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Running head: Food texture and prosociality

**Tender food, tender hearts: The metaphorical mapping of hard-soft orosensory signals to interpersonal trust and prosocial tendencies**

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## Abstract

Prior research has revealed that flavors (sweetness) may metaphorically influence social judgements and behaviors (interpersonal ‘sweetness’). Given the inherently social nature of eating, other food related sensory signals beyond flavor may be conceptually mapped to social cognition and behavior. Here we tested the hypothesis that oral processing of foods with soft (vs. hard) textures may metaphorically facilitate (vs. inhibit) social behaviors conceptually associated with ‘tenderness’ or ‘soft-heartedness’. Two studies examined the influence of imagined (Study 1) and actual (Study 2) oral processing of soft (vs. hard foods) on prosocial tendencies. Study 1 revealed that greater magnitude of sensory characteristics associated with imagined consumption of a hard food (i.e., dryness) was predictive of decreased interpersonal trust. Using actual food consumption in an interpersonal context, Study 2 demonstrated increased interpersonal trust and charitable donation of time after oral processing of soft (vs. hard) food and suggested that this effect is a result of enhanced trust following consumption of soft food rather than suppression of trust following consumption of hard food. Although effects were modest, these findings provide initial suggestions that orosensory metaphors that shape social cognition are not limited to flavors (e.g., sweetness, spiciness), and that diverse properties of food may influence patterns of sociality.

**Keywords:** food texture, orosensory processing, metaphorical cognition, embodied cognition, prosociality, trust

## **1 Introduction**

Eating is a fundamental social activity among humans. In addition to providing nutrients and energy to function in our everyday life, eating also plays a significant role in other aspects of human life such as demarcating cultural boundaries and serving as a source of identity (Fu, Morris, & Hong, 2015; Hackel, Coppin, Wohl, & Van Bavel, 2018; Rozin, 1996). As a socially-embedded activity, numerous studies have demonstrated the powerful role that social factors and socialization exerts on food preferences and eating behaviors (Cruwys, Bevelander, & Hermans, 2015; De Castro, 1994). Yet, despite prior research suggesting that food choices (Fawcett & Markson, 2010) and food sharing (Woolley & Fishbach, 2016) can also influence social relations, there has been limited investigations into how *what* is eaten with others influences subsequent patterns of sociality. The objective of the present study is to examine how the texture and associated mouthfeel of foods consumed (soft or hard) may facilitate prosocial tendencies.

### **1.1 Conceptual Metaphor in Social Judgment and Behavior**

Metaphorical expressions are embedded in our everyday language. Metaphors define one aspect of subjective experience (e.g., emotions, intuitions) based on aspects of other concrete experiences (e.g., physical and bodily sensations) (Lakoff & Johnson, 1980). As such, conceptual metaphors may function as cognitive tools that allow users to efficiently represent and experience abstract social phenomena as more concrete experiences encountered in non-social domains (e.g., bodily sensations). Incidental sensorimotor and tactile experiences (e.g., texture, temperature) can serve as inputs that may unconsciously be assimilated or associated with information processing in non-relevant domains through metaphoric transfer, producing metaphor-consistent shifts in judgments and behaviors (Landau, Meier, & Keefer, 2010; Lee & Schwarz, 2012). Consistent with this notion,

conceptual metaphors based upon bodily experiences (e.g. “cold person”) may be laden with associative cues and are more commonly used than their literal semantic equivalents (e.g. “unfriendly person”) given that they may be remembered and retrieved more easily (Akpınar & Berger, 2015).

One domain that metaphoric expressions are prevalently used is in judgments and behaviors within social and interpersonal contexts. Impressions or traits inferred from others may be ambiguously defined and difficult to articulate (Uleman, 2005); thus are well-suited for representations through conceptual metaphors of much more concrete tactile, sensory, and bodily experiences in non-social domains (Landau et al., 2010). For instance, the sensory experience of physical temperature can serve as a basis for judgments in person perception. When holding a warm object, people may subconsciously assimilate concrete tactile sensations of physical warmth to more abstract experiences of interpersonal warmth, leading to perceptions of others as having a warmer personality (Williams & Bargh, 2008; but these results were not replicated in Lynott, et al., 2014) and greater feelings of closeness to others (IJzerman & Semin, 2009).

