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Behavioral measures of risk tasking, sensation seeking and sensitivity to reward may reflect different motivations for spicy food liking and consumption

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Abstract

Based on work a quarter century ago, it is widely accepted personality traits like sensation seeking are related to the enjoyment and intake of spicy foods; however, data supporting this belief is actually quite limited. Recently, we reported strong to moderate correlations between remembered spicy food liking and two personality traits measured with validated questionnaires. Here, participants consumed capsaicin-containing strawberry jelly to generate acute estimates of spicy food liking. Additionally, we used a laboratory-based behavioral measure of risk taking (the momentary Balloon Analogue Risk Task; mBART) to complement a range of validated self-report measures of risk-related personality traits. Present data confirm Sensation Seeking correlates with overall spicy meal liking and liking of the burn of a spicy meal, and extends prior findings by showing novel correlations with the liking of sampled stimuli. Other personality measures, including Sensitivity to Punishment (SP), Sensitivity to Reward (SR), and the Impulsivity and Risk Taking subscales of the DSM5 Personality Inventory (PID5) did not show significant relationships with liking of spicy foods, either sampled or remembered. Our behavioral risk taking measure, the mBART, also failed to show a relationship with remembered or sampled liking. However, significant relationships were observed between reported intake of spicy foods and Sensitivity to Reward, and the Risk Taking subscale of the PID-5 (PID5-RT). Based on the observed patterns among various personality measures, and spicy food liking and intake, we propose that personality measures may exert their influence on intake of spicy food via different mechanisms. We also speculate that Sensation Seeking may reflect motivations for consuming spicy foods that are more intrinsic, while the motivations for eating spicy foods measured by SR and PID5-RT may be more extrinsic.

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Keywords

Sensation Seeking; Sensitivity to Reward; BART; spicy food; capsaicin; PID5

Introduction

Myriad reasons have been proposed to explain the large individual differences in consumption of foods that elicit sensations that are initially aversive. These include biological reasons, such as genetic effects (Allen, McGeary, & Hayes, 2014; Kim et al., 2004; Perry et al., 2007; Törnwall, Silventoinen, Kaprio, & Tuorila, 2012), differences in oral anatomy (Bartoshuk, 1993; Miller & Reedy, 1990), and physiology (Duffy, 2007; Duffy & Bartoshuk, 2000), which may make someone more or less sensitive to innately aversive sensations on their first encounter. Here, we focus on the burn from chili peppers, as capsaicin (the active ingredient) paradoxically triggers appetitive or chemofensive responses, depending on concentration and context. Desensitization (i.e., the drop in perceived intensity following repeated exposure (Cliff & Green, 1996; Cowart, 1981; Green, 1989, 1996; Green & Rentmeister-Bryant, 1998; Karrer & Bartoshuk, 1991; Lawless, Rozin, & Shenker, 1985; Prescott & Swain-Campbell, 2000; Rozin & Schiller, 1980; Stevenson & Prescott, 1994), may also influence the liking of spicy foods. Reports on the importance of desensitization conflict, as some suggest the supposed increased liking is merely an effect of decreased sensitivity (Logue & Smith, 1986; Rozin, 1990a, 1990b; Rozin & Schiller, 1980), while others suggest that the effects of desensitization on liking are minimal (Rozin, Mark, & Schiller, 1981; Rozin & Schiller, 1980).

While there may or may not be differences in initial sensitivity to capsaicin that are innate, there are clearly large individual differences in the affective responses to the burn capsaicin elicits (Rozin & Schiller, 1980; Stevenson & Yeomans, 1993). Social and cultural effects also play a role in the development of liking for spicy foods. Some work (Zajonc, 1968) suggests repeated exposure to spicy foods and specific types of cuisines increases the liking for these foods (Logue & Smith, 1986), consistent with the mere exposure hypothesis (Zajonc, 1968). Cultural factors, such as the desire to be perceived as an adult, or the desire to be involved in cultural customs, may also influence the liking of spicy foods (Rozin & Schiller, 1980; Rozin & Vollmecke, 1986; Stevens, 1990).

A variety of personality traits have been associated with the liking of spicy foods. Work beginning in the 1970's and continuing through the early 1990's associated the liking of spicy foods and spices with personality traits such as sensation seeking and thrill seeking (Kish & Donnenwerth, 1972; Logue & Smith, 1986; Rozin, 1990b; Rozin & Schiller, 1980; Stevens, 1990; Terasaki & Imada, 1988). This body of work theorizes that there is a link between trait sensation seeking and the liking of spices and spicy foods. More recent work has been done evaluating the relationship between personality and liking of spicy foods, with reports suggesting that spicy food liking is linked with trait anger (Ji, Ding, Deng, Jing, & Jiang, 2013) and Extraversion (Wheeler & Berger, 2007). Although suggestive, much of the work looking specifically at sensation seeking was not performed using validated measures of personality, or was not conducted in large enough groups to allow for statistical

analysis. Recently, we (Byrnes & Hayes, 2013) reported empirical evidence of strong correlations between validated measures of Sensation Seeking (Arnett, 1994) and Sensitivity to Reward (Torrubia, Avila, Moltó, & Caseras, 2001), and the liking and intake of spicy foods, suggesting individuals high in Sensation Seeking and Sensitivity to Reward are more likely to like spicy foods than individuals low in these traits. Around the same time, Ludy and Mattes failed to observe this relationship (Ludy & Mattes, 2012), although it seems likely these divergent findings may result from a smaller sample size or their use of a brief measure of sensation seeking for adolescents (Hoyle, Stephenson, Palmgreen, Lorch, & Donohew, 2002) that may not measure the same construct as the longer adult Sensation Seeking inventory we used.

There are many related traits including impulsivity, behavioral constraint, disinhibition, thrill seeking, and risk taking that have been associated with risky behaviors, including alcohol and drug consumption, theft, risky sexual behavior, and risky driving behavior (i.e., drunk driving, speeding, not wearing a seatbelt, etc) (Aklin, Lejuez, Zvolensky, Kahler, & Gwadz, 2005; Fernie, Cole, Goudie, & Field, 2010; Greene, Krcmar, Walters, Rubin, & Hale, 2000; Grossarth-Maticek & Eysenck, 1991; Hopko et al., 2006; Jonah, 1997; Lauriola & Levin, 2001; MacPherson, Magidson, Reynolds, Kahler, & Lejuez, 2010; Marino et al., 2013; Powell, Hardoon, Derevensky, & Gupta, 1999; Stanford, Greve, Boudreaux, Mathias, & Brumbelow, 1996; Stout, Rock, Campbell, Busemeyer, & Finn, 2005; Zurborg, Yurgionas, Jira, Caspani, & Heppenstall, 2007). Accordingly, associations between these traits and behaviors justifies classifying them as risk-related traits. While there is controversy about where these traits fall in the hierarchical organization of personality (e.g., Costa & Mccrae, 1998; Eysenck & Eysenck, 1978b; Zuckerman, 2002), and about the exact definition of the related traits (e.g., Arnett, 1994; Cloninger, 1987; Zuckerman, Kolin, Price, & Zoob, 1964), it is agreed that many of these traits are multidimensional (Dawe & Loxton, 2004; Evenden, 1999; Lauriola, Panno, Levin, & Lejuez, 2014; Lejuez et al., 2002). The variety of conceptualizations of these traits has lead to an assortment of personality scales designed to measure these traits.

