Published in final edited form as:
Food Qual Prefer. 2013 April 1; 28(1): 213–221. doi:10.1016/j.foodqual.2012.09.008.

Personality factors predict spicy food liking and intake

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Abstract

A number of factors likely affect the liking of capsaicin-containing foods such as social influences, repeated exposure to capsaicin, physiological differences in chemosensation, and personality. For example, it is well known that repeated exposure to capsaicin and chilies can result in chronic desensitization. Here, we explore the relationship between multiple personality variables – body awareness/consciousness, sensation seeking, and sensitivity to punishment, and sensitivity to reward – and the liking and consumption of capsaicin-containing foods. As expected, a strong relationship was found between liking of spicy foods and frequency of chili consumption. However, no association was observed between frequency of chili consumption and the perceived burn/sting of sampled capsaicin. Nor was there any association between perceived burn/sting of capsaicin and any of the personality measures. Private Body Consciousness did not relate to any of the measures used in the current study. Sensation Seeking showed positive correlations with the liking of spicy foods, but not non-spicy control foods. Sensitivity to Punishment showed no relation with frequency of chili consumption, and nonsignificant negative trends with liking of spicy foods. Conversely, Sensitivity to Reward was weakly though significantly correlated with the liking of a spicy meal, and similar nonsignificant trends were seen for other spicy foods. Frequency of chili consumption was positively associated with Sensation Seeking and Sensitivity to Reward. Present data indicate individuals who enjoy spicy foods exhibit higher Sensation Seeking and Sensitivity to Reward traits. Rather than merely showing reduced response to the irritating qualities of capsaicin as might be expected under the chronic desensitization hypothesis, these findings support the hypothesis that personality differences may drive differences in spicy food liking and intake.

Keywords

individual differences; SPSRQ; AISS; PBC; sensation seeking; food preference; Project GIANT-CS

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1. INTRODUCTION

Spicy foods are a mainstay of many culinary foodways around the world. In western industrialized nations, many individuals enjoy and seek out spicy foods while others do not. The basis of this individual variation has long captivated culinary psychologists and other food researchers. The first systematic work was conducted by Rozin and Schiller who found that liking of the orally irritating qualities of capsaicin can be learned with repeated exposure in humans (Rozin, 1990; Rozin & Schiller, 1980). Subsequent work suggests intake of these foods is not merely an academic curiosity, as capsaicin and other pungent spices are also bioactive compounds that may influence health (e.g. Ludy & Mattes, 2011; Skulas-Ray et al., 2011). Additionally, understanding the influences of ingestive behavior may help elucidate the factors that promote healthy dietary practices (Saliba, 2009).

Capsaicin consumption is also of interest due to biological effects that have important implications for obesity and wellness. A number of studies demonstrate the ability of capsaicin and related compounds to promote negative energy balance through increased energy expenditure (Ludy & Mattes, 2011; Ludy, Moore, & Mattes, 2012; Matsumoto et al., 2000; Yoshioka et al., 2004; Yoshioka et al., 1995; Yoshioka et al., 1999; Yoshioka, St-Pierre, Suzuki, & Tremblay, 1998), increased fat oxidation (Lim et al., 1997; Ludy & Mattes, 2011; Westerterp-Plantenga, Smeets, & Lejeune, 2005; Yoshioka et al., 1995; Yoshioka et al., 1998), and the ability to suppress orexigenic sensations (Ludy & Mattes, 2011; Westerterp-Plantenga et al., 2005; Yoshioka et al., 2004; Yoshioka et al., 1999). The primary deterrent in utilizing capsaicin for these beneficial effects is large variability in liking and thus consumption. It is well established that in the absence of economic and availability constraints, liking is the primary determinant of food choice (Cowart, 1981; Duffy, Hayes, Sullivan, & Faghri, 2009; IFIC, 2011; Randall & Sanjur, 1981; Rozin & Zellner, 1985; Schutz, 1957).

Numerous reasons have been proposed to explain the consumption of foods that elicit oral pungency and irritation, sensations that are otherwise aversive. These include social and associative factors linked with culture (Rozin & Schiller, 1980; Stevens, 1990), repeated exposure to a specific type of cuisine (Logue & Smith, 1986), and physiological differences such as taste phenotype (Duffy, 2007; Duffy & Bartoshuk, 2000) or oral anatomy (Bartoshuk, 1993; Miller & Reedy, 1990). It has been proposed that desensitization due to frequent capsaicin exposure, a well-documented phenomenon (Cowart, 1981; Karrer & Bartoshuk, 1991; Lawless, Rozin, & Shenker, 1985; Stevenson & Prescott, 1994), is partially responsible for the variation in reported sensitivity to and liking of the burn of capsaicin. Humans can learn to like the burn with exposure to gradually increasing levels (Logue & Smith, 1986; Rozin & Schiller, 1980). However, other work suggests only a slight desensitization is observed with chronic use and that it is not just the loss of sensation that is associated with liking of the burn (Rozin & Rozin, 1981; Rozin & Schiller, 1980). This suggests chili liking is not merely a case of increased tolerance with repeated exposure, but rather that there is an affective shift towards a preference for oral burn that is not found in chili dislikers (Rozin & Schiller, 1980; Stevenson & Yeomans, 1993). Genetics can explain individual differences in sensation and diet (e.g., Hayes et al 2011; Perry et al., 2007); thus, variability in capsaicin response could result from polymorphisms in the *TRPV1* capsaicin receptor, though solid evidence for this theory is limited (Park et al., 2007; Snitker et al., 2009). The present work is part of a larger study designed to explore influences of *TRPV1* genetics on oral sensations.

In addition to cultural and biological variables, it has been proposed that personality may play a large role in determining responsiveness to and liking of chili containing foods (Stevens, 1996). In Mexico, chili pepper consumption is linked with strength, daring, and

masculine personality traits (Rozin & Schiller, 1980). Among American college students, eating chili peppers has been linked with a number of "benignly masochistic" and thrill-seeking activities, such as riding roller coasters, gambling, and the consumption of substances such as alcohol and coffee. Each of these experiences, like chili peppers, are initially aversive yet individuals learn to enjoy them, perhaps due to the appreciation that the perceived risk is harmless (Rozin & Schiller, 1980). This "constrained risk" may be what makes chili consumption thrilling for some individuals.

