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The relationship between taste sensitivity to phenylthiocarbamide and anhedonia

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ABSTRACT

It has been proposed that taste sensitivity to bitter compounds such as, phenylthiocarbamide (PTC) and 6-*n*-propylthiouracil (PROP), represents a genetic marker for an increased vulnerability to depressive illness. Previous explorations of this idea have proven equivocal. This study refines and further explores this idea by focusing specifically on anhedonia (diminished hedonic capacity), a key symptom in some depressive illness, linked also with sensory pleasure. It is hypothesized that diminished PTC taste sensitivity will be associated with more general decrements in hedonic capacity (anhedonia). An opportunity sample of 198 university students were assessed using paper strips impregnated with PTC, the same participants also completed a widely used assessment of hedonic capacity, the Snaith-Hamilton Pleasure Scale (SHAPS). Hedonic capacity scores positively correlated with PTC taste sensitivity; specifically, heightened hedonic capacity was associated with heightened sensitivity to the bitter taste of PTC. Furthermore, modest differences were observed between those least (non-tasters) and most (supertasters) sensitive to PTC, with non-tasters reporting significantly lower hedonic capacity scores than supertasters. PTC taste sensitivity may represent a peripheral risk factor for anhedonia.

1. Introduction

Genetic differences in taste sensitivity to bitter compounds were first reported in the 1930's (Fast et al., 2002; Blakeslee and Fox, 1932). Physiologically, these genetic differences manifest as varying densities of taste buds on the tongue, more specifically, varying densities of the fungiform papillae (Fast et al., 2002). Within the taste sensitivity literature individuals with the highest densities of fungiform papillae are generally referred to as "supertasters", distinguishing them from "tasters" (an intermediate group) and "non-tasters", those individuals with the lowest densities of fungiform papillae (Bartoshuk, 1993). Rather than examining fungiform papillae densities, taste status (whether one is supertaster, taster or non-taster) can also be reliably established by exploring individual taste sensitivity to bitter compounds such as phenylthiocarbamide (PTC) and 6-*n*-propylthiouracil (PROP). A typical testing protocol involves impregnating a strip of paper with a 3–5 micrograms of PTC, which individuals then place on their tongues. Supertasters have the highest sensitivity and lowest detection thresholds for PROP/PTC, and generally report the taste – even at low doses – as extremely bitter. Tasters and non-tasters have respectively higher detection thresholds and lower taste sensitivities, with non-tasters being the least sensitive of all (Reed et al., 1995; Tepper, 1998). Occasionally within the PTC/PROP taste-sensitivity literature a simpler bimodal, or dichotomous classification is used: taster vs. non-taster. In such cases no distinction is made between supertasters and tasters, both are simply categorized and referred to as tasters.

Variations in PTC taste sensitivity are thought to influence dietary habits, and have therefore been associated an increased risk of developing health problems such as, cardiovascular diseases, obesity and some forms of cancer (Goldstein et al., 2005). A small number of studies have also attempted to explore the relationship between PTC taste sensitivity and psychological health. One of the earliest studies exploring this relationship used PTC sensitivity to establish taste status, and also administered a self-report inventory (Cattell's 16PF) to assess personality traits amongst university students (Mascie-Taylor et al., 1983). The results suggested that tasters tended to be significantly more "tense" and "apprehensive", compared with their non-taster counterparts. Based on this finding Whittemore (1986) hypothesized that tasters might be more vulnerable to depression. Exploring this idea in subsequent studies, using family history data and a small group of depressed patients, Whittemore reports longer and more severe depressive episodes for those with heightened taste sensitivity (tasters/supertasters), as well as higher rates of familial depressive illness (Whittemore, 1986, 1990). It should be noted,

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that Whittemore's study with depressed participants, relied on only 23 patients, all of them female.

In a more recent examination of the relationship between depression and PTC/PROP taste sensitivity, Joiner and Perez (2004) proposed that supertaster status might actually provide a protective factor. They argue that heightened PTC/PROP taste sensitivity has been associated with greater aversion to alcohol (DiCarlo and Powers, 1998), and that heavy alcohol use is associated with depression (see Graham et al., 2007 for review). Based on this reasoning Joiner and Perez suggest that the supertaster's greater aversion to the taste of alcohol might represent a protective factor against heavy alcohol use, thereby, indirectly reducing the risk of depression. Joiner and Perez also suggest that the heightened PTC/PROP taste sensitivity of supertasters may lead to them experiencing more intense pleasure in regards to taste, and perhaps by extension, in other sensory modalities too. This proposed heightened pleasure sensitivity – "hyper-hedonia" – is viewed as conferring protection against depressive illness. This is based on the observation that a diminished ability to experience pleasure – anhedonia – is a cardinal symptom of major depressive disorder (American Psychiatric Association, 2000) and has also been identified as a vulnerability marker for the disorder's onset (Loas, 1996; Schrader, 1997; Shankman et al., 2010).

Joiner and Perez (2004) explored these ideas using a family history methodology similar to those employed by Whittemore (1986). Healthy adults ($N=42$) were assessed and assigned to three taste-status groups (Whittmore's studies had only two groups tasters and non-tasters). Participants were asked about depressive illness within their families, as hypothesized supertasters reported significantly lower rates of depressive illness amongst their 1st degree relatives, than tasters and non-tasters. The results support the idea of heightened PTC/PROP taste sensitivity representing some kind of protective factor in the context of depression. However, the study used a relatively small sample, and was reliant on retrospective self-reports of familial depressive illness.