Previously, the relatedness of such personality instruments has been assessed using correlations (e.g., Torrubia et al., 2001; Zuckerman & Cloninger, 1996), but this measure can only provide information about the extent of overlap between the instruments themselves. As an alternative, comparing the common behaviors that two personality scales associate with provides more nuanced information as to whether the scales are measuring similar dimensions of the specific trait. For example, if two scales that are designed to measure impulsivity both associate strongly with the tendency of an individual to drive drunk, it is likely that they measure similar dimensions of trait impulsivity.

Assessment of trait influences on risky behaviors has often relied heavily on the use of self-report instruments that measure constructs such as Sensation Seeking (Zuckerman et al., 1964), Venturesomeness (Eysenck & Eysenck, 1978a), Impulsivity (Barratt, 1985; Eysenck & Eysenck, 1978a), and deficits in behavioral constraint (Tellegen & Waller, 2008). While these constructs certainly overlap with risk taking, none fully capture the multidimensional nature of risky behavior. Additionally, self-report measures are limited in that certain individuals may not be able to provide an accurate report of their own behavior. It is also

possible that individuals perceive certain consequences or stigma associated with reporting risky behaviors, which may also influence the fidelity of self-report measures of risk taking. As an alternative, behavioral measures of risk taking, such as the Bechara Gambling Task (BGT; Bechara, Damasio, Damasio, & Anderson, 1994), have their own set of advantages and disadvantages (Lejuez et al., 2002). Accordingly, it has been recommended that the best approach is to use both self-report and behavioral measures as they may provide complimentary information (Meyer et al., 2001; Weiner, 2005).

One relevant behavioral measure is the Balloon Analogue Risk Task (BART; Lejuez et al., 2002). Scores on this measure have been significantly correlated with relevant measures of risk-related personality constructs including Sensation Seeking total score, Barratt Impulsiveness total score, Eysenck Impulsivity subscale score, and the MPQ Behavioral Constraint superfactor score (Holmes et al., 2009; Hopko et al., 2006; Lejuez, Aklin, Jones, et al., 2003; Lejuez et al., 2002). The BART also correlates well with measures of real-life risky behavior, such as alcohol use, number of drugs used in the past year, and smoking behavior (Lejuez et al., 2002). This measure has seen limited use in the field of food choice research (Lejuez et al., 2002).

In addition to exploring relationships between measures of personality, perceived intensity of burning sensations, and liking and intake of capsaicin containing foods, here we also explore the possibility that individuals exhibit different responses to varying levels of capsaicin. In the sweet (Drewnowski, Henderson, Shore, & Barratt-Fornell, 1997; Lundgren et al., 1978; Pangborn, 1970) and sour (Molinier, Prescott and Hayes, under review) liking literature, multiple response types have been observed. These responses, were summarized by Drewnowski and colleagues as inverted-U (Type I), linear increasing (Type II), linear decreasing (Type III) responses, and a flat response style (Type IV) where no systematic change in response is observed with increased concentration of stimulus (Drewnowski et al., 1997). Accordingly, we wished to clarify whether reported liking of increased capsaicin concentrations can be attributed to decreased sensitivity (Logue & Smith, 1986; Rozin, 1990a; Rozin & Schiller, 1980) or whether some individuals actually enjoy the pungency of capsaicin, regardless of the perceived intensity of the burn (Rozin et al., 1981; Rozin & Schiller, 1980).

Here, we expand on prior work by examining relationships between liking of spicy foods and personality traits using a range of self-report and behavioral measures of risk-related personality traits, including Arnett's Inventory of Sensation Seeking (AISS; Arnett, 1994), the Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ; Torrubia et al., 2001), the Personality Inventory for the Diagnostic and Statistic Manual of Mental Disorders-5 (PID-5; Krueger, Derringer, Markon, Watson, & Skodol, 2012), and the Balloon Analogue Risk Task (BART; Lejuez et al., 2002). We also explore relationships between liking spicy foods and risk-related personality traits by utilizing multiple personality scales that presumably tap different dimensions of risky behaviors as they may relate to the liking and intake of spicy foods. Additionally, we assess how these personality measures relate to each other in our sample. Finally, we also examine whether participants show different hedonic response types to varying capsaicin concentrations.

Materials and Methods

Participants

Data were collected from individuals recruited from the Pennsylvania State University campus and surrounding area. To be eligible, potential participants had to be nonsmoking, fluent English speakers between 18 and 55 years old, with no known defects of taste or smell. Participants were ineligible to participate if they had cheek, lip, or tongue piercings, had a history of a condition involving chronic pain or were on prescription pain medications, were pregnant or nursing, or if they had an allergy to spices or food components. Additional exclusion criteria included a known defect in taste or smell or a history of choking or difficulty swallowing, and presence of a cold or upper respiratory condition that might hinder his or her senses of taste or smell. Participants were asked not to consume hot and spicy foods for 48 hours prior to the test and to refrain from eating or drinking anything other than water in the hour prior to their testing session.

Data from 103 participants (26 men) are reported here. Participant ages ranged from 18 to 55, with 61% falling between 18 to 25, 13% between 26 and 35, 12% between 36 and 45, and 1% between 46–55; 13% did not provide an age. Self reported race and ethnicity were collected with two separate questions according to the 1997 OMB Directive 15 guidelines. Our cohort included 7 Asians, 80 Caucasians, and 16 not reported; 3 individuals identified as being Latina or Latino, and 86 indicated they were not Latina or Latino. All data were collected with the approval of the local Institutional Review Board; written informed consent was obtained, and participants were paid for their time.

Stimuli

All materials were food grade. Capsaicin (natural, Sigma-Aldrich, St. Louis, MO) and allyl isothiocyanate (AITC; mustard oil, ≥ 93%, FCC, Sigma-Aldrich, St. Louis, MO) were chosen as they have different temporal profiles (McDonald, Barrett, & Bond, 2010), and based on prior work, these stimuli elicit sensations that are clearly perceptually distinct (Byrnes, Nestrud, & Hayes, 2015). Stock concentrations of capsaicin (2.20 mM) and AITC (3.40M) were made in 95% USP grade ethanol (Koptec, King of Prussia, PA) and stored at 4°C for up to four weeks.

To help participants concentrate on the pungency elicited by the chemesthetic stimuli (here, capsaicin and allyl isothiocyanate) and to avoid any expectancy effects (Prescott & Stevenson, 1995b) from learned associations with certain foods (e.g., salsa or mustard), we chose strawberry jelly as our food matrix. Recent work by Törnwall and colleagues delivered capsaicin in a firm strawberry-flavored gel made with pectin based jelly sugar that was then cut into cubes for serving (Törnwall et al., 2012). As firm gels with this texture would typically be made with gelatin in North America (e.g. Jell-O), we instead made a softer flowable jelly with the texture akin to a fruit spread. The recipe for these jellies is provided in Table 1.

To minimize variation between jelly samples within a testing session, all samples used within a session were produced from a single batch of jelly. The jelly was separated into five lots and spiked with the appropriate amount of capsaicin or AITC stock to produce a blank,

3.0 μM capsaicin, 12 μM capsaicin, 0.5 mM AITC, and 2.0 mM AITC samples. Duplicate samples came from same lot of spiked jelly to minimize differences between duplicates. Samples were mixed thoroughly and 3 g was weighed into individual 1-ounce serving cups. Samples were capped, labeled with randomly assigned three-digit blinding codes, and stored at 4°C for up to two weeks.

