics, and an emotion task (detailed below). A total of 183 students participated in part one (147 women, 37 men; Mage = 20.42 years, SD = 2.65), and a total of 59 students were recruited for Part 2. Most of our participants identified as European American (n = 116), and the remaining participants identified as African American (n = 22), Latino/a (n = 22), Asian (n = 16), other (n = 3), Native American (n = 2), Middle Eastern (n = 1), and Mixed (n = 1).

Participants were asked to report conditions
related to gustation and olfactory function, seasonal allergies, mild traumatic brain injury, and cigarette smoking habits. Although no participants reported conditions related to gustation and olfactory function, our protocol would have excluded them from participation in Part 2 to avoid any confounding variables because individuals with deficits in gustation and olfaction would likely perform worse on the UPSIT (Doty et al., 1983). In addition, 58 participants (32% of our sample) reported seasonal allergies, but were not excluded due to the large frequency of these symptoms in the sample. We also excluded one participant from Part 2 with a reported chronic history of cigarette use and one participant with a history of traumatic brain injury. Three of the 59 Part 2 participants did not complete the ERT due to scheduling issues and inconsistencies within the testing parameters.

**Materials**

**Social Interaction Anxiety Scale (SIAS).** The SIAS (Mattick & Clarke, 1998) is a 20-item, self-report survey primarily utilized for measuring levels of distress when interacting with other individuals. Participants respond to statements utilizing a Likert-type scale ranging from 0 (not at all characteristic of me) to 4 (extremely characteristic of me). Questions in the SIAS include “I have difficulty talking to other people” and “I feel I’ll say something embarrassing when talking.” Mattick and Clarke (1998) reported that the SIAS was found to possess high levels of internal consistency (.94) and test-retest reliability at four weeks (.92). The authors also found that the measure was able to discriminate between social phobia, agoraphobia, and normal samples. Scores were also shown to correlate with well-established measures of social anxiety (Mattick & Clarke, 1998).

**Behavioral Inhibition/Behavioral Activation Scale (BIS/BAS).** The BIS/BAS (Carver & White, 1994) is a 24-item questionnaire used to assess individual differences in the activation of the behavioral avoidance (or inhibition) systems and behavioral approach systems. The statements measure four different subscales: BAS Drive (4 out of 24 items; e.g., “I go out of my way to get things I want.”), BAS Fun Seeking (4 out of 24 items; e.g., “I’m always willing to try something new if I think it will be fun.”), BAS Reward Responsiveness (5 out of 24 items; e.g., “When I’m doing well at something I love to keep at it.”), and BIS (7 of 24 items; e.g., “Criticism or scolding hurts me quite a bit.”). Four out of the 24 items are used as fillers. Participants rate each of the 24 statements on a Likert-type scale of 1 (very true for me), 2 (somewhat true for me), 3 (somewhat false for me), or 4 (very false for me). Carver and White (1994) found the BIS/BAS to have adequate psychometric properties including reasonable alpha reliabilities for the BAS Drive (.74), BAS Reward Responsiveness (.73), BAS Drive (.76) and BAS Fun Seeking (.66; Carver & White, 1994).

**Schizotypal Personality Questionnaire - Brief (SPQ-B).** The SPQ-B (Fonseca-Pedrero et al., 2009) is a 22-item questionnaire that contains subscales related to positive (10 of 22 items; e.g., “Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?”), negative (10 out of 22 items; e.g., “I feel very uncomfortable in social situations involving unfamiliar people”), and disorganized symptoms (6 out of 22 items; e.g., “I find it hard to communicate clearly what I want to say to people”). Participants respond “yes” or “no” to each of the items. Fonseca-Pedrero et al. (2009) conducted a study to validate the psychometric properties of the SPQ-B and found it to have adequate psychometric properties. Specifically, the internal consistency of the subscales and total score ranged from .61 to .81. The internal reliabilities for the total score ranged from .75 to .83 and .58 to .87 for the subscales. Test-retest reliability ranged from .70 to .95. In addition, confirmatory factor analyses indicated that the three-factor model (positive, negative, and disorganized) and the four-factor model (positive, paranoid, negative, and disorganized) fit well in comparison to the remaining models. These results also confirmed the multifactor structure of the schizotypal personality in a subclinical population (Fonseca-Pedrero et al., 2009).

For the purpose of this study, participants scoring 0–4 on the SPQ-B were placed in the low group, scores of 9–11 were considered the middle group, and participants with 14 or more were labeled as the high group. The middle group was created following pilot data which suggested there may be a greater difference among middle and high, or middle and low scoring groups as compared to the difference between high and low scoring groups.