Texture can also serve as a source of metaphoric transfer during interpersonal judgments. The tactile sensation of roughness was associated with greater likelihood of interpreting ambiguous social interactions as being tougher and harder (Schaefer, Denke, Heinze, & Rotte, 2013), such that the physical roughness experienced by touching a rough surface was transferred metaphorically to individuals construing uncertain social exchanges as one with more interpersonal difficulties. However, sensory inputs of physical roughness may also enhance empathy and prosociality through increasing one’s attention to others in need (Wang, Zhu, & Handy, 2016).

Likewise, numerous metaphorical expressions to describe personality traits across cultures are based on descriptions of haptic or tactile sensations associated with handling hard

or soft objects. In English, metaphorical expressions such as “soft-hearted,” “hard-hearted,” “soft spot” (for others), “softie,” “hardy,” “hard-headed” and “soft-spoken,” use soft/hard-related concepts of texture to describe personality (Schechter & Broughton, 1991). Such expressions are not only limited to English, with languages such as Chinese also involving similar metaphors of hardness/softness to represent abstract dispositions: 心软 (soft-hearted) and 铁石心肠 (hard-hearted).

In the domain of metaphors of hardness/softness, the haptic sensation of touching hard/soft items may also affect social perceptions and judgments. Specifically, participants who touched a hard item judged an employee as being more inflexible and stringent than did those who touched a soft item, but this did not lead to more positive overall impressions (Ackerman, Nocera, & Bargh, 2010). The haptic sensation along the hard-soft dimension may also be conceptually associated with the subjective experience of uncertainty. Participants who were primed to feel uncertain favored items with soft characteristics which coincided with their need for a “soft reassurance” in times of uncertainty. Correspondingly, participants who held onto items with soft characteristics felt more assured on an ambiguous task and were more tolerant toward uncertainties faced in life (Van Horen & Mussweiler, 2014).

## **1.2 Food as a Basis for Conceptual Metaphors**

While tactile sensations may be one critical means of navigating and interacting with the physical environment, rich sensory experiences are also encountered during eating. Eating food not only provides sensory experiences of flavor and texture, but also signals of whether the food may contain contaminants or toxins. Similarly, these signals and experiences are also mapped onto conceptual metaphors that may frame social judgment and behavior.

Sensory cues that may signal contamination and elicit prompt rejection of food may also serve as a conceptual basis for psychological rejection of other offensive non-ingestible

stimuli, such as moral violations (Rozin, Haidt, & Fincher, 2009; Tybur, Lieberman, Kurzban, & DeScioli, 2013). Aversive tastes or foul odors, which may signal contamination, may facilitate suspicion or rejection in non-food related social judgments. For instance, exposure to 'fishy' smells (potentially signaling decaying organic matter) was associated with greater suspiciousness and lowered willingness to engage in social risks (Lee & Schwarz, 2012). This metaphoric link between fishy smells and heightened suspicion within a situation may have emerged from an adaptive tendency to more cautiously scrutinize the edibility of foods that emit chemosignals of contamination. Additionally, individuals who consumed bitter drinks endorsed harsher and more punitive judgments on moral topics such as consensual incest between second cousins and a student stealing library books (Eskine, Kacinik, & Prinz, 2011).

Other taste-related experiences that do not trigger disgust may also influence person perception and social judgments. Individuals instinctively judged people who like spicy food to have a hot-tempered personality (Ji, Ding, Deng, Ma, & Jiang, 2013). Similarly, participants judged people who liked sweet foods to be more agreeable (Meier, Moeller, Riemer-Peltz, & Robinson, 2012). Moreover, metaphors associated with gustatory experiences are not only projected onto perceptions and expectations of others' traits, but can also influence self-perception and behaviors. Consuming a sweet food has been associated with increases in individuals' self-reports of their own level of agreeableness and intentions to donate time to help others (Meier et al., 2012). Importantly, the metaphorical concepts activated by these food-based and gustatory experiences may be constrained by culture and language. For instance, in a culture where 'sweetness' is associated with inauthenticity, consuming sweet foods during impression formation may subsequently activate metaphors of inauthenticity rather than kindness and promote perceptions of insincerity of others (Gilead, Gal, Polak, & Cholow, 2015).