Previous work in our laboratory showed that a 25 μM capsaicin stimulus would produce a mean burning/stinging intensity rating between “strong” and “very strong” on a general Labeled Magnitude Scale (Hayes, Allen, & Bennett, 2013). Pilot testing with the jelly samples was conducted to intensity match the low capsaicin and low AITC stimuli, and the high capsaicin and high AITC stimuli, respectively. This testing indicated that the low concentrations (3 μM capsaicin and 0.5 mM AITC) were not significantly different from each other in perceived burning/stinging intensity, producing a burning/stinging sensation that was rated near “weak” on a gLMS. The high concentrations (12 μM capsaicin and 2.0 mM AITC) were significantly more intense than the low concentration samples but were not significantly different from each other, producing ratings around “moderate” on a general Labeled Magnitude Scale (gLMS).

Data Collection

All data were collected using Compusense version 5.2 (Guelph, Ontario, Canada). Liking and intensity ratings for the sampled jellies were collected on one computer using Compusense while a second computer running Compusense *five* Plus was used to collect personality measures and remembered food liking ratings. Momentary BART (mBART) data were collected using a custom software application presented on a Google Nexus 7 tablet running the Android operating system (Google, Mountain View, California, U.S.A.). This custom application was kindly provided by R. Ross MacLean (MacLean, Smyth, Geier, & Wilson, Under Review), and was coded as specified by Lejuez and colleagues (Lejuez et al., 2002).

Prior to evaluating any stimuli, participants completed an orientation on how to use a general Labeled Magnitude Scale (gLMS), followed by a warm-up exercise. Ratings on the gLMS range from “No Sensation” on the left of the scale and “Strongest Imaginable Sensation of Any Kind” on the right of the scale; intermediate labels (Barely Detectable, Weak, Moderate, Strong, and Very Strong) are located along the scale (Bartoshuk, Duffy, Green, et al., 2004; Green et al., 1996). To encourage participants to make their ratings in a generalized context, in the warm-up, participants rated the intensity of a list of 15 remembered or imagined sensations that include both oral and non-oral (Hayes et al., 2013).

In total, ten jellies were evaluated, with blank, low and high capsaicin concentration, low and high AITC concentration jellies all evaluated in duplicate. Stimuli were presented in a pseudo-randomized order, such that the first jelly that participants evaluated was always a blank jelly sample containing no capsaicin or AITC. The presentation order of the remaining nine samples was fully counterbalanced across all participants. Participants were instructed to rinse their mouths with RO water prior to tasting the first sample, and between samples.

All jellies were sampled in the same manner. Participants were taught to scoop the entire jelly sample (3g) from the plastic cup with a plastic spoon and then to flip the spoon over so that the jelly contacted their tongue before the spoon. They were instructed to make sure that all the jelly was off of the spoon and then to use their tongue to move the jelly around in their mouth for five seconds. They then expectorated the sample and rated liking and intensity of the burning/stinging sensation before rinsing with RO water. In the break between jelly samples participants completed personality instruments and food liking surveys on a second computer. They were instructed to continue rinsing with RO water while completing these surveys. A minimum interstimulus interval of 3 minutes was enforced between samples, and participants were instructed not to proceed to the next jelly until they felt that there was no lingering sensation from the prior sample. If a participant felt a sensation from the sample remained after 3 minutes, the experimenter instructed the participant to continue to rinse with water and not to continue with the protocol until they confirmed any lingering sensation was gone. No water or jelly samples were swallowed in this protocol. All data were collected one-on-one with an experimenter seated across from the participant to ensure the protocol was followed.

Personality measures

The personality trait sensation seeking is characterized by the need for varied, complex, and novel sensations, and the willingness to seek out these experiences regardless of possible associated physical and social risks (Arnett, 1994; Zuckerman, 1964; Zuckerman & Neeb, 1979). Arnett's Inventory of Sensation Seeking (AISS; Arnett, 1994) is a scale designed to measure a construct similar to Zuckerman's Sensation Seeking Scale, form five (SSS-V). While there is conflicting evidence of whether these two scales measure the same construct (Carretero-Dios & Salinas, 2008; Ferrando & Chico, 2001), we chose to use Arnett's scale, to avoid differences that may arise between the two scales in older individuals. For the remainder of this document, we use lower case letters when referring to the general concept of sensation seeking, and use the phrase Sensation Seeking (capitalized) or the initialism AISS when referring to scores on Arnett's Inventory of Sensation Seeking.

The Sensitivity to Punishment and Sensitivity to Reward Questionnaire (SPSRQ) is a scale developed to measure the reactivity to and avoidance of rewarding and punishing stimuli (Torrubia et al., 2001). The SP subscale measures individual's responses to situations involving punishment, cues for failure, or frustrative non-reward (Cooper & Gomez, 2008; O'Connor, Colder, & Hawk, 2004; Torrubia et al., 2001), while the SR subscale measures reactivity to reward, specifically rewards pertaining to money, social status and approval, and sexual partners (Cooper & Gomez, 2008; Dawe & Loxton, 2004; O'Connor et al., 2004). While work applying the SPSRQ in food choice research is very limited, recently we reported a positive correlation between scores on the SR subscale and the remembered liking of spicy foods (Byrnes & Hayes, 2013, 2015).

The PID-5 is a personality inventory for the Diagnostic and Statistic Manual of Mental Disorders V (DSM-5) constructed by Krueger and colleagues (Krueger et al., 2012). This model operationalizes maladaptive personality traits from the DSM-5 in 5 higher order

domains: negative affect, detachment, antagonism, disinhibition, and psychoticism (Krueger et al., 2012; Thomas et al., 2012; Wright et al., 2012).

The Balloon Analogue Risk Task (BART) is a laboratory-based behavioral measure of risk-related constructs. In this task, the participant plays a game where he or she presses a button to inflate a balloon on a computer screen. Each time the participant pumps up the balloon and the balloon does not pop, the participant receives a nominal cash reward into a temporary bank. After each pump, the participant must choose whether to cash out his or her winnings on that balloon and transfer to a permanent bank, which starts a new balloon, or to continue pumping up the balloon via additional button presses. If the balloon pops, all money in the temporary bank is lost and a new balloon is started. This game operationalizes risk taking, as each successive pump on an individual balloon trial both increases the amount to be lost if the balloon pops and decreases the relative gain from any additional pumps. Here, we used the mBART, a version of the original BART that was adapted for use on mobile devices such as tablets (MacLean et al., Under Review). Average adjusted pumps were calculated as the average number of times that a participant pumped a balloon before collecting money, when the balloon did not pop. To incentivize our participants, we informed them at the start of the task that we would be recording their total earned, and the top three earners would be re-contacted after all testing was complete to pick up their winnings: the first, second, and third place earners received $75, $50, and $25 USD, respectively.