**Emotion Recognition Task (ERT).** The ERT (Cambridge Cognition, 2019) is intended to measure an individual’s ability to identify human emotions by utilizing computer generated faces, each depicting different human emotions (sadness, happiness, fear, anger, disgust, or surprise). Participants must identify a total of 180 faces, split into two 90-face sessions with a short break in
Olfaction and Atypical Behaviors

between. The ERT has been utilized to measure cognitive function in relation to schizophrenia, depression, and other affective disorders. The task is administered on a tablet with Cambridge Cognition’s CANTAB Cognitive Research Software. This test was chosen based on the ease of administration as well as its adequate psychometric properties (Strauss, Shermann & Spreen, 2006).

University of Pennsylvania Smell Identification Test (UPSIT). Olfactory identification was assessed with the UPSIT (Doty et al., 1983). The UPSIT is a widely used “scratch and sniff” test that contains 40 items presented as a four-alternative forced-choice olfactory identification test. Each odorant is contained in a microencapsulated pocket and is released by scratching the pocket with a pencil. The UPSIT is comprised of four packets, each with 10 odorants presented on an individual page, along with four choices for smell identification. Participants were scored based on their accuracy (yielding a score out of 40 for the number of correctly identified odorants). Additionally, participants rated (on a 9-point Likert-type scale) each odorant’s perceived pleasantness, intensity, and irritation. Doty et al. (1983) found the UPSIT to accurately differentiate between participants with known olfactory disorders (e.g., Kallmann’s syndrome; Korsakoff’s syndrome) and normal controls. The authors found the test-retest reliability to be adequate (6-month interval; \( r = .918, p < .001 \)). This test was also found to correlate with thresholds of odor detection \( (r = -.794, p < .001; \text{Doty et al., 1983}) \).

Procedure

All experimental procedures were approved by the Human Subjects Committee. Participants signed up for the first part of the study through an online recruitment portal. The experimenter reviewed informed consent with each volunteer. Participants then completed a packet of questionnaires containing a demographics survey, the SPQ-B, the SIAS, and the BIS/BAS. After completing the questionnaire, participants were told to wait while a random number generator determined participation in part two (participants were not told that their scores determined qualification at this stage). Participants who fell into one of three groups (low, medium, or high) based on their SPQ-B score scheduled a second session to complete the UPSIT. Those that were not placed in one of the four groups were given a debriefing form for the first part of the study. During the second visit, while completing the UPSIT, participants were asked to identify scents and rate their pleasantness, intensity, and irritation. When finished with the UPSIT, participants then completed an ERT. After completing the ERT, participants were given debriefing forms for each part of the study.

Results

Pearson-product moment correlations indicated a significant relationship between scores on the SPQ-B and scores on the SIAS \( (r = .63, p < .01; \text{see Figure 1}) \) and the BIS Drive subscale \( (r = .51, p < .01; \text{see Figure 2}) \). No significant relationship between SPQ-B scores and BAS subscales was observed \( (\text{BAS Drive}: r = -.05, p = .47; \text{BAS Fun Seeking}: r = .09, p = .24; \text{BAS Reward}: r = -.13, p = .07) \).
A total of 59 participants qualified for the second part of the study based on the cutoff scores for the SPQ-B established for this study (low SPQ-B group: N = 22; middle SPQ-B group: N = 15, high SPQ-B group: N = 22). To include odor hedonics as part of the analyses, a total of three odorants were selected based on pilot data that identified natural gas, grass, and watermelon as the items that were rated the most negative, neutral, and positive, respectively. A one-way ANOVA showed no significant difference in UPSIT accuracy, pleasantness, or intensity ratings of odorants across groups (see Table 1). Subjective ratings of irritation, however, for the natural gas odorant (considered negative), significantly differed across groups, $F(3, 63) = 3.05, p = .04$, with a small effect size ($d = .13$; see Figure 3). Although this difference is small, it may be attributed to our small sample size or lack of a clinical sample.

Post-hoc comparisons conducted using Tukey’s HSD revealed that the middle SPQ-B group had significantly different ratings compared to the low SPQ-B group on the SIAS ($M = 15.27, SD = 2.92, p = .00$). The middle SPQ-B group had significantly different ratings compared to the high SPQ-B group ($M = 10.10, SD = 2.62, p = .00$). The high SPQ-B group had significantly different ratings compared to the low SPQ-B group on the SIAS ($M = 25.37, SD = 3.04, p = .00$).