While incidental haptic experiences from manual touch and flavors of food may produce conceptual transfer in social perception and judgment, it remains unknown whether haptic experiences from oral processing of food (e.g., hardness-softness) will also produce conceptual transfer into the social domain. Prior research in ingestive behavior has indeed demonstrated that mouthfeel from hardness/softness of foods may influence judgments in the domain of food and eating behavior. For instance, soft and smooth (compared to hard and rough) foods may signal expectations of higher calorie density (Biswas, Szocs, Krishna, & Lehmann, 2014). Furthermore, consumption of hard foods (compared to soft versions of similar foods) is associated with slower eating rates and lower total caloric intake (Bolhuis, Forde, Cheng, Xu, Martin, & de Graaf, 2014). Prior studies have suggested that hard/soft sensory inputs from touch may metaphorically influence judgments of rigid and stable personality traits (Ackerman et al., 2010). Yet, these hard/soft sensory inputs linked to food and eating may also be especially readily mapped to prosocial tendencies, given the everyday representation and expressions of abstract social concepts of concern, sensitivity and empathy for others through metaphors of softness (vs. hardness) (e.g., 'soft-hearted,' 'tender,' being 'soft' on others).

## **2 Overview of Research**

In this paper, we presented two studies conducted as initial exploratory tests of whether the act of orally processing and ingesting (chewing, biting, swallowing) hard or soft foods may influence interpersonal judgment and prosocial behavior. Study 1 was a preliminary study to examine whether the manipulation of perceived softness (vs. hardness) of food may metaphorically transfer to prosocial tendencies. Study 2 assessed the effects of actual hard/soft food consumption with a partner on interpersonal judgments and trust.



## **2.1 Study 1**

In Study 1, the texture of an imagined food (hard vs. soft) was manipulated to examine whether these perceived properties may metaphorically transfer to prosocial tendencies. Prior research has suggested that the imagined consumption of food also activates mental and sensory processes associated with actual consumption (Cornil & Chandon, 2016; Krishna & Schwarz, 2014; Morewedge, Huh, & Vosgerau, 2010). We hypothesize that imagined orosensory experience of soft (vs. hard) foods will activate metaphorical concepts (i.e. soft-hearted, tenderness) that subsequently manifest as prosocial intentions and behaviors, such as greater levels of trust for a stranger on the Trust Game (Berg, Dickhaut, & McCabe, 1995).

### **2.1.1 Participants**

One hundred and twenty participants (58 female,  $M_{\text{age}} = 36.53$ ,  $SD_{\text{age}} = 10.95$ ) were recruited from the United States of America on Amazon's Mechanical Turk online marketplace. Participants were compensated USD\$0.50 for completing the study in addition to bonus payment contingent on their decisions on the Trust Game.

### **2.1.2 Procedure and Materials**

Participants who accepted the study on Amazon's Mechanical Turk were provided the survey link of the study. They were first required to read and provide their consent on the online informed consent before starting the study's survey.

#### **2.1.2.1 Baseline Hunger Assessment**

First, participants rated their current level of hunger, level of fullness, and their desire to eat using 100-point visual analogue scales (VAS). A composite index of baseline hunger ( $\alpha = .85$ ) was computed by averaging the three ratings with fullness reverse-scored. There was

no significant difference between the baseline hunger of both condition,  $t(118) = .06, p = .95, d = .48$ .

### **2.1.2.2 Imagined Food Consumption**

Next, participants were randomly assigned to one of the two conditions, soft and hard food. Participants in the soft (vs. hard) food condition were presented with an image of untoasted soft white bread (hard toasted baguette) and asked to imagine eating the food item. Instructions were adapted from Cornil and Chandon (2016), wherein participants were asked to take all the time needed to produce a "mental image" as detailed as possible of the experience of biting, feeling in the mouth, and chewing the imagined food. Participants then provided open-ended descriptions of the sensory experience of taking a bite of, feeling (in mouth), and chewing the food to further reinforce the mental simulation. Next, participants rated a series of sensory properties associated with the imagined food. Harder and soft foods have been identified to also differ in dryness and chewiness (Bolhuis, Forde, Cheng, Xu, Martin, & de Graaf, 2014). Furthermore, given that sweetness of foods has also been found to influence prosocial behaviors (Meier, et al, 2012), sweetness was assessed to confirm that any influence of hard/soft food texture on trust observed in the present study would not be due to incidental differences in perceived sweetness of the test foods. Therefore, participants also rated perceived sensory characteristics (softness, chewiness, dryness, and sweetness) and the vividness of their imaged sensory quality of the food (bite, feel, and chew) on 100-point VAS.