Measuring food liking

During testing, one of the measures that participants completed between jelly samples was a generalized Degree of Liking (gDOL) survey. The gDOL used here is a 63-item affective survey with 47 food items (including ratings of “your favorite food”, “your least favorite food”, “overall spicy meal”, and “burn of a spicy meal”), three alcoholic beverages, and 13 non-food sensations. Responses were collected using a bipolar, unstructured, horizontal visual analog scale (VAS), ranging from “strongest disliking of any kind” (−100, left side) and “strongest liking of any kind” (+100, right side), with the midpoint of the scale labeled “neutral” (0). Similar measures have been used previously to measure associations between food liking and intake (Byrnes & Hayes, 2013, 2015; Hayes, Sullivan, & Duffy, 2010), food liking and health outcomes (Duffy, Hayes, Sullivan, & Faghri, 2009), food liking and taste phenotypes (Pickering, Jain, & Bezawada, 2013), and food liking and genetic polymorphisms (Hayes, Feeney, & Nolden, 2015). The same bipolar hedonic scale was also used to collect ratings of the liking of the burning/stinging sensation experienced when sampling the jellies.

Follow-up web-based questionnaire

After leaving the laboratory, participants completed a web-based questionnaire to collect demographic data, including race, ethnicity, and gender, as well as food intake frequency data. To assess intake frequency, we used an updated, extended version of the questionnaire originally developed by Lawless and colleagues (Lawless et al., 1985). Here, participants were asked to indicate how often they consumed various foods on a survey. Response options consisted of a seven-point category scale with the descriptors “never”, “1–10 times/

year", "1–2 times/month", "1–3 times/week", "4–6 times/week", "1–2 times/day", and "more than 2 times/day". The specific foods on the follow-up survey included: wasabi, horseradish, spicy food, spicy brown mustard, yellow mustard, spicy Korean food, non-spicy Korean food, spicy BBQ, non-spicy BBQ, spicy Mexican/Latin food, non-spicy Mexican/Latin food, spicy Thai food, non-spicy Thai food, spicy Indian food (creates burning, hot, or stinging/pricking sensation), non-spicy Indian food (can still be highly aromatic but does not create burning, hot, or stinging/pricking sensation), Buffalo wing sauce (ex: Frank's Red Hot), Tabasco sauce or other hot sauces (excluding Sriracha), hot salsa, mild salsa, Sriracha (Rooster Sauce), spicy Chinese food, and non-spicy Chinese food. Participants were asked, that if they had never tried the food to refrain from making a rating. For analysis, these responses were converted to an annualized measure, such that "never" became 0 (times per year), "1–2 times/month" became 12, "1–2 times/week" became 52, etc. up to "more than 2 times/day", which became 730.

Statistical analyses

One-way ANOVA showed that there was no significant effect of order and that all sample duplicates had intensity ratings that were not significantly different from one another. Thus, means for the intensity and liking ratings were calculated from the duplicates, and used for all subsequent analyses. SAS 9.2 (Cary, North Carolina, U.S.A.) was used for all data analysis. Pearson correlations were calculated using *proc corr* and descriptive statistics were generated using *proc means* and *proc freq*. Difference scores were calculated for intensity and affective ratings prior to analysis, such that the mean intensity and affective ratings for blank samples were subtracted from the mean intensity and affective ratings for the spiked samples. Importantly, because of this transformation, the possible ranges of the difference scores (−100 to 100 for intensity ratings and −200 to 200 for affective ratings) were larger than for the original scales. Significance criteria was set at alpha = 0.05.

Results

In this cohort (n=103), perceived intensity for the low and high capsaicin-spiked jelly samples (possible range −100 to 100) showed wide variation, as shown in Table 2. As suggested by an anonymous reviewer, to streamline the results and discussion, we focus exclusively on the capsaicin results, and data for the AITC samples are not reported here.

The mean number of average adjusted pumps we observed is similar to that reported in the original BART manuscript (Lejuez et al., 2002) and in more recent work (Hunt et al 2005). Accordingly, this suggests the reward scheme used here functioned to appropriately incentivize study participants, as participants did not behave in an overly risky way (in essence, they did not "shoot the moon"; see Lejuez et al., 2002).

Burn did not relate to yearly intake of spicy foods or personality traits

Perceived intensity (burn) of the 3 μM capsaicin-spiked jelly was not related to yearly intake of spicy foods or to any of the personality traits. Burn from the 12 μM capsaicin-spiked jelly also failed to show any association to yearly intake of spicy foods or any personality measures.

Liking and intake of capsaicin-containing foods were related

As expected, remembered overall liking of a spicy meal and remembered liking of the burn of a spicy meal both showed significant relationships with reported intake of spicy foods ($r = 0.48$, $p < 0.0001$ and $r = 0.39$, $p = 0.0005$, respectively). Relationships between liking of sampled capsaicin spiked jellies and annual spicy food intake varied as a function of concentration: liking of the 3 μM capsaicin-spiked jelly was not correlated with yearly intake, while liking of the 12 μM capsaicin-spiked jelly was significantly correlated with yearly intake of spicy foods ($r = 0.35$, $p = 0.002$).

Remembered and sampled liking are related

Liking of the 12 μM capsaicin-spiked jelly correlated with both remembered overall liking of a spicy meal ($r = 0.49$, $p < 0.0001$) and with remembered liking of the burn of a spicy meal ($r = 0.45$, $p < 0.0001$), as would be expected with the intake frequency data above. Consistent with the intake data, liking of the 3 μM capsaicin-spiked jelly was not associated with the remembered liking of an overall spicy meal or the liking of the burn of a spicy meal (p's > 0.5).

Personality related to liking and intake of capsaicin-containing foods

The AISS showed significant correlations with liking of the 12 μM capsaicin-spiked jelly ($r = 0.30$, $p = 0.002$); conversely, no relationship was observed with liking of the 3 μM capsaicin-spiked jelly. Replicating our prior finding in a separate cohort, AISS also showed significant correlations with overall liking of a spicy meal ($r = 0.23$, $p = 0.02$) and liking of the burn of a spicy meal ($r = 0.24$, $p = 0.02$), and yearly intake of spicy foods and AISS were correlated ($r = 0.33$, $p = 0.003$). The SR subscale of the SPSRQ showed a significant relationship with yearly intake of spicy foods ($r = 0.27$. $p = 0.02$). The Risk-Taking subscale of the PID5 measure also showed significant correlations with yearly intake of spicy foods ($r = 0.31$, $p = 0.005$). The SP subscale of the SPSRQ, the Impulsivity subscale of the PID5, and the mBART did not show any correlations with spicy food liking or intake.

Personality measures did not relate to liking of non-spicy foods

As controls, three non-spicy foods were selected from the gDOL survey on the basis of mean liking scores and range of liking scores that were similar to the reported overall liking of a spicy meal and the liking of the burn of a spicy meal. These foods were fried chicken (mean liking ± SE: 32.73 ± 3.07, range: −89 to 99), hamburgers (mean liking ± SE: 33.16 ± 2.65, range: −78 to 100), and doughnuts (mean liking ± SE: 33.86 ± 2.97, range: −81 to 100). None of the personality traits showed significant correlations with the liking of these foods. Additionally, the relationships between personality traits and the rated liking for "your favorite food" (mean liking ± SE: 71.91 ± 16.39, range: 32 to 100) and "your least favorite food" (mean liking ± SE: −63.31 ± 27.49, range: −100 to 9) were assessed. No significant correlations existed between either of these measures and any of the personality traits.

