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Increased negative emotional responses in PROP supertasters

Michael Macht *, Jochen Mueller

Department of Psychology, University of Würzburg, Marcusstr. 9-11, D-97070 Würzburg, Germany

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Abstract

Based on animal data it has been suggested that an increased sensitivity to bitter tastes is linked with increased emotional reactivity. The present study examined for the first time in humans whether the intensity of experimentally induced negative emotional responses is related to sensitivity to the bitter tasting compound PROP (6-*n*-propylthiouracil). Normal-weight participants (61 men, 57 women) with a mean age of 24 years were classified into PROP non-tasters ($n=54$), medium tasters ($n=25$), or supertasters ($n=39$), and were shown two film clips to induce negative emotional response patterns: one pattern predominated by anger and tension, and another predominated by sadness and depressed mood. A third film clip was emotionally neutral. Before and after film clip viewing, self-rated emotional responses were obtained. PROP supertasters showed more intense responses than non-tasters or medium tasters after the anger-inducing film clip (increased anger, tension, sadness and fear as well as decreased mood and joy). Significant correlations were found between emotional responses and a continuos measure of PROP sensitivity. Group differences and correlations could not be attributed to personality measures, trait affectivity, or gender. For emotional responses after the sadness-inducing film clip, no differences between taster groups could be detected. PROP sensitivity appears to be related to arousability of emotions, in particular those emotions that are associated with an increased readiness to respond actively to stimuli from the environment, e.g. anger, disgust and fear.

Keywords: Taste; Emotion; Affect; Mood; PROP (6-*n*-propylthiouracil); Taste sensitivity; Anger; Sadness

1. Introduction

Humans differ in sensitivity to the bitter compound PROP (6-*n*-propylthiouracil): non-tasters perceive PROP as tasteless or slightly bitter, medium tasters as moderately bitter, and supertasters as extremely bitter [1]. There is evidence that PROP sensitivity is determined by genetic factors and that taster groups differ in tongue anatomy (i.e., supertasters have the most fungiform papillae; [2–4]). PROP sensitivity is related to perception of sensory characteristics of foods, food preference and intake. Supertasters perceive many non-PROP oral stimuli as more intense than non-tasters, e.g. oral burn from irritants [2], fat content in salad dressings [5], and bitter taste in vegetables [6]. Whereas research on relationships between PROP sensitivity and nutritional behavior continues, less is known on a possible link between PROP sensitivity and affect.

From an evolutionary perspective, it has been suggested that sensitivity to bitter tastes and emotional reactivity were linked very early when organisms were under high pressure to evaluate substances as edible or not [7]. Because bitter substances are often toxic and of potential harm, it may have been essential for survival to reject them immediately. In fact, rejection responses to bitter tastes have been found to have a strong biological basis. Comparative studies demonstrated that bitter tastes evoke emotionally negative facial responses in human newborns and adults [8–10], in other primates [11] and even in rats [12]. It was shown that gapes to bitter tastes are universal among all primates [13]. Interestingly, animal data indicate that increased bitter sensitivity is even associated with increased emotional reactions to non-taste threatening stimuli. Rats selectively bred for sensitivity to bitter tastes are more reactive to emotional stimuli such as the open-field test, acoustic startle or stress-induced analgesia [14].

There is also scattered evidence that bitter sensitivity varies with negative affectivity in humans. Bitter tasters report more trait apprehensiveness and tension [15] and higher levels of depressive symptoms than non-tasters [16,17]. Due to small sample sizes and a purely correlative approach, these results can, however, only be regarded as tentative. The present study examines for the first time in humans whether the intensity of experimentally induced

* Corresponding author. Tel.: +49 931 312836; fax: +49 931 8887059.
E-mail address: macht@psychologie.uni-wuerzburg.de (M. Macht).

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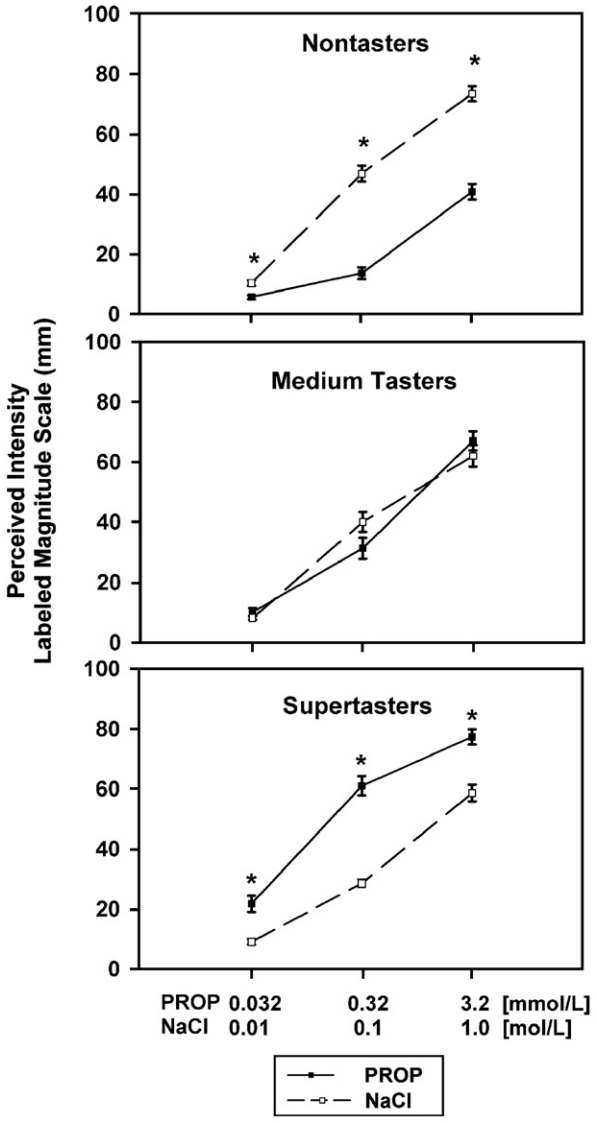