In addition, the low SPQ-B group did not have significantly different ratings compared to the middle SPQ-B group on the BIS Drive ($M = 2.09, SD = 1.02, p = .175$). The middle SPQ-B group did not have significantly different ratings compared to the high SPQ-B group on the BIS Drive ($M = .910, SD = .92, p = .754$), while the high SPQ-B had significantly different ratings compared to the low SPQ-B group on the BIS Drive ($M = 3.00, SD = 1.06, p = .027$).

Post-hoc comparisons conducted using Tukey’s HSD also revealed that the middle SPQ-B group had significantly lower irritation ratings on the natural gas odorant (5.6 out of 9) compared to the high SPQ-B group (7.9 out of 9; $M = -2.31, SD = 0.79, p = .025$). Irritation ratings for the low SPQ-B group (7.09 out of 9) did not significantly differ from the high SPQ-B group ($M = .82, SD = .72, p = .66$), and the 1.49-point difference between low and middle SPQ-B group did not reach statistical significance ($M = 1.49, SD = 0.79, p = .25$).

Using Bonferroni adjusted alpha levels of .0125 per test (.05/4), results indicated that the low SPQ-B group had significantly different ratings on the SIAS compared to the middle SPQ-B group ($M = -15.27, SD = -2.92, p = .00$). The middle SPQ-B group had significantly different ratings on the SIAS compared to the high SPQ-B group ($M = -10.10, SD = 2.62, p = .00$). The low SPQ-B group had significantly different ratings on the SIAS compared to the high SPQ-B group ($M = -15.27, SD = -2.92, p = .00$).

Results indicated that the low SPQ-B group did not have significantly different ratings on the BIS Drive compared to the middle SPQ-B group ($M = 2.09$).

### Table 1

<table>
<thead>
<tr>
<th>UPSIT Item</th>
<th>$F$</th>
<th>$p$</th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Total UPSIT Accuracy</td>
<td>1.47</td>
<td>.23</td>
<td>32.86</td>
<td>2.87</td>
<td>32.27</td>
<td>3.73</td>
</tr>
<tr>
<td>IRRITATION (NEGATIVE)</td>
<td>3.05</td>
<td>.04</td>
<td>7.09</td>
<td>2.69</td>
<td>5.60</td>
<td>2.92</td>
</tr>
<tr>
<td>PLEASANTNESS (NEGATIVE)</td>
<td>2.47</td>
<td>.07</td>
<td>1.59</td>
<td>1.01</td>
<td>2.67</td>
<td>2.23</td>
</tr>
<tr>
<td>INTENSITY (NEGATIVE)</td>
<td>0.40</td>
<td>.75</td>
<td>3.78</td>
<td>3.24</td>
<td>2.87</td>
<td>2.23</td>
</tr>
<tr>
<td>IRRITATION (NEUTRAL)</td>
<td>1.54</td>
<td>.21</td>
<td>4.14</td>
<td>2.98</td>
<td>2.60</td>
<td>1.68</td>
</tr>
<tr>
<td>PLEASANTNESS (NEUTRAL)</td>
<td>0.82</td>
<td>.49</td>
<td>4.41</td>
<td>2.36</td>
<td>5.47</td>
<td>1.40</td>
</tr>
<tr>
<td>INTENSITY (NEUTRAL)</td>
<td>0.37</td>
<td>.77</td>
<td>4.45</td>
<td>2.86</td>
<td>4.20</td>
<td>2.54</td>
</tr>
<tr>
<td>IRRITATION (POSITIVE)</td>
<td>0.52</td>
<td>.67</td>
<td>1.95</td>
<td>2.13</td>
<td>1.33</td>
<td>0.62</td>
</tr>
<tr>
<td>PLEASANTNESS (POSITIVE)</td>
<td>1.06</td>
<td>.37</td>
<td>7.59</td>
<td>1.71</td>
<td>8.07</td>
<td>1.33</td>
</tr>
<tr>
<td>INTENSITY (POSITIVE)</td>
<td>0.05</td>
<td>.98</td>
<td>4.45</td>
<td>2.92</td>
<td>4.20</td>
<td>2.83</td>
</tr>
</tbody>
</table>