One of the most widely used personality constructs in the food literature is sensation or novelty seeking. The Sensation Seeking Scale (SSS), first developed by Zuckerman, was based on the conceptualization of sensation seeking as "the need for varied, novel and complex sensations and experiences" (Zuckerman, 1964). This trait is also characterized by the willingness to seek out these experiences regardless of the associated physical and social risks (Arnett, 1994; Dawe & Loxton, 2004; Zuckerman & Neeb, 1979). The scale was initially developed to measure overall sensation seeking, and after refinement, four factors emerged which measure specific constructs of sensation seeking. These include thrill and adventure seeking (TAS), experience seeking (ES), boredom susceptibility (BS), and disinhibition (DIS) (Zuckerman, 1996). A number of weaknesses of the Zuckerman's Sensation Seeking Scale have been identified by Arnett and others (see methods). Given these critiques, Arnett (Arnett, 1994) developed a newer measure than captures the same underlying construct (Ferrando & Chico, 2001) while avoiding these flaws.

Miller's Private Body Consciousness (PBC) scale purportedly measures self-awareness and self-consciousness by asking about state changes that are observable only by the individual, such as heart rate or hunger pangs (Miller, Murphy, & Buss, 1981). Individuals with high PBC reportedly have enhanced ability to identify and detect differences in sensory properties of food due to their supposed increased sensitivity to sensory stimuli (Jaeger, Andani, Wakeling, & MacFie, 1998; Miller et al., 1981; Stevens, 1990; Ueland, 2001). PBC has also been linked with sensitivity to pain (Ferguson & Ahles, 1998; Martin, Ahles, & Jeffery, 1991) and irritation caused by spicy foods (Stevens, 1990). Specifically, pilot data suggests high PBC participants rate the burn of piperine and capsaicin more intensely than low PBC counterparts; however, PBC only associates with chili use among frequent users (Stevens, 1990).

Gray's neuropsychological theory of personality (Reinforcement Sensitivity Theory; RST), states that two basic brain systems control behavior and emotions (Corr, 2004; Franken, Muris, & Georgieva, 2006; McNaughton & Gray, 2000; Pickering, Diaz, & Gray, 1995). The Behavioral Approach System (BAS) is activated by stimuli associated with reward and termination of punishment while the Behavioral Inhibition System (BIS) is activated by both punishing and new (i.e. unconditioned) stimuli and the termination of reward (Caseras, Avila, & Torrubia, 2003; Dawe & Loxton, 2004; Franken et al., 2006; Gray, 1987). Numerous scales have been proposed to measure these constructs, but the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) appears to be the best operationalization of the BIS/BAS model (Caseras et al., 2003; Torrubia, Avila, Molto, & Caseras, 2001).

The current study had a number of objectives. First, we explore the relationship between personality variables and individuals' response to the burn / sting of capsaicin utilizing a number of personality measurements including Private Body Consciousness, Sensation Seeking, and Sensitivity to Punishment and Sensitivity to Reward. The second objective was to determine the relationship between personality factors and the liking of different spicy foods, looking at not only spicy meals in general but also the hedonic ratings of spicy foods

that vary in energy density. The final aim was to explore the theorized relationship between sensation seeking and frequency of chili consumption.

2. MATERIALS AND METHODS

2.1. Overview

Present data were collected as part of a larger, ongoing study of the genetics of oral sensation. This multisession study involved one-on-one testing across 4 days; only data from the first day are reported here. Participants completed a food-liking questionnaire and rated the intensity of sensations from sampled stimuli, including capsaicin. After leaving the laboratory, participants filled out an online survey that included several different personality measures. This questionnaire also asked participants to report their frequency of consumption of foods containing chili peppers.

2.2. Participants

Participants were recruited from the Penn State campus and the surrounding area. To be eligible, individuals needed to be non-smoking, fluent English speakers between 18 and 45 years old, with no known defect of taste or smell. Additional exclusion criteria included pregnancy, taking prescription pain medications, the presence of lip, cheek, or tongue piercings, or prior diagnosis with a disorder involving either a loss of sensitivity or chronic pain. Qualified participants were asked not to eat or drink within 1 hour of testing and were asked to abstain from eating hot and spicy foods for at least 48 hour prior to testing.

Data from 97 participants (24 men) are reported here. Ages of panelists ranged from 18 to 45 (mean 27.65). Self reported race and ethnicity were collected according to the 1997 OMB Directive 15 guidelines; our sample included 9 Asians, 8 African Americans, 79 Caucasians, and 1 not reported. Three individuals identified themselves as being Latina or Latino, 94 responded as being not Latina or Latino.

2.3. Measuring Sensation Intensity

All intensity ratings were collected on a generalized Labeled Magnitude Scale (Bartoshuk et al., 2004) presented via Compusense *five* Plus, version 5.2 (Guelph, Ontario, Canada). Prior to rating samples, participants were oriented to using a list of 15 imagined or remembered sensations that included both oral and non-oral items (Hayes, Allen, & Bennett, 2012). Both the scale instructions and orientation procedure encouraged participants to make ratings in a generalized context. The top of the scale was labeled as the “strongest imaginable sensation of any kind”. For each sample, participants were asked to rate sweetness, bitterness, sourness, burning/stinging, savory/umami, and saltiness.

2.4. Sampled Stimuli

Participants were presented a series of six food grade stimuli, including potassium chloride, acesulfame potassium, sucrose, quinine, capsaicin, and a mix of monosodium glutamate and inosine monophosphate, but only capsaicin data are reported here. All stimuli were presented as 10 mL aliquots in plastic medicine cups at room temperature. Participants rinsed twice with room temperature reverse osmosis (RO) water prior to the first stimulus and ad libitum between each subsequent stimulus.