Fig. 1. Classification of participants as PROP non-tasters ($n=54$), medium tasters ($n=24$) and supertasters ($n=39$) by the three-solution test [18]. Non-tasters gave higher intensity ratings to NaCl than PROP. Medium tasters gave similar ratings to NaCl and PROP. Supertasters gave higher intensity ratings to PROP than NaCl. *Significant differences between PROP and the corresponding NaCl concentration, $p<.001$. Data are expressed as means ± SEMs.

emotional responses is related to PROP sensitivity. We classified individuals with regard to PROP sensitivity into non-tasters, medium tasters and supertasters, and showed them excerpts of films which have been found to induce negative emotions reliably in the laboratory. We assumed that emotional responses are more pronounced in individuals with a heightened sensitivity to PROP.

2. Methods

2.1. Participants

One hundred and eighteen healthy, normal-weight volunteers (61 men and 57 women) between 18 and 52 years of age were recruited from a Caucasian population through advertisements placed around the university and were paid 15 Euros at completion of the study. They were screened to exclude smokers and persons who had food allergies or medical conditions such as diabetes.

PROP taster status was determined using the three solution test described by Tepper et al. [18]. Participants tasted three NaCl solutions (0.01, 0.1 and 1.0 mol/l) and three PROP solutions (0.032, 0.32 and 3.2 mmol/l) in fixed ascending order. They tasted a sample (10 ml), expectorated it and rated its intensity on the Labeled Magnitude Scale [18] from 0 = " barely detectable" to 100 = "strongest imaginable." Before they began and between each sample they rinsed their mouth with water. They waited 45 s between each sample. Individual PROP and NaCl functions were compared by visual inspection, a method that has been shown to yield high reliability in comparison with other methods for PROP status classification [19]. Participants who rated NaCl more intense than PROP at least two concentration levels were labelled as non-tasters (with one of these differences 10 points on the scale; $n=54$, 25 women, 29 men). Those who rated PROP more intense than NaCl at least two concentration levels were labelled as supertasters (with one of these differences 10 points on the scale; $n=39$, 20 women, 19 men). Those who gave similar ratings to NaCl and PROP were labelled as medium tasters ($n=25$, 12 women, 13 men). As shown in Fig. 1, non-tasters gave, on average, lower and super tasters gave higher ratings of PROP compared to NaCl on all concentration levels. Expectedly, ANOVA with intensity ratings revealed a Taster status Taste × Concentration interaction, $F(230,4)=39.8$, $p<.001$.

In the present data, no marked influences of sex on intensity ratings of taste solutions and on PROP taster status were detected. Although ANOVAs with sex as an additional factor revealed a significant taste × sex interaction, $F(112,1)=4.2$, $p=0.04$, and a marginally significant main effect of sex, $F(112,1)=3.0$, $p=0.9$, there were no interactions of sex with taster status, $F(112,2)=1.6$, $p=0.2$, and with concentration,

Table 1
Taste intensity ratings of female (F) and male (M) PROP non-tasters, medium tasters and supertasters

			Non-tasters ($n=54$)			Medium tasters ($n=24$)			Super tasters ($n=39$)		
			M	SD	*t*(52)	*M*	SD	*t*(23)	*M*	SD	*t*(37)
NaCl (mol/l)	0.01	F	9.4	6.0	−0.9	9.6	3.3	2.3[a]	9.3	5.4	0.3
		M	11.0	7.7		6.9	2.5		8.7	6.8	
	0.1	F	46.2	19.8	−0.2	40.0	19.3	0.0	30.8	9.6	1.6
		M	47.2	19.4		40.0	14.7		26.1	8.8	
	1.0	F	74.4	20.6	0.4	60.4	17.9	−0.4	62.5	18.0	1.4
		M	72.6	16.6		63.5	18.6		54.5	16.4	
PROP (mmol/l)	0.032	F	5.6	5.5	−0.2	9.2	5.1	−0.8	26.0	20.7	1.8
		M	5.9	4.4		11.2	7.4		17.1	9.5	
	0.32	F	14.6	15.7	0.5	31.3	22.7	0.0	70.0	17.8	3.1[b]
		M	12.8	13.3		31.2	11.2		52.1	18.3	
	3.2	F	44.2	20.6	1.3	70.4	15.1	1.0	81.3	16.0	1.6
		M	37.8	17.0		63.8	16.7		73.2	14.9	

Note. M: mean, SD: standard deviation. There were 25 female and 29 male non-tasters, 12 female and 13 male medium tasters, and 20 female and 19 male super tasters. [a]$p=0.034$, [b]$p=0.004$. *T*-tests were computed to compare the ratings of women and men within taster groups.