One explanation for the previously equivocal findings in relation to PTC/PROP taste sensitivity and depression (Whittemore, 1986, 1990; Joiner and Perez, 2004) is that depression (MDD) is a heterogeneous syndrome characterized by a wide variety of symptoms some of which are mutually exclusive, for example, weight loss/weight gain; hypersomnia/insomnia. If we suspect the link with depression is related to the symptom of diminished hedonic capacity (anhedonia), then it may prove more fruitful to focus specifically on this symptom. This would directly explore the idea that PTC/PROP taste sensitivity is associated with hedonic capacity, and as such, may reflect some kind of a vulnerability/protective marker for depression.

The present study follows-up on the idea of a link between PTC/PROP taste-sensitivity and hedonic capacity/anhedonia first proposed by Joiner and Perez (2004). However, rather than have participants retrospect about familial depressive illness, this study directly explores the relationship, assessing the hedonic capacity and PTC/PROP taste sensitivity of all participants. If such taste sensitivity reflects some kind of a vulnerability marker for anhedonia, then we might expect hedonic capacity scores to vary as a function of taste-status. To the best of our knowledge, this is the first study to explore the following hypotheses:

H1. There will be a positive correlation between PTC taste sensitivity and hedonic capacity.

H2. Individuals identified as non-tasters, will report significantly lower hedonic capacity scores than tasters and supertasters.

2. Method

2.1. Participants

Participants were an opportunity sample of 198 Emirati students taking general education courses at Zayed University in the UAE. Females were 60.1% of the sample, reflecting the institution's gender ratios. The mean age was 22.05 (S.D.=5.9); there were no significant gender differences for age. All participants were bilingual and spoke Arabic as their first language.

2.2. Measures

2.2.1. Snaith–Hamilton Pleasure Scale (Snaith et al., 1995)

The SHAPs was translated into Arabic and independently back translated by bilingual masters-level faculty within Zayed University. The psychometric properties of this dual-language instrument has been favorably reported elsewhere (Thomas et al., 2012). The14-item scale assess anhedonia across 4 domains: interest/pastimes, social interaction, sensory experience, and food/drink. The following is an example item: – *"I would get pleasure from helping others"*.

Items are scored from 1 to 4, with 1 anchored to the response "*Strongly Disagree*", while a score of 4 is anchored to "*Strongly Agree*" etc. (Snaith et al., 1995). This scoring method means lower scores are indicative of greater anhedonia (diminished hedonic capacity). Previous psychometric explorations have reported acceptable internal consistency, 0.91 (Franken and Muris, 2007) and 0.86 (Leventhal et al., 2006) for the scale. Similarly, its convergent and discriminant validity, and its test re-test reliability have all, also yielded acceptable correlations (Leventhal et al., 2006; Franken and Muris, 2007).

2.2.2. The PTC taste test strips

The test strips were pre-prepared by a commercial supplier, Precision Laboratories. Each strip of blotting paper was 5 cm in length and 0.5 cm in width and had been impregnated with 3–5 micrograms of phenylthiourea-phenylthiocarbamide. This method has become increasingly popular in the field (Tepper et al., 2001) and has been widely used to good effect in previous studies of PTC/PROP taste sensitivity (Intranuovo and Powers, 1998; Dicarlo and Powers, 1998; Reed et al., 1999; Prescott and Swain-Campbell, 2000).

2.3. Procedure

Zayed University human subjects ethics committee approved the study. All participants gave informed consent, and were tested in classrooms in groups of approximately 15, over a 2-week period. Participants were tested at the end of class and had not consumed food or beverages for at least 1 h prior to testing. Participants first completed the SHAPS and then were each given PTC impregnated taste-test strips and a taste-rating sheet. The taste-rating sheet was a nine-point scale anchored at 0 with the phrase (in English and Arabic) "no taste at all" through to 9, with the phrase "tastes extremely bad/bitter".

2.4. Statistical analysis

After log transforming the skewed SHAPS scores, all continuous data met the assumptions for parametric statistical analysis. Pearson's product moment was used to conduct the bivariate correlational analysis based on a one-tailed hypothesis. The comparison of mean SHAPS scores between the three taste-status groups was undertaken using a univariate general linear model (ANCOVA) and a post hoc test. All analyses were undertaken using SPSS version 20.

3. Results

The mean score on the SHAPS was 48.08 (S.D.=4.87); for males alone the mean was, 48.34(S.D.=4.85), and for females, 47.89 (S.D.=5.26). These gender differences were not statistically significant. Similarly no gender differences were observed for PTC taste sensitivity scores between females ($M=6.48$, S.D.=3.01) and males ($M=5.42$, S.D.=3.44). Using Cronbach's alpha, the internal reliability of the Arabic translation of SHAPs was acceptable: $\alpha=0.78$.

Participants were categorized according to the tripartite system. Supertaster status was assigned if the participant reported a PTC taste sensitivity score of 7, 8, or 9. Taster status was assigned for scores of 4, 5, and 6, whereas non-tasters were defined as those reporting scores 1, 2 or 3. This method of assigning taste status