Participants received 25 uM capsaicin samples, as previous work in our laboratory indicated this would produce a mean burn in between “strong” and “very strong” on the gLMS (Hayes et al., 2012). After swirling the sample in his or her mouth for three seconds and expectorating, but prior to rinsing, participants were asked to rate all six sensation qualities using a gLMS. Only burning / stinging data are used here. Capsaicin samples were prepared

by diluting a 2.5 mM stock (0.076g capsaicin, natural, Sigma-Aldrich, St. Louis, MO, in 100 mL 95% ethanol, USP, Koptec, King of Prussia, PA) with RO water to 500 mL. The final ethanol concentration was 1%.

2.5. Measuring Food Preference

During the laboratory visit, participants completed a generalized Degree of Liking (gDOL) questionnaire. The gDOL used here is a 63 item hedonic survey with 27 foods and 20 alcoholic beverages. Critically, it includes 16 non-food experiences to help generalize the affective responses outside of a context solely focused on food. Affective ratings were collected on an unstructured, horizontal visual analog scale, with the ends of the scale being labeled “strongest disliking of any kind” (left side) and “strongest liking of any kind” (right side); the midpoint of the scale was labeled “neutral”. Similar instruments have been used to study associations between food liking and health outcomes (Duffy et al., 2009) and taste phenotype (Pickering, Jain, & Bezawada, 2012). Here, we analyzed affective ratings for six of the 27 food items on the gDOL. The primary outcome measure was liking of “the burn of a spicy meal”. Secondary measures, liking for “spicy Asian food” and “spicy and/or BBQ spare ribs”, were also included to tentatively disentangle perceived pungency from energy density. We also identified three non-spicy foods with similar mean liking and variability on the gDOL, “skim milk”, “hot dogs”, and “cotton candy” (aka candy floss), to control for non-specific effects of personality on food liking. These foods were chosen from the list of the 27 foods on the gDOL because they are diverse in taste quality and had similar liking scores (mean and variance) to the three spicy foods used in the study.

2.6. Web-based questionnaire

After leaving the laboratory, participants completed a web-based personality survey that combined the Private Body Consciousness (PBC; Miller, Murphy et al. 1981), the Arnett Inventory of Sensation Seeking (AISS; Arnett 1994), and the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia et al., 2001). To assess intake frequency, we used an updated version of the question used by Lawless and colleagues (Lawless, Rozin, & Shenker, 1985); specifically, we asked “how often do you consume all types of chili peppers in foods including Mexican, Indian, Chinese, Thai, Korean, and other foods that contain chili pepper and cause tingling or burning. Answers were recorded on an 8-point category scale (never, <1/month, 1-3/month, 1-2/week, 3-4/week, 5-6/week, 1/day, 2+/day). These values were recoded as yearly frequency (e.g. 1-3/month=24, 3-4/week=182, 1/day=365, etc) and quarter root transformed prior to analysis. A quarter root transform was used *a priori* as intake frequency data is typically skewed; a quarter root was selected because it roughly approximates a log transform without needing to remove zeros.

2.7. Personality Measures

Miller’s PBC scale is a 5 item instrument that asks participants to characterize how aware they are of changes in their internal state using a 5 point Likert scale (0 - Extremely Uncharacteristic to 4 - Extremely Characteristic). The items are summed to create an overall score. Miller originally defined high and low PBC individuals as the top and bottom 40% of the sample respectively (Miller et al., 1981); here, we used PBC as a continuous variable to avoid throwing away the middle 20%.

The best-known measure of sensation seeking is Zuckerman’s Sensation Seeking Scale-V (SSS-V) questionnaire. However, Arnett and others have identified a number of weaknesses of Zuckerman’s scale. There are a number of items on the SSS-V that, although relevant when the scale was initially developed, have become very dated (e.g. “I would like to make friends in some of the ‘far-out’ groups like artists or ‘hippies”). The SSS-V also includes items directly addressing alcohol and drug use, sexual behavior, illegal activities, and

various activities that break social norms. This often results in criteria contamination when the SSS-V is used in studies focused on these behaviors. Additionally, there are a number of criteria that focus on physical strength, endurance, and exertion, factors confounded with age. Some individuals might also find the forced choice (yes/no) response method of the SSS frustrating or difficult to complete as they feel that the response options do not accurately represent them. Based on these criticisms (Arnett, 1994; Haynes, Miles, & Clements, 2000), we use Arnett's Inventory of Sensation Seeking (AISS) instead.

The AISS is a 20 item alternative to the Zuckerman scale that improves upon the SSS-V by deemphasizing risk behavior and removing age dependent, culturally dated, and norm-breaking items. Examples of AISS items include "I would have enjoyed being one of the first explorers of an unknown land" and "I like a movie where there are a lot of explosions and car chases". Individuals answer each item on a 4-point category scale (1 -"does not describe me at all", 2 – "does not describe me very well", 3 – "describes me somewhat", 4 – "describes me very well"), resulting in a score ranging from 20 to 80. The AISS does include 2 items (questions) that deal with spicy foods and food neophobia; removing these items did not meaningfully alter the results of our analyses, so we report results for the complete 20 item instrument as originally published and validated. For the remainder of the manuscript, we use sensation seeking (lower case) when referring to the overall construct, and Sensation Seeking (capitalized) when referring to its operational measurement here via the AISS.

Gray's BIS/BAS model has been operationalized via the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; (Torrubia et al., 2001), which has two subscales. The SP subscale items measure an individual's response to situations involving punishment, cues for failure, or frustrative non-reward (Cooper & Gomez, 2008; O'Connor, Colder, & Hawk, 2004; Torrubia et al., 2001). The SR subscale measures reactivity to reward in a number of situations. Unlike the BAS, which is associated with sensitivity to conditioned cues for general reward and non-punishment, the SR subscale items focus on a number of specific rewards, such as money, sexual partners, and social status and approval (Cooper & Gomez, 2008; Dawe & Loxton, 2004; O'Connor et al., 2004; Torrubia et al., 2001). It has also been highlighted that while measures of novelty and sensation seeking are measures of general impulsivity, SR is a measure of planned approach to rewarding stimuli (Dawe & Loxton, 2004). Here, we use the 48 item English language SPSRQ from O'Connor and colleagues (O'Connor et al., 2004), a translation of the original Catalan language scale developed by Torrubia et al.