Note. Participants were grouped based on Schizotypal Personality Questionnaire-Brief scores (SPQ-B; Fonseca-Pedrero et al., 2009). Olfactory accuracy (total score out of 40) was based on performance on The University of Pennsylvania Smell Identification Test (UPSIT; Doty et al., 1983). Olfactory accuracy includes irritation, pleasantness, and intensity ratings on a 9-point Likert-type scale for natural gas (negative odorant), grass (neutral odorant), and watermelon (positive odorant). Total UPSIT score out of 40 questions.
The middle SPQ-B group had lower irritation ratings on the natural gas odorant compared to the high SPQ-B group, but did not reach statistical significance \((M = -2.31, SD = 0.79, p = .03)\). Irritation ratings for the low SPQ-B group did not significantly differ from the high SPQ-B group \((M = -0.82, SD = 0.72, p = 1.00)\). In addition, the 1.49-point difference between low and middle SPQ-B group did not reach statistical significance \((M = 1.49, SD = 0.79, p = .39)\). All data were analyzed with SPSS.

**Discussion**

Olfactory identification ability and subjective ratings of odorants were expected to differ across groups of individuals that score either relatively high or low on the SPQ-B compared to middle-range scores. This project represents a first step toward reconciling inconsistencies in the literature, and could be a foundation for future research aimed at refining behavioral assessments for early symptom detection and monitoring.

Part 1 analyses revealed a significant relationship between scores on the SPQ-B and scores on the SIAS, as well as the BIS Drive subscale. These were anticipated as previous literature has established the relationship between behavior inhibition and social anxiety in relation to schizophrenia symptom behaviors (Gieslak et al., 2015). Further, it is well-established that individuals with schizophrenia also experience social anxiety and social dysfunction (Gieslak et al., 2015; Fonseca-Pedrero et al., 2009).

Part 2 results were not significant when analyzing group differences in UPSIT accuracy, pleasantness, or intensity ratings. However, subjective ratings of irritation for the aversive odorant (natural gas) did vary among groups. Our findings are of particular interest, as our population was entirely subclinical. Results indicated that participants in the mid-scoring group had significantly lower irritation ratings when compared to those of the high-scoring group. Individuals in the mid-scoring group endorsed less atypical behaviors than the high-scoring group. This suggests that individuals that endorsed more atypical behaviors also have a heightened irritation reaction to the aversive odorant, when compared to those with a moderate amount of atypical behaviors.

Although the difference in irritation ratings between the low-scoring and mid-scoring group did not reach statistical significance, the difference is trending in a way to possibly suggest a curvilinear relationship, such that those scoring high or low on the SPQ-B may be more reactive to the aversive odorant. This relationship suggests that individuals who scored in both extremes, high in atypical behavior endorsement and low in atypical behavior endorsement, may have more irritation to the aversive odorant than those with a moderate, or average, amount of atypical behaviors. It is possible that a larger sample size may help elucidate this relationship.

In addition, our findings may suggest that odorants perceived as irritating may be the most aversive and/or reactive to humans when compared to positive or neutral odorants (even if positive odorants may also be considered equally intense). This conclusion would support findings from Albrecht et al. (2010) which found negative odorants to produce anxiety reactions in a group of participants. The negative odorant we chose (natural gas) might have evoked a strong, irritating reaction in participants based on their past experiences with the odorant. For example, natural gas can be involved in fires or explosions and is usually associated with toxicity. Thus, the perception of this specific negative odorant might have elicited a fear response in participants (Smeets & Dalton, 2005). Because the effect size of the negative odorant irritation across SPQ-B group was small, results should be interpreted with caution. A larger sample size or the inclusion of a clinical group may clarify our findings and allow for a larger effect size. One major limitation of our design was that we did not conduct a power analysis prior to starting the study. Our sample size was constrained by the number of available UPSITs.

The lack of significant relationship between olfactory accuracy and atypical behaviors could be due to the method chosen to characterize olfactory ability, specifically the UPSIT. Although well-validated, this measure may not be sensitive enough to detect individual differences in olfactory identification, particularly in a subclinical population. This may explain the lack of difference in scores among the high-scoring and low-scoring SPQ-B groups. Similarly, identification performance could have been affected by participants’ past experiences with the items on the UPSIT. For example, a few of the items on the UPSIT are relatively uncommon.
Olfaction and Atypical Behaviors
Cary, LaFrance, Costello, and Bovier

Olfactory threshold measures could be useful, with a staircase procedure being the most successful. Olfactory threshold measures could be useful to determine a fault in an individual’s detection ability, which may be predictive of mental illness and degenerative disease. Other forms of olfactory processing, other than smell identification, may be significantly related to atypical behaviors, and therefore may be more informative sensory markers.

