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Taste assessment in normal weight and overweight individuals with co-occurring Binge Eating Disorder

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ABSTRACT

Background: Taste perception influences food choice, and may contribute to both weight status and disordered eating. Relatively little work has attempted to disentangle contributions of weight status and Binge Eating Disorder (BED) to human taste perception. We predicted weight status and BED would interact, showing difference in taste perception from non-eating disorder matched groups.
Methods: The four study groups included: normal weight BED (NW BED), normal weight healthy controls (NW HC), overweight BED (OW BED), and overweight healthy controls (OW HC) ($N = 60$). Groups were matched for age (±5 years), ethnicity, and weight status. Participants were assessed using the Structured Clinical Interview for DSM-IV Axis I Disorders, the Eating Disorder Examination Version 16.0, and the NIH Toolbox Gustatory Assessment with additional taste solutions and taste stimulus delivered with edible taste strips.
Results: Interactions were found between weight status and diagnosis on measures of regional taste intensity for quinine hydrochloride (CI 95% [44.61, 56.31], $p = 0.018$), sucrose (CI 95% [46.79, 56.45], $p = 0.003$), and 6-*n*-propylthiouracil (CI 95% [25.557, 39.269], $p = 0.015$). OW BED participants perceived these taste stimuli significantly less intensely than OW HC and NW BED. Whole mouth taste intensity tests at suprathreshold amounts did not reveal group differences. All four groups reported similar hedonic response to taste stimuli. Edible taste strips had medium to large significant correlations with NIH Gustatory Assessment taste stimuli.
Conclusions: There were significant differences in the taste perception of OW BED relative to the other three groups. These findings may provide partial explanation as to why previous studies correlating taste and weight status have mixed results. Replication in larger samples assessed longitudinally is needed to extend this work.

1. Introduction

Taste intensity, taste quality, and hedonic response play an important role in food selection, and influence food intake patterns (Drewnowski, 1997). The bitter taste stimuli, 6-*n*-propylthiouracil (PROP) and quinine hydrochloride (HCl) encourage aversion, and the sweet taste stimulus, sucrose, encourage approach. These are the most researched tastes in weight and eating disorders, however gaps remain in our characterizations of taste perception, specifically in Binge Eating Disorder (BED).

BED is marked by aberrant eating patterns, including frequent binges, where objectively large amounts of food are consumed rapidly in a finite time period. Binge foods typically have high sugar, high salt, high fat, and low protein content (Yanovski et al., 1992). BED co-occurs with obesity, with approximately 23–55% of overweight individuals seeking weight loss treatment also meeting BED criteria (Linde et al., 2004). Though taste perception contributes to food selection and intake, taste has not yet been studied in BED nor have differences in taste perception been disentangled from the effect of weight status. Given that individuals with BED appear to have a distinct preference for sweet and salty taste stimuli during bingeing, any differences in taste perception specific to BED are important to identify to better understand the etiology of the disorder and inform therapeutic interventions (Yanovski et al., 1992).

Sensitivity to bitter tastes is regarded as representative of overall taste functioning (Coldwell et al., 2013). Associations between bitter

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taste stimuli and weight have produced mixed results. Perception of quinine HCl bitterness is relatively universal, and sensitivity to quinine HCl is associated with consuming plant products (Coldwell et al., 2013), whereas PROP perception is partly determined by fungiform papillae density and the *TAS2838* receptor genotype (Calò et al., 2011; Hayes, Bartoshuk, Kidd, & Duffy, 2008). Taste blindness to PROP is associated with preference for high calorie foods (Duffy & Bartoshuk, 2000; Hayes & Duffy, 2007; Tepper & Nurse, 1998; Tepper, Neilland, Ullrich, Koelliker, & Belzer, 2011). Some studies show an inverse correlation between PROP perception and Body Mass Index (BMI) (Goldstein, Daun, & Tepper, 2005; Tepper & Ullrich, 2002; Tepper, 1999, 2008; Tepper et al., 2008), while others show that very low weight restrictive eating disorders are associated with reduced sensitivity to PROP (Barbosa et al., 2015; Mitchell & Crow, 2006; Polivy, 1996) Additional examinations of BMI and PROP have revealed no association (Drewnowski, Henderson, & Cockroft, 2007; Kaminski, Henderson, & Drewnowski, 2000; Yackinous & Guinard, 2001, 2002). Importantly, obesity is highly heterogeneous and there are likely multiple endophenotypes within a given obese sample (Sacks et al., 2009). As such, there is a need to examine biological and psychological variations within samples of the same weight status to differentiate these endophenotypes. Differentiating endophenotypes within obesity may subsequently allow for more efficacious interventions. Some have hypothesized that BED is a specific endophenotype of obesity (Hudson et al., 2006). Taste perception may be one way to differentiate a BED-specific endophenotype. Those with co-occurring BED may perceive taste differently, and this finding could account for the mixed results in taste perception and weight status research.