Personality measures related to one another

Behavioral and self-reported personality measures were significantly correlated with one another. These relationships are summarized visually in Figure 1 and a correlation matrix is provided in Supplemental Table 1.

Distinct response styles were observed

Figure 1 shows the change in participants' liking of the jellies as the perceived intensity of the jellies increases. In this figure, participants were divided into two groups based on whether the slope of this line was positive or negative. For ease of discussion, we call those with a positive slope (meaning they liked the high concentration more than the low concentration) "capsaicin likers" and those with a negative slope (meaning they liked the low concentration more than the high concentration) "capsaicin dislikers". As would be expected, the mean slope values for the capsaicin likers and dislikers were significantly different from each other.

Mean scores for the personality measures, AISS, SP, SR, PID5-Impulsivity, PID5-Risk Taking, and the number of average adjusted pumps, from the mBART were compared between capsaicin likers and dislikers using Student's t-test for independent groups. No significant differences were seen in SP, SR, PID5-Impulsivity, PID5-Risk Taking, and average adjusted pumps. However, the capsaicin likers showed significantly higher scores on the overall AISS and higher scores on the AISS-Novelty Seeking subscale than capsaicin dislikers.

Discussion

Here, we replicate earlier findings (Byrnes & Hayes, 2013) in a new group of individuals, suggesting these effects are consistent across different groups. We also extend these findings, showing remembered and sampled liking for capsaicin-containing foods are related, and that both of these measures associate with reported yearly intake of spicy foods. Once again, there was no association of personality traits with the perceived burning/stinging sensation from a sampled capsaicin stimulus and we failed to observe any evidence of chronic desensitization in this cohort at the concentrations tested here. Sensation Seeking, as measured by AISS, related to all measures of liking of spicy foods, remembered and sampled, and to yearly intake of spicy foods. No other personality measures were related any measures of liking of spicy foods in this dataset. Notably however, the Sensitivity to Reward subscale from the SPSRQ and the Risk Taking subscale from the PID-5 questionnaire both correlated with reported yearly intake of spicy foods. This discrepancy between liking and intake is discussed in detail below. A secondary aim of this study was to explore whether individuals showed different response types, similar to those that are seen with other stimuli (e.g., Drewnowski et al., 1997). Here, we found that at least two types of responders exist and that significant differences exist between the groups. Participants who showed higher liking as the concentration of capsaicin increased (i.e., capsaicin likers) showed higher AISS scores than the individuals whose liking for the jellies decreased as capsaicin increased (capsaicin dislikers). Again, no other personality traits differed when participants were dichotomized into these two groups. In summary, the association of Sensation Seeking with

liking and intake suggests that for individuals high in Sensation Seeking, there may be an innate rewarding aspect of capsaicin as a stimulus. Conversely, for other personality constructs that associated only with spicy food intake, the enjoyable aspect of consuming capsaicin may potentially be related more to social aspects of consuming spicy foods (see discussion below).

As the perceived intensity of the burning/stinging sensation for the 12 μM capsaicin-spiked jelly provided better discriminatory ability between individuals compared to the 3 μM capsaicin-spiked jelly sample, our discussion here focuses primarily on the results from the 12 μM capsaicin-spiked jelly samples.

While desensitization is a well-established phenomenon (Cowart, 1987; Green, 1989; Karrer & Bartoshuk, 1991; Lawless et al., 1985; Prescott & Stevenson, 1995a), in our cohort, the perceived intensity of 12 μM capsaicin showed no relationship with reported yearly intake of spicy foods, suggesting any effect of desensitization on liking would be minimal. Rozin and colleagues showed that even though there are significant differences in detection thresholds to capsaicin between individuals who consume capsaicin frequently and those that consume capsaicin infrequently, there is a large amount of overlap between the groups and the effects on liking are slight (Rozin et al., 1981; Rozin & Schiller, 1980). Moreover, differences in detection thresholds do not necessarily imply differences in perceived intensity at suprathreshold concentrations.

Previously, we reported remembered liking of capsaicin-containing foods associates with reported intake of spicy foods (Byrnes & Hayes, 2013, 2015). Here, we replicate this, and also show that in addition to remembered liking of an overall spicy meal, remembered liking of the burn of spicy foods is related to reported intake of spicy foods. We extend these results by also showing that this relationship is not limited to remembered liking: the liking of a sampled stimulus (12 μM capsaicin in jelly) significantly correlated with yearly intake of spicy foods, though the strength of the relationship between intake and liking was slightly lower when using sampled liking ($r = 0.35$) compared to remembered liking ($r = 0.48$). Previous work on other foods suggests remembered (surveyed) liking is a good indicator of sampled liking (Hayes et al., 2010; Sharafi, Hayes, & Duffy, 2013). To our knowledge, this is the first time this type of relationship has been assessed for capsaicin-containing foods. Here, sampled liking shows correlations with remembered overall liking of a spicy meal, and with the remembered liking of the burn of a spicy meal ($r = 0.49$ and $r = 0.45$, respectively). Initially, these values may appear modest, however considering that “spicy” includes more than just capsaicin-containing foods as previously shown (Byrnes et al., 2015; Cliff & Heymann, 1992) and that these concentrations may be higher or lower than an individual’s preferred concentration of capsaicin resulting in lower liking of the sampled capsaicin stimuli compared to foods that are optimally seasoned by the individual, we propose that remembered liking is a reasonable proxy for sampled liking for capsaicin-containing foods.

Personality related to liking and intake of capsaicin-containing foods

A number of personality traits showed significant associations with measures of liking and intake of spicy foods. Importantly, none of the personality traits tested here showed significant associations with liking of non-spicy foods, “your favorite food”, and “your least

favorite food", indicating that the effects of personality observed here are not simply a generalized affective shift for all foods.

Sensitivity to Punishment, the Impulsivity subscale of the PID-5, and the number of average adjusted pumps from the mBART did not show a relationship to any measure of liking of spicy foods or to yearly intake of spicy foods. Previously, we hypothesized that the SP scale would be negatively correlated with the liking of spicy foods, as the more sensitive an individual is to punishment, the less they enjoy the burning/stinging of capsaicin (Byrnes & Hayes, 2013); however, when this hypothesis was actually tested, no relationship was observed (Byrnes & Hayes, 2013, 2015). Based on our prior finding, it was not expected here that SP would show a relationship to spicy food liking or intake, and it did not.

Regarding the PID5-Impulsivity subscale, there may be a number of reasons why no association was observed between impulsivity and spicy food liking. While impulsivity and sensation seeking are related traits (Eysenck & Eysenck, 1978b; Hur & Bouchard Jr, 1997; Zuckerman, 1964), and have been associated with common behaviors, such as alcohol and substance abuse, gambling, and drunk driving (Dawes, Tarter, & Kirisci, 1997; Jaffe & Archer, 1987; Stanford et al., 1996; Tarter et al., 2014), there is a critical distinction between impulsivity and sensation seeking. Specifically, impulsivity, unlike sensation seeking, has to do with the failure to inhibit behavior that will likely produce negative consequences (Baumeister & Heatherton, 1996; Schalling, 1978). Impulsivity and sensation seeking are multidimensional traits that have been conceptualized in a variety of ways (Evenden, 1999; A. D. Pickering & Gray, 1999). While AISS and impulsivity are related, it is possible that the dimensions of AISS that associate with liking spicy foods are not the dimensions that overlap with impulsivity. This may reflect the fact that the PID-5 was developed as a personality inventory to help identify clinically relevant populations, and compared to the risks associated with obtaining or using illicit substances, capsaicin-containing foods come with very little risk.