2.8. Statistical Analysis

All data were analyzed using SAS 9.2 (Cary, NC). Pearson correlations were calculated using *proc corr* and descriptive statistics were obtained via *proc univariate* . Raw (non-normalized) data were used for the intensity and affective ratings. Significance criteria was set at alpha = 0.05.

3. RESULTS

In our cohort, self reported chili intake (annualized) showed wide variation (interquartile range [IQR]: 24-182 times per year) with an average consumption frequency of 107.5 ± 16.4 (mean ± standard error) times per year. The perceived intensity of capsaicin burn was also variable (IQR: 14.5 -43.0), with a mean of 29.5 ± 2.2. Liking of the six food items on the gDOL (possible range −100 to +100) showed similar mean scores and interquartile ranges, as shown in Table 1. The difference in mean liking scores for the various spicy foods highlights that numerous aspects of the foods influence liking scores, including energy density, and the presence of other compounds that might be considered "spicy".

Suitable variability was also observed in the personality measures. Out of a total possible range of 0 to 24, SP scores in this cohort ranged from 2 to 20 (IQR: 6 to 13). SR scores ranged from 3 to 23 (IQR: 7 to 13). AISS scores ranged from 35 to 76 (IQR: 48 to 61), out of a total possible range of 20 to 80.

3.1. The burn/sting of capsaicin was not directly related to personality

There were no significant relationships observed between any of the personality measures used in this study and perceived intensity of a 25μM capsaicin stimulus: PBC ($r = -0.06$, $p = 0.60$), AISS ($r = -0.11$, $p = 0.34$), SP ($r = 0.11$, $p = 0.31$), and SR ($r = 0.04$, $p = 0.68$).

3.2. Liking was related to intake

As shown in Figure 1, a strong positive correlation was observed between the liking of a spicy meal and reported chili intake ($r = 0.58$, $p < 0.0001$). Similar positive relationships (not shown) were observed for the other two spicy foods on the liking survey, although the relationship was not as strong for spicy/BBQ ribs ($r = 0.28$, $p < 0.01$) as for spicy Asian food ($r = 0.58$, $p < 0.0001$). This may reflect that ribs are often consumed with tangy, flavorful sauces that may or may not contain capsaicin.

3.3. Intake did not relate to perceived intensity

Contrary to expectations, we did not find any evidence to support chronic desensitization with habitual intake. No relationship was observed between reported intake and the intensity of burning and stinging elicited by 10mL of 25uM capsaicin ($r = 0.10$, $p = 0.89$).

3.4. PBC did not relate to other measures

No significant relationships were found between PBC scores and liking of spicy meals ($r = 0.03$, $p = 0.79$) or either of the other two spicy foods on the gDOL, spicy Asian food ($r = 0.06$, $p = 0.59$) and spicy/BBQ ribs ($r = 0.03$, $p = 0.75$). Also, there was no evidence for a relationship between PBC and annual chili intake ($r = -0.06$, $p = 0.57$).

3.5. Personality measures correlated with each other

Between the personality scales used in this study, no significant correlations were found between PBC and any other measure (AISS, and both SPSRQ subscales). AISS showed a significant negative correlation with the SP subscale ($r = -0.51$, $p < 0.0001$) and a significant positive correlation with the SR subscale ($r = 0.46$, $p < 0.0001$). The SP and SR subscales were independent from each other ($r = -0.11$; $p = 0.31$). Correlations across the measures are summarized in Table 2.

3.6. AISS related to liking and intake

As Figure 2 shows, Sensation Seeking (measured via Arnett's Inventory) was significantly related to the liking of a spicy meal ($r = 0.50$, $p < 0.0001$). Significant positive correlations were also found between Sensation Seeking and the liking of spicy Asian food ($r = 0.45$, $p < 0.0001$) and the liking of spicy/BBQ ribs ($r = 0.25$, $p = 0.02$). Figure 3 shows that Sensation Seeking was positively related to intake frequency of chilis and chili-containing foods ($r = 0.39$, $p = 0.0001$).

3.7. SPSRQ was related to liking and intake frequency

The Sensitivity to Punishment subscale showed a negative relationship with the liking of spicy meals ($r = -0.19$, $p = 0.06$; Figure 4) and nonsignificant negative relationships with the liking of spicy Asian food ($r = -0.14$, $p = 0.19$) and spicy/BBQ ribs ($r = -0.09$, $p = 0.39$). SP showed no relationship with intake frequency (Figure 5). As shown in Figure 4, the

Sensitivity to Reward subscale was positively correlated with the liking of spicy meals (r= 0.23, p= 0.03). A nonsignificant, positive relationship was observed between SR and the liking of spicy Asian foods (r= 0.18, p= 0.08). Likewise, a nonsignificant, positive relationship was seen between SR and the liking of spicy/BBQ ribs (r= 0.13, p= 0.22). As shown in Figure 5, SR showed a weak positive relationship with intake frequency (r= 0.23, p= 0.03).

3.8. Personality effects on liking were generally limited to spicy foods

To control for non-specific effects of personality on food liking, we tested whether any of the personality traits described above correlated with the liking or disliking of three foods: skim milk, cotton candy, and hot dogs. These foods were chosen from the list of the 27 foods on the gDOL because they are diverse in taste quality and had similar liking scores (mean and variance) to the three spicy foods used in the study (see Table 1). None of the personality measures were a significant predictor of spicy food liking (p's > 0.14), with one exception: Private Body Consciousness was weakly correlated with liking for skim milk (r =.27; p =0.01).

