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Some like it hot: Testosterone predicts laboratory eating behavior of spicy food

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HIGHLIGHTS

- We analyze the relationship between spicy food eating and endogenous testosterone.
- Testosterone is related with the quantity of hot sauce participants consumed.
- No correlation was observed between testosterone and a control substance.

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ABSTRACT

In the present study, we analyzed the relationship between eating behavior of spicy food and endogenous testosterone. Participants included 114 males between the ages of 18 and 44 recruited from the community. They were asked to indicate their preferences regarding spicy food and were then asked to season a sample of mashed potatoes with pepper sauce and salt (control substance) prior to evaluating the spiciness of the meal. A positive correlation was observed between endogenous salivary testosterone and the quantity of hot sauce individuals voluntarily and spontaneously consumed with a meal served as part of a laboratory task. In contrast, significant correlations were not observed between testosterone and behavioral preference for salty foods. This study suggests that behavioral preference for spicy food among men is related to endogenous testosterone levels.

Man is the only animal that likes Tabasco sauce
[~ Paul Bloom, How pleasure works, p. 52.]

1. Introduction

Many people throughout the world, particularly males [1,18], like eating capsaicin-containing foods such as hot peppers, in spite of capsaicin's ability to elicit discomfort, irritation, and even pain. Sociologists have pointed out that the ability of spicy food to produce these aversive physiological reactions has engendered a link between these foods and masculine personality traits in many cultural contexts throughout the world [24]. However, it remains unclear as to whether the link between preferences for spicy foods and these traits is driven more by physiology or by environment. After reviewing the literature on the correlates of spicy-food preference, we introduce the present study involving a test of the hypothesized relationship between spicy food preference and endogenous testosterone, a hormone that is generally related to stereotypical masculine preferences and behavior [5].

A wide range of factors, including genetic, physiological, psychological and social forces, influence the liking and consumption of capsaicin-containing food. From a genetic perspective, the preference for and consumption of spicy food have been shown to be influenced by both taste phenotype [6] and oral anatomy [2]. Moreover, a recent behavioral genetics research study involving 331 adult Finnish twins found that shared genetic influence accounted for 18–58% of the variation in preference for spicy foods [24].

Physiologically, foods such as those containing capsaicin have been found to influence metabolism or homeostasis, sometimes resulting in clinically important effects on animal gastrointestinal, cardiovascular and respiratory systems [7,19]. Human studies have demonstrated that red pepper consumption decreases appetite while it increases satiety [26], as well as energy expenditure [28], which is thought to be mediated by increased activity of sympathetic nervous system by capsaicin [25].

Individual experience also influences the preference for spicy foods. Rozin and Schiller provided the first systematic study showing that preference for the orally irritating qualities of capsaicin can be learned through repeated exposure ([24]; see also [16]). Another study confirmed

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that the more one is exposed to spicy food, the more favorable the evaluation — this latter study specifically demonstrated that attenuation of sensory response to capsaicin exposure can occur within a few minutes following a single application [11]. It has also been shown that repeated tasting of spicy solutions over a 2-week period can lead to reduced ratings of burn intensity and increased liking of the burning-sensation associated with capsaicin [22].

Research studies show that gender and personality represent an important factor related to spicy food consumption [1,17]. Preference for spicy foods has been linked to higher levels of trait anger [13] and, as mentioned above, in some cultural contexts, the consumption of chili pepper is related to strength, daring and masculine personality traits [21]. As outlined by Byrnes and Hayes [4], among American college students, eating hot peppers is sometimes a thrill-seeking activity that involves a strong social component. There is a significant and positive correlation between high sensation seeking and preference for spicy foods [4,14,23]. One study suggested that individuals with high levels of extroversion prefer spicy foods when given the option to choose a selection from a cookbook [27]. Liking of spicy food is also related to responsivity to rewards such as money, sex, and social status [4], which is consistent with historical reports indicating that eating spicy foods served as a symbol of high social status [30]. Finally, people depicted as preferring spicy foods are sometimes perceived as being more irritable than those with a stated preference for sour, sweet, or bitter foods [14].

Dietary intake has been hypothesized as being associated with hormonally related behaviors including those influenced by testosterone. This hormone has been consistently associated with many of the factors related to capsaicin preference including social dominance and aggression [5,18,31] and novelty and sensation seeking [9,32,33], in addition to daring behavior [5]. Conversely, low testosterone levels have been associated with lethargic or depressive mood [29] and other behaviors inconsistent with the behavioral correlates of capsaicin intake.

2. Current study

In light of the available literature, we hypothesized that salivary testosterone would be positively associated with (a) self-reported preference for spicy food, (b) the quantity of hot sauce individuals would voluntarily and spontaneously eat with a meal served in a laboratory setting, and (c) the evaluation of the spiciness of their meal after they had tasted it. Regarding this last hypothesis, we believed that the evaluation of the meal's spiciness would logically be linked to the quantity of hot sauce participants chose to consume. Such effects would not be expected in a protocol where participants were not given the choice regarding the quantity of hot sauce administered. By contrast, we did not expect any correlation between testosterone and a control substance (salt) for these three variables.

3. Method

3.1. Participants and procedure

The participants were 114 males aged between 18 and 44 (M = 29.31, SD = 6.6) from the mid-size city of Grenoble (pop. 340,000) and the surrounding communities. Participants had a diverse range of occupational and educational levels. An advertisement was published in the main regional newspaper indicating that a food-tasting session was being organized by a food research company looking for male participants between the ages of 18 and 45 years old. The participants were told that they were being recruited for a sensory analysis of food that was ostensibly going to be commercialized in the future and were asked to abstain from food and drink (except water) for a period of 3 h prior to their scheduled appointment. On the day of the session, participants were greeted at a front desk by a 25-year-old host and were tested between 9 AM and 6 PM. Prior to starting the tasting activity, participants were asked to rate on a 4-point Likert type scale (1 = *not at all*, 4 = *yes, definitely*) how much they liked spicy and salty foods.