The link between sweet taste perception and obesity is unclear. While some studies have revealed a positive association between BMI and hedonic response to sucrose, others have found an inverse relationship, and others have found no association (Drewnowski, Brunzell, Sande, Iverius, & Greenwood, 1985; Drewnowski, Kurth, Holden-Wiltse, & Saari, 1992; Frijters & Rasmussen-Conrad, 1982; Grinker, 1978; Malcolm, O'Neil, Hirsch, Currey, & Moskowitz, 1979; Salbe, DelParigi, Pratley, Drewnowski, & Tataranni, 2004). Undetected eating disorder pathology may muddle these results. For example, while there is a correlation between self-reported hedonic response and neural response to sucrose in normal weight healthy individuals, there is no correlation between these responses in normal weight individuals with a history of very low weight, restrictive eating disorders (Wagner et al., 2008). In contrast, normal weight women with Bulimia Nervosa relative to normal weight women without eating disorders, report greater hedonic liking of sweet taste stimuli (Franko, Wolfe, & Jimerson, 1994). Eating disorders including BED may influence taste perception relative to individuals without eating disorders. To our knowledge, there are currently no studies examining sucrose taste perception in BED.

The current study examines taste intensity and hedonic response in four groups matched for age, ethnicity, and weight status; normal weight BED (NW BED), normal weight women without BED (NW HC), overweight BED (OW BED), and overweight HC. Women have been shown to have more fungiform papillae, the taste buds that respond to sweet, sour, bitter, and salty tastes, than men (Bartoshuk, Duffy, & Miller, 1994; Miller & Reedy, 1990). There is evidence for differential neural responses to sweet taste stimuli in men compared with women (Cornier et al., 2015) To avoid confounds introduced by sex difference, only women were included in this sample. The modified NIH Toolbox Gustatory Assessment and edible taste strips containing one of two different taste stimuli were used to examine taste perception with the objective of clarifying the role of weight status and BED (Coldwell et al., 2013; Smutzer, Desai, Coldwell, & Griffith, 2013; Smutzer et al., 2008). We predicted that eating disorder status and weight status would interact, showing differences in OW BED and NW BED relative to HC groups. We also predicted an additional interaction between eating disorder status and weight status, where OW BED and NW BED would report different hedonic response from sucrose taste compared with HC groups on NIH Gustatory Assessment measures. Finally, we predicted ratings on PROP and sucrose-containing edible taste strips ratings would correspond to ratings on these same measures within NIH Gustatory Assessment in this clinical sample.

2. Methods and materials

2.1. Participants

This study was conducted at a northeastern United States university and was approved by the university's Internal Review Board. All participants provided written consent before beginning the study. Participants included 60 women between the ages of 18 and 57 years ($M = 27.82$, $SD = \pm 10.11$) recruited through paper and online advertisements from the local community as a part of a larger study.

2.2. Measures

2.2.1. Eating Disorder Examination Version 16.0

The EDE (Fairburn, Wilson, & Schleimer, 1993) is an assessor-driven, semi-structured interview that assesses frequency and severity of behavioral features and cognitions associated with eating disorders. The EDE has both good inter-rater and test-retest reliability for BED (Grilo, Masheb, Lozano-Blanco, & Barry, 2004). The assessor rates items by degree of severity from 0 (no or minimal symptom) to 6 (extremely severe symptom). Individuals in the BED group met criteria as outlined in the Diagnostic and Statistical Manual (DSM) 5 (American Psychiatric Association, 2013).

2.2.2. NIH Toolbox Gustatory Assessment

The NIH Toolbox for Assessment of Neurological and Behavior Function offers a gustatory assessment, along with directions for assessing whole mouth and regional taste sensitivity of sweet, salty, and bitter (Coldwell et al., 2013). Four taste stimuli were presented following the procedures described by Coldwell et al. (2013); bitter (quinine HCl), salty (sodium chloride), sweet (sucrose), and bitter (PROP). Two measures of bitter taste perception were included because, while quinine HCl is detectable to most, some individuals show taste blindness to PROP (Bartoshuk, 1979)

2.2.3. Edible taste strips

Edible taste strips were prepared using a pullulan base with the polymer hydroxypropyl methylcellulose (HPMC) at a 11.5:1 wt/wt ratio of pullulan to HPMC, as in Smutzer et al. (2008). Two taste stimuli were prepared; sucrose and PROP. Sucrose strips contained between 2.5% and 5% wt/vol of taste stimulus, and PROP strips contained 0.11% wt/vol of taste stimulus. These levels are considerably above the established suprathreshold for each respective taste and have been validated previously as a highly sensitive tool for assessing human taste perception (Smutzer et al., 2013; Smutzer et al., 2008).

2.2.4. Weight status

Participants' heights and weights were measured using a Health-o-Meter 500KL Professional Digital Scale and stadiometer to calculate Body Mass Index (BMI). BMI classifications from the World Health Organization (2011) were used. Normal weight was defined as a BMI between 18.50 and 24.99. Overweight was defined as a BMI $\geq$25.00.