4. DISCUSSION

The general aim of this study was to determine what relationships existed between personality variables and liking of spicy food. The burning/stinging sensation produced by capsaicin, a major deterrent for many individuals, did not show a direct relationship with any of the personality measures used in this study. PBC showed no association with any of the other variables tested and did not correlate with any of the other personality measures used. Sensation Seeking and Sensitivity to Reward both showed positive relationships with the liking of a spicy meal, spicy Asian food, and spicy/BBQ spare ribs as well as with chili intake frequency. Sensitivity to Punishment showed negative correlations with the liking of spicy foods and showed no relationship with chili intake frequency. Overall, the personality measure assessing sensation seeking behavior showed a strong relationship with the liking and a moderate association with the intake of chili-containing foods, while reward sensitivity showed significant but weak relationships with the liking and intake of capsaicin-containing foods.

4.1. Liking related to intake

Liking of a food is one of the primary drivers of food intake (Duffy et al., 2009; Eertmans, Baeyens, & Van den Bergh, 2001; IFIC, 2011) in meals both in and outside the home. Here we observed a strong positive correlation between the liking of a spicy meal and chili intake frequency, which supports this assertion. A moderate and weak relationship was also found between intake and liking of the two other spicy foods on the gDOL, spicy Asian and spicy/BBQ spare ribs, respectively. The associations between liking of a spicy meal and chili intake fall within the range of correlations previously reported between liking and intake measures (Bell & Tepper, 2006; Duffy et al., 2009; Raynor, Polley, Wing, & Jeffery, 2004). These findings also support Rozin's observation of the positive relationship between use and liking of chili peppers (Rozin, 1990; Rozin & Schiller, 1980).

4.2. Reported Intake did not relate to burn intensity

While a strong relationship was observed with liking and intake, there was no relationship observed between chili intake frequency and perceived burning/stinging, a finding that appears to contradict the well documented phenomenon of capsaicin desensitization (Stevenson and Prescott 1994, Karrer and Bartoshuk 1991, Cowart 1987, Lawless et al. 1985). The current study was not designed to pull apart the reason for the absence of this relationship, but we can speculate about several potential explanations for this result. It is

possible that the results are due to a reporting error and that there are several individuals reporting frequent chili use who have a daily intake of capsaicin that, while frequent, is low enough that it does not induce desensitization. Likewise, an individual who is sensitive to the burn of capsaicin who consumes very low levels of capsaicin on a regular basis might still perceive the food as “spicy”, resulting in a high reported annual chili intake, while another individual, who is very tolerant to the burn of capsaicin may consume high levels of capsaicin relatively infrequently, resulting in a low intake frequency. In this situation it is possible that the low dose-high frequency consumer does not consume enough capsaicin to induce desensitization while the high dose-low frequency consumer does reach the desensitized state. Desensitization can occur after frequent application of low concentrations capsaicin as well as after a single high concentration dose (Green 1989, Karrer and Bartoshuk 1991). Here, the amount of capsaicin consumed was not assessed; thus it is possible that the minimum dose, or dosing frequency, necessary to achieve chronic capsaicin desensitization was not reached by some participants regardless of frequency of chili intake.

Another hypothesis, as suggested by Rozin, is that any desensitization is expected to be slight (Rozin & Schiller, 1980). This is consistent with the idea that frequent chili users increase their consumption of chilis not because they fail to sense the burn but rather that they come to enjoy the burn produced by the chilis (Stevens, 1990). This hypothesis would suggest that there exists some difference (perhaps personality) between the individuals who come to enjoy the burn of chilis and those who do not learn to like this sensation. The present analysis is not powered for the moderator analysis required to tease apart this question; we plan to revisit this in future work.

4.3. PBC did not relate to other measures

No significant relationship was found between PBC scores and the intensity of burning and stinging produced by a 25uM capsaicin; this conflicts with prior reports that high PBC individuals are more sensitive to the irritation of piperine and capsaicin (Stevens, 1990). This previous work suggests that the difference in sensitivity to capsaicin and piperine between a high and low PBC individual varies throughout regions of the mouth. The area with the largest difference in sensitivity to both capsaicin and piperine was the tip of the tongue. It is possible that with whole mouth stimulation, as in the present study, the differences in sensitivity between individuals with high and low PBC scores are not seen.

Additionally, no relationship existed between PBC score and liking of spicy meals in this study. Conflicting literature exists for the link between PBC and food choice (Kahkonen, Tuorila, & Lawless, 1997; Solheim & Lawless, 1996; Stevens, 1990). It is possible that a relationship is not seen because the personality construct of PBC may not be associated with food choice. It is also possible that there is an interaction of this personality construct with one, or many, of the other factors important in determining food choice, which may explain these inconsistent results. Further exploration into this topic is warranted.

4.4. Personality measures correlated with each other

In agreement with previously reported literature, the SP and SR subscales were independent from each other. Significant negative and positive correlations were observed between AISS and SP and SR scales, respectively. We are unaware of prior work comparing these measures in the same individuals.

4.5. Sensation seeking is related to liking and intake

A strong positive correlation was seen between the liking scores of spicy meals and Sensation Seeking. This finding confirms prior literature linking sensation seeking and enjoyment of spicy foods, though this specific operationalization of sensation seeking,

AISS, has not been used previously with food. This may explain why the correlation is stronger than has previously been reported with other sensation seeking measures (see methods for a discussion of the flaws in other measures of sensation seeking). Recently, Ludy and Mattes did not find a relationship between sensation seeking as measured with a brief 4-item measure of sensation seeking in 25 individuals; their inability to find a relationship may reflect the low power in their sample, or imprecision of a brief personality survey (Ludy & Mattes, 2012). Additionally, we used more contemporary methods to assess food liking (i.e. a generalized scale on a survey that included non-food items) than many previous studies, which may have deattenuated correlations compared to prior work. The AISS measure also showed moderate positive relationships with the measure of liking of a spicy Asian meal and a weak but significant positive relationship with the liking of spicy/BBQ spare ribs. (The weaker relationship with spicy/BBQ ribs is discussed below in section 4.6.) High AISS scores were moderately associated with chili intake, accounting for roughly 15% of variation in intake frequency of chili-containing foods, highlighting the important role that personality factors play in determining consumption of spicy foods. Notably, Sensation Seeking did not associate with liking for non-spicy control foods, indicating this effect is specific to spicy foods and not the result of a general affective shift for food.