Finally, the differences in atypical behaviors between our high-scoring SPQ-B group and low-scoring SPQ-B group may not be significant enough in themselves. Future directions could include a clinical group, likely yielding more significant results, due to the greater difference in behavior between a healthy group and a clinical group. Characterizing this relationship in the general population would lend support for designing and implementing a study with a clinical population at local mental health facilities.

Due to the established relationship between psychiatric disorders and olfactory deficits, it is clear that olfactory measures may be a useful tool to implement in diagnosis, prevention, or treatment of disorders. Specifically, when an olfactory deficit is discovered, preventative measures or early intervention may be warranted to help delay the progression of the illness. Olfactory tests could be added to a battery of assessments to aid in the diagnosis of an individual, along with other screening procedures such as psychiatric evaluations and interviews. Through further research, a defect in the olfactory system could even become a new symptom domain in schizophrenia spectrum, neurodegenerative, or anxiety disorders.

References
Cary, LaFrance, Costello, and Bovier | Olfaction and Atypical Behaviors

https://doi.org/10.1016/0893-9384(84)90269-5

Author Note. Julianne Cary, https://orcid.org/0000-0002-2000-3853, Psychology Department, State University of New York at Oswego; Joseph LaFrance, Psychology Department, State University of New York at Oswego; Sara Costello, Psychology Department, State University of New York at Oswego; and Emily R. Bovier, Psychology Department, State University of New York at Oswego. Julianne Cary is now at The Department of Clinical and Counseling Psychology, Teachers College, Columbia University.

This research was supported in part by funding from Psi Chi, the International Honor Society of Psychology.

Special thanks to Psi Chi Journal reviewers for their support. Correspondence concerning this article should be addressed to Emily R. Bovier, Department of Psychology, State University of New York at Oswego, Oswego, NY 13126. E-mail: emily.bovier@oswego.edu
Find your **career**.

Eight graduate degree programs and four certificates in **Educational Psychology**

**PhD in Educational Psychology**
Engage in the science of learning. Prepare for a career where you can use your knowledge of human learning and development to help shape the school environment and public policy. Core program areas include learning, motivation, and research design.

**MS or MA in Educational Psychology**
Broaden your ability to apply psychological principles to a variety of professional contexts or prepare for your future doctorate in social science.

**MS in Quantitative Psychology**
Do you like numbers, statistics, and social science? Prepare for a career in research, assessment, and data analysis. Develop proficiency in advanced statistical techniques, measurement theory, and data analytics.

**PhD in School Psychology** (five-year program)
Prepare for a career as a licensed psychologist. Gain competencies in health service psychology to work in schools, private practice, or hospital settings. Accredited by the American Psychological Association (APA)** and approved by the National Association of School Psychologists (NASP). Scientist-practitioner model with advocacy elements. Specializations available.

**MA/EdS in School Psychology** (three-year program)
Be immersed in community engaged, real-world field experiences and intervention opportunities in our scientist-practitioner-advocate program. Leads to licensure as a school psychologist. Accredited by the National Council for Accreditation of Teacher Education (NCATE).

**MA in School Counseling** (two-year program)
Be a leader and advocate for educational equity for all students in PK–12 schools. Leads to licensure as a school counselor. Accredited by the Council for Accreditation of Counseling and Related Educational Programs (CACREP) and nationally recognized by The Education Trust as a Transforming School Counseling program.

**Certificates**
High Ability/Gifted Studies,* Human Development and Learning,* Identity and Leadership Development for Counselors,* Neuropsychology*
Graduate assistantships and tuition waivers are available.

**bsu.edu/edpsy**

*Online programs are available.
**Questions related to the PhD in school psychology's accreditation status should be directed to the Office of Program Consultation and Accreditation, American Psychological Association, 750 First St. NE, Washington, D.C. 20002; (202) 336-5979; apaaccred@apa.org; or apa.org/ed/accreditation.
Master of Arts in Psychology

A Master’s degree in psychology can lead to a new or more rewarding career in health & human services or a doctorate.

Featuring flexible program scheduling, CCSU’s MA in Psychology offers three tracks:

- General Psychology
  - Highly flexible and tailored to students’ particular interests, the graduate program in General Psychology prepares graduates for careers in human services or further graduate study.

- Community Psychology
  - The program in Community Psychology prepares students to be active practitioners in prevention and community-based research. You can take the lead in developing and implementing interventions against the onset of substance abuse, interpersonal violence, and depression.