AISS was the only measure that was significantly related to any measure of spicy food liking: it was positively correlated with both measures of remembered liking, as well as sampled liking of capsaicin-containing stimuli. AISS was also associated with yearly intake of spicy foods. While the effect sizes here are slightly lower than our previous work (Byrnes & Hayes, 2013, 2015), confirmation in a new cohort suggests the effects are robust, at least in the Northeastern United States. Unlike our previous work, SR did not show a significant relationship with the measures of liking of spicy foods here. However, the present data did show a significant correlation between SR and yearly intake of spicy foods. Given our prior work showing the effects for SR are likely smaller than for Sensation Seeking (Byrnes & Hayes, 2013, 2015), and the fact that the effects noted here for Sensation Seeking are smaller than were seen previously, it is possible that the current cohort is not large enough to see any effect of SR. Alternatively, it is possible the discrepancy between Sensation Seeking and Sensitivity to Reward reflects different motivations for the consumption of spicy foods, a point that will be discussed in more detail below. Additionally, the Risk Taking subscale of the PID5 questionnaire (PID5-RT) did not show significant relationships with measures of liking of spicy foods, but did show significant correlations with yearly intake of spicy foods.

Prior literature has examined the relatedness of personality measures, showing a number of the scales used here are correlated to each other (e.g., (Bornovalova et al., 2009; Torrubia et al., 2001; Zuckerman & Cloninger, 1996). However, little work has been done with the PID-5, as it is a relatively new scale. Supplemental Table 1 shows the relationships observed in this study between each of the personality measures. While a number of these personality traits are correlated to one another, it is important to note they may still be measuring different constructs. The difference in trait sensation seeking as measured by AISS and risk taking as measured by the PID5-RT subscale may be the reason that PID5-RT associates only with intake of spicy foods, while AISS associates with liking and intake of spicy foods. Also, this may be why PID5-RT shows a relationship to spicy food intake, while another measure of risk taking, the mBART, does not show a relationship to any measure of spicy food liking or intake, in spite of their being correlated to each other. Previous literature using the BART links this measure of risk taking with behaviors such as alcohol consumption, smoking, risky sexual behaviors, theft, and use of illicit substances (Aklin et al., 2005; Lejuez, Aklin, Jones, et al., 2003; Lejuez, Aklin, Zvolensky, & Pedulla, 2003; Lejuez et al., 2002).

As alluded to above, the risk associated with procuring and consuming spicy foods is not comparable to the risk associated with behaviors such as procuring and using illicit substances, binge drinking, or speeding while driving a car. Similarly, in our dataset, the mBART is associated with AISS but not with PID5-Impulsivity. Thus, it seems possible that the dimensions of risk taking assessed by using mBART overlap with dimensions of AISS, distinct from PID5-Impulsivity and spicy food liking. We suggest the differences between the associations of these personality constructs with behaviors show domain specificity. In other words, the dimensions of impulsivity or sensation seeking that are tapped by one measure may associate with early- versus late-onset alcoholism (Dom, Hulstijn, & Sabbe, 2006), while another measure may tap dimensions related to disordered eating (Dawe & Loxton, 2004; Loxton & Dawe, 2001), while yet another may tap dimensions that associate with liking of spicy foods. Each of these behaviors may be associated with one another and with general sensation seeking, but the pattern of association between the personality traits and individual behaviors is different depending on the measure that is used and the behavior that is assessed. Impulsivity and sensation seeking are multifaceted traits and thus, these differences in the patterns of association provides information regarding the dimensions of impulsivity or sensation seeking that are key in predicting different behaviors.

Here, sensation seeking, sensitivity to reward, and the PID5-RT were each related to measures of spicy food liking and intake. However, based on the pattern of the relationships, it seems likely they act through different mechanisms (illustrated in Figure 2). Given the observed patterns of relationships between the variables of personality, spicy food liking, and spicy food intake, we propose a mechanism by which these risk-related personality traits act on liking and intake of spicy foods. Specifically, the effect of sensation seeking may act on intake of spicy foods through greater liking of spicy foods, while SR and PID5-RT effects may not be mediated via liking. That is, the effects of AISS may reflect more of an intrinsic motivation for the consumption of spicy foods. Perhaps the individuals who are higher in trait sensation seeking tend to have a higher neurobiological response to doses of capsaicin that results in increased liking or wanting of capsaicin-containing foods. Conversely, present

data suggest SR and PID5-RT do not associate with liking of spicy foods, and thus, likely do not exert an effect on intake of spicy foods via increased liking for burn. Instead, we suggest the differences in effects of Sensation Seeking and Sensitivity to Reward and PID5-RT may reflect motivation for consumption of spicy foods by external factors. Indeed, while the BAS is a measure of sensitivity to conditioned cues for reward and non-punishment, SR is a measure of reactivity to a specific subset of rewards including social praise (Cooper & Gomez, 2008; Dawe & Loxton, 2004; O'Connor et al., 2004).

Previously, it has been suggested the apparent liking that is noted in "chili likers" might be merely an effect of desensitization (Cowart, 1981; Karrer & Bartoshuk, 1991; Lawless et al., 1985; Stevenson & Prescott, 1994). That is, individuals who ate chili peppers were consuming enough capsaicin to induce desensitization, and thus, the perceived intensity of capsaicin burning was lower, making the sensation more pleasant, and thus, making capsaicin more liked. Previously, we saw no evidence of desensitization but showed strong associations between Sensation Seeking and liking of spicy foods. Here we show these same effects in a new cohort, suggesting high sensation seekers may be more likely to actually enjoy the pungency of spicy foods more than low sensation seekers. As seen in other, non-chemesthetic stimuli (Drewnowski et al., 1997; Lundgren et al., 1978; Pangborn, 1970), we also show that at least two distinct types of responses to capsaicin can be seen (Figure 1). Capsaicin likers liked the high capsaicin jelly more than the low capsaicin jelly, resulting in a positive slope. Conversely, capsaicin dislikers, those who liked the low capsaicin jelly more than the high capsaicin jelly, show negative slopes.

When comparing the groups, there were no significant differences between the liking or perceived intensity of the low capsaicin concentration. However, the capsaicin dislikers rated the burning/stinging sensation of the high capsaicin jelly significantly more intense than the capsaicin likers; likewise they also rating the liking for the high capsaicin jelly significantly lower. The lack of difference between the two groups with regard to the low capsaicin concentration again suggests that there is not chronic desensitization in the cohort that influences the liking of capsaicin. It is notable that at the low concentration of capsaicin there is no significant difference in liking between the two groups, with mean burning/stinging intensity ratings for both groups just above "weak" on the gLMS. Instead, it is at the high concentration of capsaicin that differences between the groups are observed. The fact that capsaicin dislikers show lower affective ratings for the stimuli that they perceive as more intense is not surprising. That said, we also find these groups also show differences in Sensation Seeking, consistent with the putative role of personality in the differential liking of spicy food.