4.6. SPSRQ related to linking and intake

Sensitivity to Reward was associated with liking of a spicy meal. While AISS is a general measure of sensation seeking and SR is a measure of sensitivity to more specific type of rewards, the two scales are correlated. Due to the strong relationships of AISS with SR and with the liking of spicy meals, a correlation between SR and spicy meals might be expected. Nonetheless, it interesting that liking of spicy foods shows correlation with a personality construct thought to measure responsivity to rewards such as money, sex, and social status. This finding seems to supports Rozin's hypothesis that the consumption of chilis is linked with an individual's perception among peers, or "machismo" and the perception of strength (Rozin, 1990). Positive (albeit nonsignificant) trends were also found between liking of spicy Asian foods and spicy/BBQ ribs and sensitivity to reward. It is tempting to speculate that this could reflect a lower "machismo" factor for these foods, but additional work is needed to formally test this idea. Finally, in spite of a significant negative correlation between AISS and SP, there was no evidence of a relationship between liking of spicy meals and Sensitivity to Punishment. We believe this is the first time SP and SR have been applied in research on food choice.

Rozin suggested that one of the reason that Americans might like spicy foods is the association of chili pepper with calorically dense, high fat foods such as barbecue, hot wings, and American Mexican foods (Rozin, 1990). While this was proposed at a time when the typical middle American diet incorporated far fewer spices and spicy foods than today, the present gDOL questionnaire included a number of different types of spicy foods to determine if reported liking was potentially influenced by energy density. Recently, we reported that liking for a spicy meal was predictive of biomarkers associated with lower cardiovascular risk (Duffy, Hayes, Sullivan, & Faghri, 2009), but this may not reflect a causal physiological mechanism for capsaicin (e.g., increased satiety) as spicy foods can also vary dramatically in energy density (cf. Buffalo chicken wings versus a vegetable based stir-fry).

Here, participants were asked to rate their liking of non-specific "spicy meals" as well as two more detailed items, "spicy Asian food" assessing a group of lower calorie, lower fat spicy foods, and "spicy and or BBQ spare ribs' to target a high fat, high calorie food. As discussed earlier, there were a number of situations in which correlations of varying strengths and significance were observed between the three spicy foods and a specific personality trait. Disparities in the relationships between the different personality scales and

liking of spicy meal, spicy Asian foods, and spicy/BBQ spare ribs may be due to differences in the interpretations of the items on the gDOL. For example, when asked about 'spicy Asian foods' participants may have included orally irritating compounds which do not activate or cross desensitize TRPV1 receptors, such as allyl isothiocyanate found in wasabi, in their definition of "spicy". Further research in this area to elucidate the conceptualization of the term "spicy" and its identity in a number of different cultures would be useful in determining the cause of this variation. Additionally, exploration of other orally irritating compounds and any link with these personality traits would help to understand the nature of the affective shift from disliking to liking the irritation.

In this vein, spicy/BBQ spare ribs showed a significant positive association that was only slightly less than that observed for non-specific "spicy meals" in relation to sensation seeking behaviors. Conversely spicy meals showed significant relationship with Sensitivity to Reward while spicy BBQ did not. As with the implicit complexities of the spicy Asian meal item, delving into the source of this variation between BBQ and the other two spicy foods is beyond the scope of the present study. Still, it seems possible that the frequent inclusion of sugar in BBQ sauces and the high fat content of the BBQ itself, reduces the perception of capsaicin in these foods due to physicochemical (Lawless, Hartono, & Hernandez, 2000) and cognitive factors (Stevens & Lawless, 1986). Additionally, the wide variety of BBQ among regions in the US (vinegar sauces versus tomato sauces versus dry rubs) introduces a complication not accounted for in the present study design.

5. CONCLUSION

The relationships presented in this study confirm that liking or disliking of spicy foods is not solely determined by an individual's sensitivity to capsaicin but that personality factors exist that influence and the affective response to the initially aversive burning/stinging sensation of capsaicin.

Sensation Seeking and Sensitivity to Reward were strongly linked with the liking of all of the spicy foods measured here, and with reported chili intake. Although sensation seeking behavior has been previously linked with the liking of spicy foods, this study provides new insights into personality variables that play a role in food choice.

Significant positive associations were found between Sensation Seeking and the liking of spicy meals, including spicy Asian foods and spicy/BBQ spare ribs, though the relationships varied in strength. Sensitivity to Reward showed a significant relationship only with the liking of a spicy meal. The inconsistency in relationships between the personality measures and liking scores for the three spicy foods included on the gDOL cannot be determined in this study (AISS was predictive of all three foods, compared to SR, which only correlated with one). Further exploration into the source of these differences is essential to fully understand the drivers of food choice with chemesthetic compounds.

It is clear from present data that personality variables influence the liking of spicy foods and food choice. Notably however, we did not observe any relationships between the liking of non-spicy foods and the personality measures that correlated with spicy food liking, suggesting that individuals with high scores in these traits do not show an overall affective shift toward food. Individuals who were higher in Sensation Seeking and Sensitivity to Reward also report consuming capsaicin containing foods more frequently. The relationships presented here, while indicative that personality variables are related with food choice and liking, are only associations. In the future, structural equation modeling could be utilized to better characterize the nature of the relationships between these variables.

Acknowledgments

This manuscript was completed in partial fulfillment of the requirements for a Doctorate of Philosophy at the Pennsylvania State University by the first author. The authors warmly thank Alissa L. Allen and Meghan Kane for their assistance with data collection and our study participants for their time and participation.