As a part of another experiment, participants interacted with a confederate before the tasting session. A few minutes later, each participant was then presented with a plate of approximatively 150 g of mashed potatoes and was given 50 doses (1.5 ml) of Tabasco® sauce in plastic capsules and 80 sachets each containing 2 g of salt. Information regarding the correspondence between amount of salt and of hot sauce doses and their sensory effects was given across six levels labeled 1–6, e.g., 1 salt dose = *salted*, 6 salt doses and more = *excessive burning sensation* and 1 Tabasco dose = *spicy*, 6 Tabasco doses = *risks of temporary extinction of the sense of taste, risks of vomiting*. Although the descriptions stopped at level 6, there was no limit in the quantity the participants could choose. Finally, participants were asked to rate on a 5-point Likert scale (1 = *not at all*, 5 = *yes, definitely*) if they considered the meal they just ate to be spicy and/or salty. This final question had several other filler items (e.g., floury, creamy, granular, and light).

3.2. Testosterone saliva measurement

Saliva samples were collected using standard methods. We collected 2.5 ml of saliva from each participant using a polypropylene microtubule. Collected samples were frozen at −20 °C and stored until analysis. Salivary levels of testosterone were assayed in duplicate by using a radioimmunological method with a sensitivity of 15 pg, accuracy of 10.5%, and intra-assay reproducibility of 6.1% [15]. All hormone samples were tested in the same series to avoid any variations between tests. Salivary measures quantify bioactive or free testosterone concentration and research suggests that salivary testosterone levels in men are highly correlated with both serum free and total testosterone levels in males [10]. In our sample, mean salivary testosterone concentration was 90.24 pg/ml (SD = 46.06), which is typical of the observations in previous research. All values were log-transformed because the raw hormone measures were positively skewed [5] (the results with or without log transformation were equivalent). Preliminary analysis showed that testosterone was not related with time of day ($r = -.08$, $p = .38$).

4. Results

Consistent with hypotheses, salivary testosterone was related to the number of spicy doses participants spontaneously placed in their meals ($r = .294$, $p = .002$) and their evaluation of the spiciness of the meal after consumption ($r = .28$, $p = .003$). The correlation between a preference for spicy foods (measured before the food task) and testosterone was marginally significant ($r = .15$, $p = .11$). Age was unrelated to the concentration of salivary testosterone ($r = -.11$, $p = .21$), but was related to the number of spicy doses selected ($r = .19$, $p = .03$) and marginally related to evaluation of the meal's spiciness after consumption ($r = .16$, $p = .08$) as well as a general preference for spicy foods ($r = .18$, $p = .04$). When we controlled for age by calculating partial correlations, significant associations remained between testosterone and the number of spicy doses participants spontaneously placed in their meals ($r = .32$, $p = .001$), evaluation of the meal's spiciness after consumption ($r = .30$, $p = .001$), and preference for spicy foods ($r = .19$, $p = .04$).

The correlation between testosterone and the control substance (salt) was not statistically significant for any of the measures. Testosterone was not related to preference for salty foods ($r = .06$, $p = .49$), the quantity of salt doses participants elected to place in their meals ($r = .01$, $p = .86$), or their evaluation of the saltiness of their meals after they seasoned them ($r = .12$, $p = .21$).

5. Discussion

This study demonstrated a positive correlation between endogenous salivary testosterone and the quantity of hot sauce male participants voluntarily and spontaneously consumed with a meal served in a laboratory. Additionally, testosterone levels correlated with participants' perceptions of the spiciness of their meal after a tasting task. There was no correlation between testosterone and a preference for or the use of a control substance (salt).

To our knowledge, this is the first study in which a behavioral preference for spicy food has been linked to endogenous testosterone in a laboratory setting. The juxtaposition of using highly accurate laboratory measurement with a diverse community sample of male participants ensures adequate levels of both internal and external validity. This study provides new insights into the biology of food preference by expanding our understanding of the link between hormonal processes and food intake.

In spite of these strengths, there are many notable limitations. Foremost, the underlying cause of the use of spice by individuals with high testosterone levels should be further analyzed, as it may be the product of learned or innate preferences. Moreover, the correlational nature of this research precludes causal inferences regarding the role of testosterone and behavioral preferences for spicy foods. For example, it may be the case that consuming spicy foods produces elevated levels of testosterone. In a study published in 2013, Ilhan and Erdost showed that the serum testosterone levels were increased during the pubertal and adult periods of rats fed on a diet containing capsaicin. These authors demonstrated that when a low dose of capsaicin was added to the diet of rats during the developing period, serum testosterone levels and spermatogenic cell activity increased, especially in the adult group. While these results should be observed among humans to be generalized, they indicate that capsaicin can affect the release of testosterone directly or indirectly. Future administration studies will be necessary to evaluate the causal relationship between elevated testosterone and preference for spicy foods. Finally, we cannot exclude that the color of the spicy doses we used in this study may have contributed to the participant's choice. As a recent study showed, individuals who chose red in a lab-based experiment as a symbol color to represent themselves had higher testosterone levels and rated their color as having higher levels of certain characteristics, such as dominance and aggression, than did those participants who chose blue [8]. The method that was used in the present study to evaluate preference for spicy food in a single presentation could also be completed by multiple presentations or other methodologies (see [12,20]). In conclusion, this study showed that food preference was linked to physiological factors and indicated that salivary testosterone represents an individual difference variable related to the behavioral preference for spicy food in a laboratory setting.

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