As with many other stimuli, pleasure increases as intensity increases to a certain point, after which pleasure decreases as intensity continues to increase (Beebe-Center, 1935; Coombs & Avrunin, 1977; Moskowitz, 1981; Moskowitz, Kluter, Westerling, & Jacobs, 1974; Pfaffmann, 1980). This point, or range has been called the "bliss point" (Moskowitz, 1981), and represents the level(s) of intensity required to produce optimal liking. It is likely that everyone has this inverted-U-style response to a range of stimuli but the curve parameters (steepness of the rising phase, width of the plateau, steepness of the falling phase) depend on the stimuli being assessed, and potentially environmental influences. It is possible the

different response types that are seen for stimuli like sweeteners (Lundgren et al., 1978; Pangborn, 1970) are merely close-up snapshots of a limited portion of that person's underlying response function that is not fully indicative of his or her responses if a wider range of intensities of these same stimuli were given. With this in mind, it remains possible the discrepancy in liking ratings between capsaicin likers and dislikers occurs because we are simply sampling from different points along that individual's inverted-U function (see Supplemental Figure S1).

Past experiences with pain significantly influence the use of a gLMS (Bartoshuk, Duffy, Chapo, et al., 2004; Stevenson & Prescott, 1994). The difference in the perceived intensity of burning/stinging between the capsaicin likers and dislikers for the high capsaicin concentration may be due to differences in previous experience. Capsaicin likers showed significantly higher AISS scores than capsaicin dislikers, and the same difference was seen for the Novelty Seeking subscale of the AISS. It seems possible that capsaicin likers, being more sensation seeking than capsaicin dislikers, have experienced a wider range of burn intensities (and overall sensation intensities) prior to taking part in the study, thus making the high capsaicin concentration seem less intense in comparison. Future work using concentrations that are intensity-matched rather than concentration-matched may better tease apart relationships between perceived intensity, liking, and sensation seeking.

Conclusions

Here, we examined the relationship between risk-related personality traits and the liking and intake of spicy foods in a new cohort of participants, suggesting our previously reported results are consistent across multiple groups of individuals. Additionally, we extend these findings, using a variety of self-report personality measures, as well as a behavioral measure of risk taking, to explore the effect of personality on liking of remembered and sampled spicy foods. We utilized modern, validated measures of personality and selected a variety of personality measures that tap a range of dimensions associated with risk-related behaviors.

While all the personality measures correlated with one another, only AISS, SR, and PID5-RT showed significant associations with intake of spicy foods, and only AISS showed significant relationships with measures of liking of spicy foods. Based on the different relationships between these three measures (AISS, SR, and PID5-RT), and the liking and intake of spicy foods, we propose a hypothetical model of how these personality measures may influence the intake of spicy foods. Although all three measures were all related to spicy food intake, we propose they may act through different mechanisms. As AISS is a measure of the propensity of an individual to seek out and enjoy varied, novel, and complex experiences, and it consistently associates with liking and intake of spicy foods, we suggest sensation seeking directly influences the liking of capsaicin-containing foods, which then drives intake of these foods. Conversely, we also speculate that the effect of the other two intake related measures (SR and PID5-RT) may instead reflect external (i.e., social) motivation for consuming spicy foods.

We also show there are at least two distinct response types to the concentrations of capsaicin used, empirically showing that some individuals enjoy the pungent sensation elicited by

capsaicin. While this evidence supports the hypothesis that certain individuals enjoy the burning sensation produced by capsaicin, there maybe be subtleties of the relationship that are not captured by only using two points to classify the participant's underlying response function. Given research with other stimuli, it seems very unlikely that the hedonic response function to capsaicin is not an inverted-U. However, testing with more than two stimuli is needed to better resolve these patterns, as this is a clear limitation of the present work. Additionally, it is possible that differences in liking between the capsaicin likers and dislikers are influenced, in part, by the differences in perceived intensity of the stimuli, and these differences may arise from variation in the individual's prior experiences with painful or intense stimuli. Studies utilizing an a range intensity-matched concentrations across individuals to explore different responder types are warranted.

Overall, present findings suggest the relationships between liking and intake of spicy foods are robust across studies. While further research is needed to elucidate specific mechanisms, we propose that risk-related personality traits may show differential effects on the liking and intake of spicy foods, and that they may act through different mechanisms. These findings highlight the dual motivation system that may exist for the consumption of spicy foods.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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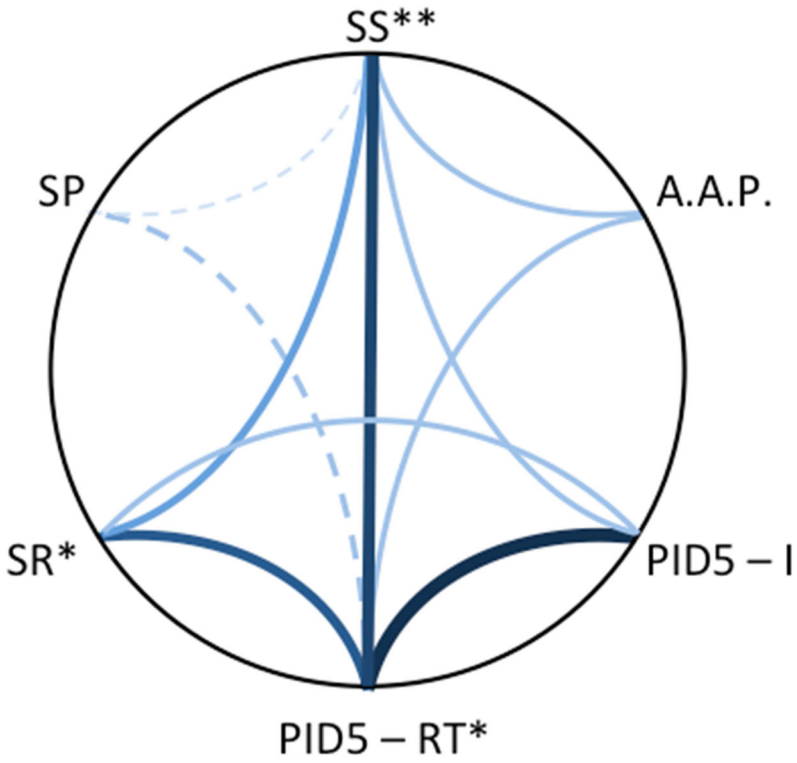

Figure 1.

Visual summary of relationships between personality variables used in this study. Solid lines are positive correlations and dashed lines indicate negative correlation; the line thickness and darkness indicate the strength of the correlation. From the top clockwise, the abbreviations are Sensation Seeking (SS) from Arnett's Inventory (SS), Average Adjusted Pumps (A.A.P) from the mBART, Impulsivity (PID5–I) from the DSM5 Personality Inventory, Risk Taking (PID5–RT) from the DSM5 Personality Inventory, Sensitivity to Reward (SR) from Torrubia et al.'s SPSRQ, and Sensitivity to Punishment (SP) from Torrubia et al.'s SPSRQ. A * indicates association of that personality measure with yearly intake of spicy foods and ** indicates association of personality measure with liking of spicy foods and yearly intake of spicy food. A detailed correlation matrix is also provided in Supplemental Table 1.