FUNDING

This work was supported by a National Institute of Health National Institute National of Deafness and Communication Disorders grant [DC010904] to the corresponding author.

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- Sensation Seeking was positively associated with chili liking and intake
- Sensitivity to Reward was positively associated with chili liking and intake
- Chili liking was positively associated with chili intake
- Private Body Consciousness was not associated with liking or intake
- No evidence of chronic desensitization was observed

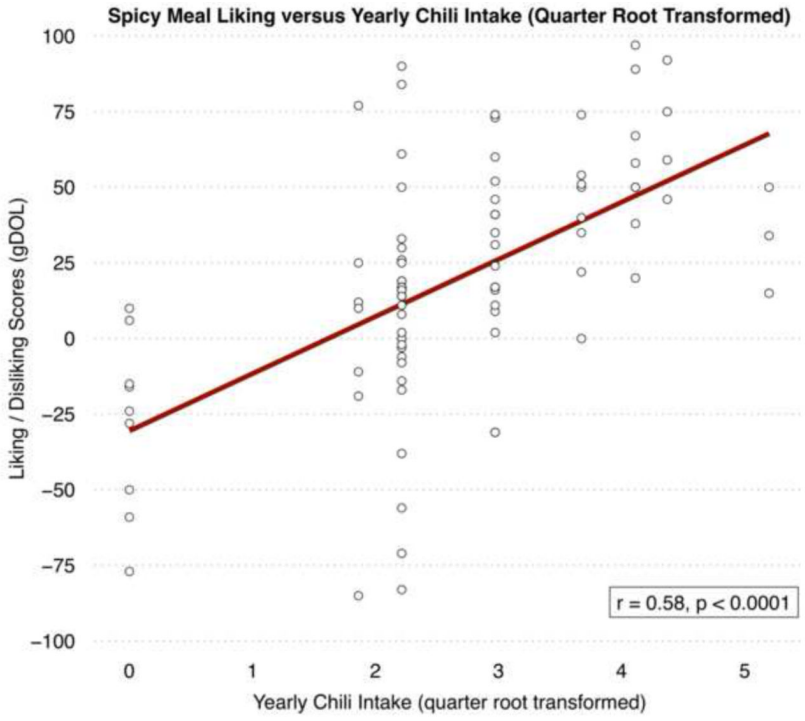

Figure 1.

Relationship between self-reported liking of a spicy meal and chili intake frequency. Individuals were asked to rate how much they like or dislike a spicy meal on a generalized hedonic scale. Participants reported their intake of chili-containing foods on an 8-point scale, ranging from “never” to “two or more times a day”. Intake frequency was converted to an annualized frequency and quarter root transformed.

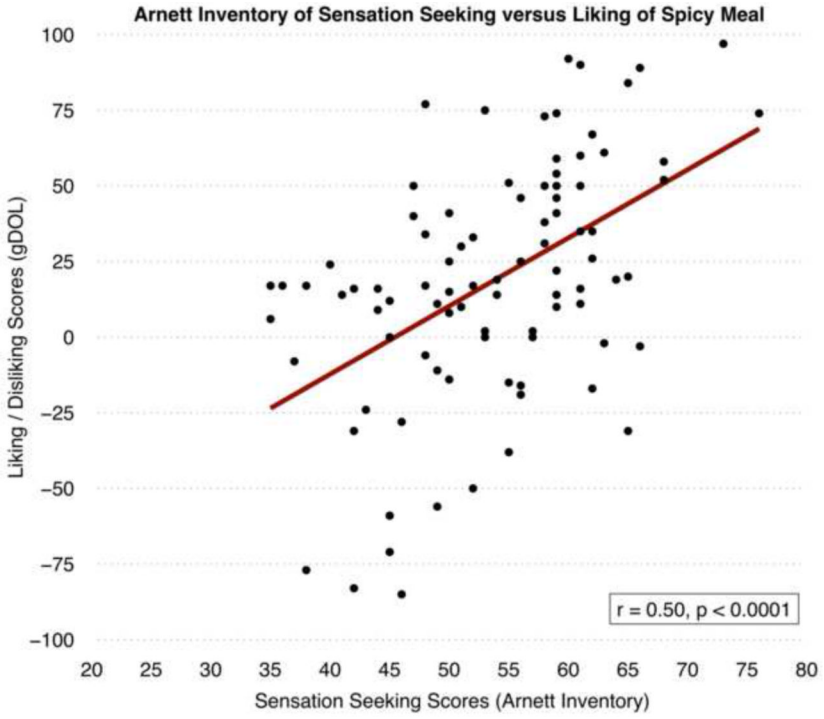

Figure 2.

Strong positive relationship between scores on the Arnett Inventory of Sensation Seeking and self-reported liking of a spicy meal. Sensation Seeking was measured using Arnett's Inventory of Sensation Seeking (1994).