- Health Psychology
  - The only program of its kind in New England, the program in Health Psychology enables students to deeply understand biological, behavioral, and social factors in health and illness and to develop interventions fostering health.

WE ARE ALSO EXCITED TO ANNOUNCE A NEW GRADUATE CERTIFICATE PROGRAM IN GERONTOLOGY!

Looking for Collaborative Research Experience?

Join the Psi Chi CROWD!

Students and faculty within the United States and beyond are invited to participate in the CROWD, which is Psi Chi’s annual, guided cross-cultural research project. Specific benefits of joining the CROWD include:

- a reduced burden of having to solicit large numbers of participants,
- increased diversity of student samples,
- accessible materials and protocols for participating researchers, and
- a convenient platform to engage students in the scientific research process.

Contributing to the CROWD provides unique data collection and publication experiences that can be used to strengthen any student’s CV.

For more information, visit https://www.psichi.org/Res_Opps or contact the NICE Chair, Megan Irgens, at nicechair@psichi.org.
OUR JOURNAL
Advertising in Psi Chi Journal allows you to connect with established psychology researchers and mentors, as well as undergraduates and graduate students striving to build a career in one of the many areas of research. People regularly visit our journal online to

- view current and past issues,
- submit their research for publication,
- learn about reviewing for Psi Chi Journal, and
- share invited editorials as teaching tools in the classroom.

All issues and advertisements are permanently free online to both members and nonmembers alike. During the 2018–19 fiscal year, psichi.org received almost 1.5 million page views, ensuring that high-achieving students and professionals will see your content for years to come.

To further enhance the visibility of our journal, latest issues and calls for submissions are regularly featured in Psi Chi Digest e-mails (175,000+ subscribers) and on our four social media platforms.

- Facebook (23,000+ followers)
- Twitter (5,500+ followers)
- LinkedIn (6,000+ followers)
- Instagram (1,800+ followers)

Articles are also indexed in PsycINFO, EBSCO, and Crossref databases—essential tools that researchers use to search for millions of psychology-related articles. This makes Psi Chi Journal a key place to communicate your message with our Professional Organization’s three quarters of a million lifetime members and far beyond.

AD SPECIFICATIONS
Digital format: PDF, EPS, and TIFF
Resolution: 300 dpi | B&W line art—1,200 dpi
Black & white ads (no RGB or 4-color process)
PDF settings: Press quality, embed all fonts

DEADLINE/BILLING
Payment due upon receipt of invoice.

CONTACT
Submit contract by e-mail to
Susan Iles
Advertising Sales
Psi Chi Central Office
E-mail: susan.iles@psichi.org
Phone: 423-771-9964

See past issues of Psi Chi Journal of Psychological Research at http://www.psichi.org/page/journal_past

All advertisements must be scholarly and professional in nature, and Psi Chi reserves the right to reject (or cancel) any ads that are not in the best interest of the Organization or consistent with the Society’s mission.
Publish Your Research in *Psi Chi Journal*

Undergraduate, graduate, and faculty submissions are welcome year round. Only the first author is required to be a Psi Chi member. All submissions are free. Reasons to submit include

- a unique, doctoral-level, peer-review process
- indexing in PsycINFO, EBSCO, and Crossref databases
- free access of all articles at psichi.org
- our efficient online submissions portal

View Submission Guidelines and submit your research at [www.psichi.org/?page=JN_Submissions](http://www.psichi.org/?page=JN_Submissions)

---

**Become a Journal Reviewer**

Doctoral-level faculty in psychology and related fields who are passionate about educating others on conducting and reporting quality empirical research are invited to become reviewers for Psi Chi Journal. Our editorial team is uniquely dedicated to mentorship and promoting professional development of our authors—Please join us!

To become a reviewer, visit [www.psichi.org/page/JN_BecomeAReviewer](http://www.psichi.org/page/JN_BecomeAReviewer)

---

**Resources for Student Research**

Looking for solid examples of student manuscripts and educational editorials about conducting psychological research? Download as many free articles to share in your classrooms as you would like.

Search past issues, or articles by subject area or author at [www.psichi.org/page/journal_past](http://www.psichi.org/page/journal_past)

---

**Add Our Journal to Your Library**

Ask your librarian to store Psi Chi Journal issues in a database at your local institution. Librarians may also e-mail to request notifications when new issues are released.

Contact *PsichiJournal@psichi.org* for more information.