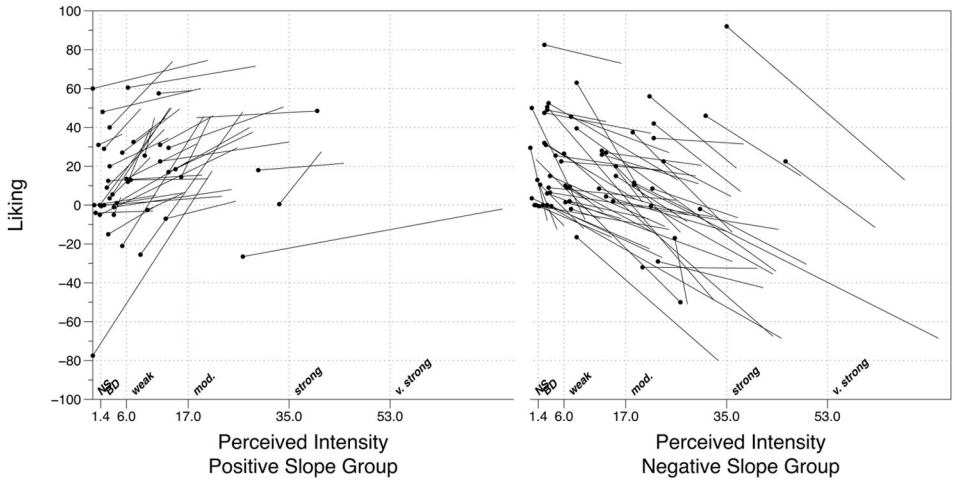

Figure 2.

Liking of the burning/stinging sensation in 3 μM and 12 μM capsaicin-spiked jellies versus perceived intensity of the burning/stinging sensation in 3 μM and 12 μM capsaicin-spiked jellies. On the left are capsaicin dislikers (n=60) while on the left are capsaicin likers (n=42). Points on the plot indicate the location of the 3 μM capsaicin-spiked jelly sample on the plot. Along the x-axis, the labels, and corresponding values from the gLMS are plotted.

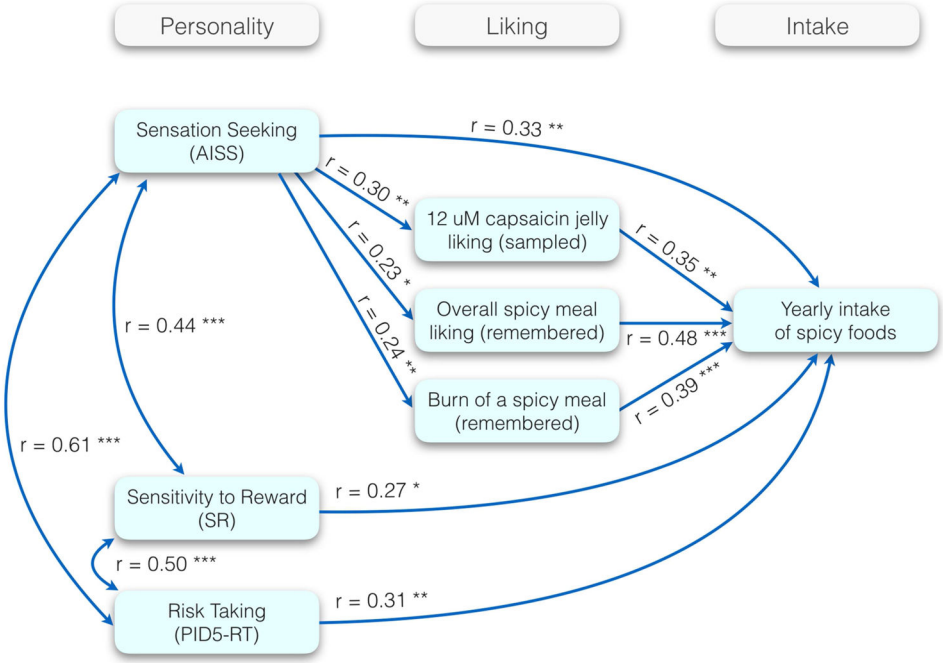

Figure 3.

Proposed model for the effects of various personality traits on liking and intake of spicy foods. All values shown are correlations. On the far left, the correlations between the personality measures are shown. The triple line arrows indicate that these relationships have been previously shown. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.0001$.

Table 1

Recipe for strawberry jelly used in this experiment.

<table>
<tr><th>Ingredient</th><th>Amount</th><th colspan="2">Directions</th></tr>
<tr><td>Sucrose</td><td>642.50 g</td><td rowspan="3">Combine flavoring, sucrose, food coloring, and 283.90 g water</td><td rowspan="6">Combine the pectin mix and the sucrose mix, stirring constantly for three minutes to dissolve the sucrose. Cool, dispense into individual lots, and spike with the appropriate amount of capsaicin or allyl isothiocyanate stock solution for desired concentration.</td></tr>
<tr><td>Imitation strawberry extract (McCormick, Hunt Valley, Maryland, U.S.A.)</td><td>4.32 g</td></tr>
<tr><td>Red food color (McCormick, Hunt Valley, Maryland, U.S.A.)</td><td>1.47 g</td></tr>
<tr><td>Reverse osmosis (RO) water</td><td>283.90 g + 141.96 g (separate)</td><td rowspan="2">Whisk together pectin and 141.96 g water in a pot over medium heat. Bring to a boil and stir constantly for one minute. Remove from heat.</td></tr>
<tr><td>Pectin (100% natural Sure-Jell, Premium Fruit Pectin, Kraft Foods, Deerfield, Illinois, U.S.A.)</td><td>39.68 g</td></tr>
<tr><td>Capsaicin stock solution</td><td colspan="2">Amount dependent on jelly volume and desired concentration.</td></tr>
<tr><td>Allyl isothiocyanate stock solution.</td><td colspan="2">Amount dependent on jelly volume and desired concentration.</td></tr>
</table>

Table 2

Descriptive statistics on perceived intensity, liking, intake and personality measures across all participants.

Variable	Min	Q1	Mean ± SE	Q3	Max
Perceived intensity (3 uM capsaicin)	1.75	8.25	7.00 ± 0.81	11.50	33.50
Perceived intensity (12 uM capsaicin)	1.50	12.75	22.79 ± 1.32	29.00	72.00
Liking (3 uM capsaicin)	−77.50	−1.00	13.58 ± 2.52	29.50	90.50
Liking (12 uM capsaicin)	−130.50	−33.50	−11.57 ± 4.04	13.00	99.50
Liking of an overall spicy meal	−81	13	30.80 ± 3.16	52	98
Liking of the burn of a spicy meal	−78	6	22.9 ± 2.97	44	83
Yearly intake of spicy foods (times per year)	0	12	73.05 ± 9.87	59	365
AISS (possible range 20–80)	31	47	52.7 ± 0.8	58	70
SP subscale of SPSRQ (possible range 0–24)	0	7	11.4 ± 0.5	16	23
SR subscale of SPSRQ (possible range 0–24)	2	8	11.7 ± 0.4	14	21
PID-5 – Impulsivity (possible range 0–24)	5	6	9.5 ± 0.4	12	30
PID-5 – Risk Taking (possible range 0–56)	11	20	26.78 ± 0.83	33	45
Average adjusted pumps (mBART)	1.03	19.3	30.7 ± 1.4	40.3	67.46