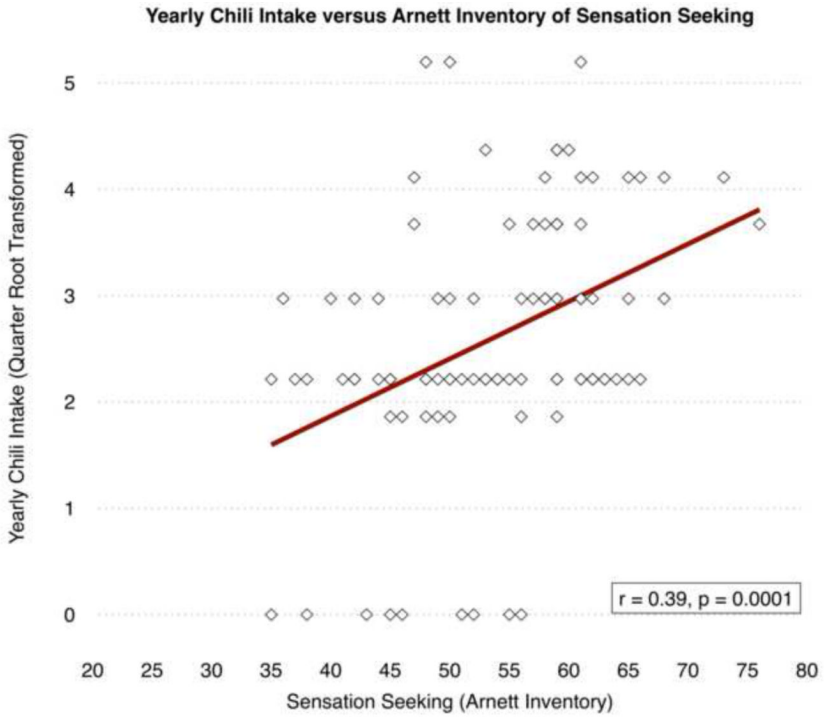

Figure 3.
Strong positive relationship between chili intake frequency and scores on the Arnett Inventory of Sensation Seeking.

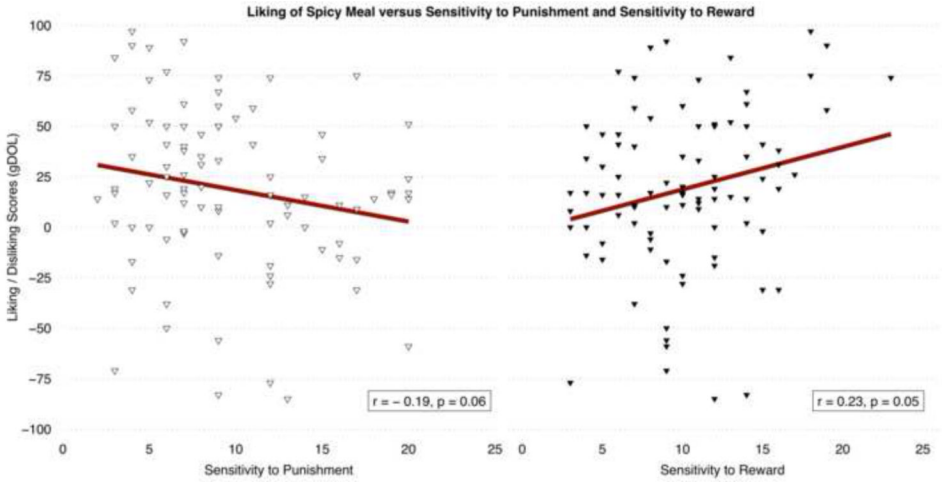

Figure 4.

Relationships between Sensitivity to Punishment, Sensitivity and Reward, and liking of a spicy meal. Sensitivity to Reward showed a significant positive correlation with the liking of a spicy meal. In contrast, Sensitivity to Punishment showed a nonsignificant trend towards a negative relationship with spicy meal liking.

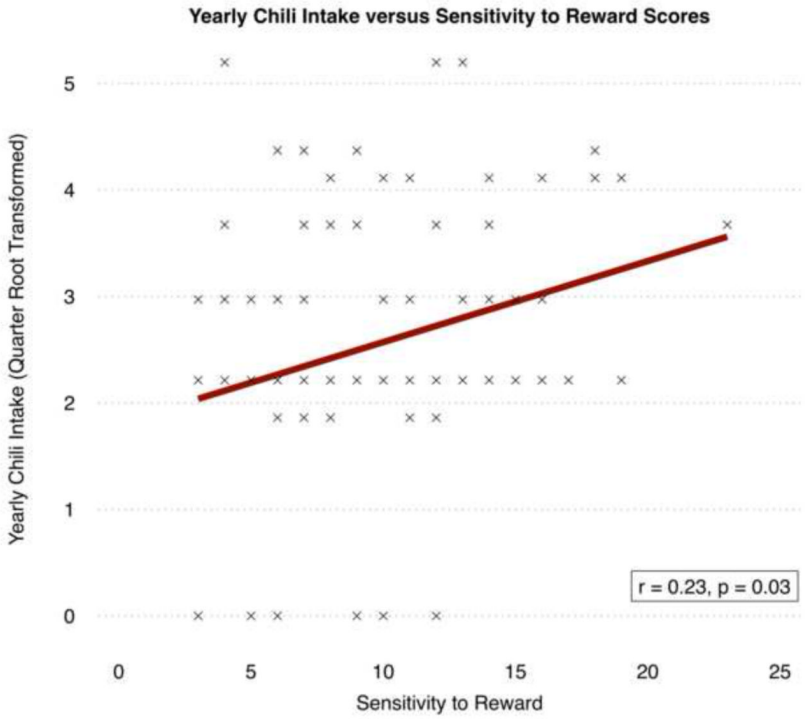

Figure 5.
A moderate positive relationship was observed between chili intake frequency and Sensitivity to Reward.

Table 1

Descriptive Statistics for 6 Food Items from the generalized Degree of Liking (gDOL) questionnaire (see methods for more information).

Liking for:	Mean	95% CI	n	Interquartile Range (IQR)
Burn of a Spicy Meal	18.4	10.5-26.3	97	0 to 50
Burn of Spicy Asian Food	27.5	18.3-36.7	95	5 to 61
Burn of spicy /BBQ spare ribs	28.0	18.5-37.5	92	−1 to 58
Cotton Candy	23.1	15.9-30.3	96	1 to 44
Hot Dog	24.2	15.9-32.6	95	4 to 50
Skim milk	23.5	15.0-32.0	95	0 to 52

Table 2

Correlation matrix of personality measures used in the present study. Private Body Consciousness (PBC) showed no correlation with any of the other measures used. Arnett's Inventory of Sensation Seeking (AISS) showed significant correlations with both subscales of the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ). The SP and SR subscales of the SPSRQ were not correlated with each other. Bolded values are significant at $p < 0.0001$.

	AISS	SP	SR
PBC	−0.09	0.10	−0.04
AISS		−0.51	**0.46**
SP			−0.11