### **2.1.2.3 Trust Game**

Participants were then provided with instructions for the Trust Game (Berg et al., 1995). Participants were informed that their responses would be matched, at the end of the study completion, to another participant who completes the experiment to form a dyad. In the first round, participants made decisions about how much of a 10-point endowment they

would send to the other player (remaining points would be kept by the participant). The amount contributed to the other player was tripled when the other player received it. Participants were informed that the other player would also decide how much of his/her 10-point endowment to send to the participant in the first round. The points sent by participants were used to represent the degree of trust for the other player.

In the second round, participants decided how much of the tripled points received from the other player in round 1 to send back to the other player. Participants were informed that the other player would also make the same decision for the participant's endowment sent in round 1. Participants were shown an array of all possible amounts of points that could be received from the other player during round 1, and asked to indicate how much he/she would return to the other player based on each possible amount that could have been received in round 1. Points returned in round 2 for all possible amounts that could have been received in round 1 were averaged to form a composite score. Participants were also informed that every point received at the end of the Trust Game will be translated to one cent of real-world bonus payment at the conclusion of the entire study (which was eventually paid through MTurk's worker bonus system).

#### **2.1.2.4 Food Preference.**

Finally, the participants rated their preference (liking) for the imagined food on a 5-point Likert scale (1 = not at all like, 5 = very much like). There was no significant difference between the condition ( $M_{\text{hard}} = 3.16$ ,  $SD_{\text{hard}} = 1.49$ ;  $M_{\text{soft}} = 3.05$ ,  $SD_{\text{soft}} = 1.39$ ),  $t(118) = -.42$ ,  $p = .68$ ,  $d = .08$ .

### **2.1.3 Results**

#### **2.1.3.1 Manipulation Check**

Independent sample *t*-tests showed significant differences in participants' ratings of hardness, dryness, and chewiness of food between the hard and soft food conditions.

Participants in the hard food condition ( $M_{\text{hardness}} = 76.75$ ,  $SD_{\text{hardness}} = 20.72$ ;  $M_{\text{dryness}} = 66.07$ ,  $SD_{\text{dryness}} = 28.61$ ) rated the food as being significantly harder,  $t(118) = 15.77$ ,  $p < .001$ ,  $d = 2.89$ , and drier,  $t(118) = 4.50$ ,  $p < .001$ ,  $d = .82$ , than did participants in the soft food condition ( $M_{\text{hardness}} = 14.02$ ,  $SD_{\text{hardness}} = 22.66$ ;  $M_{\text{dryness}} = 41.63$ ,  $SD_{\text{dryness}} = 30.67$ ). On the other hand, no differences were observed in ratings of chewiness between the hard food condition ( $M = 56.35$ ,  $SD = 27.96$ ) and the soft food condition ( $M = 60.83$ ,  $SD = 30.42$ ),  $t(118) = .84$ ,  $p = .41$ ,  $d = .15$ .

No significant differences were observed on ratings of sweetness of food between the hard ( $M = 32.46$ ,  $SD = 27.37$ ) and soft ( $M = 34.33$ ,  $SD = 27.30$ ) food conditions,  $t(118) = .38$ ,  $p = .71$ ,  $d = .07$ . This suggests that any differences observed in trust across the hard and soft food conditions (Meier, Moeller, Riemer-Peltz, & Robinson, 2012) may not be attributable to incidental variations in sweetness of the foods between the two conditions. Perceived softness of the food item was negatively correlated to the dryness,  $r(118) = .51$ ,  $p < .01$ , but not correlated to chewiness of the food item,  $r(118) = .07$ ,  $p = .43$ .

### **2.1.3.2 Trust**

An independent sample *t*-test was conducted to test the effect of the hard/soft food manipulation on trust. The results revealed no significant differences in trust for interaction partners in the first round of the Trust Game,  $t(118) = .18$ ,  $p = .86$ ,  $d = .02$ , between participants in the soft food condition ( $M = 5.54$ ,  $SD = 3.77$ ) and hard food condition ( $M = 5.46$ ,  $SD = 3.81$ ).

An analysis of covariance (ANCOVA) controlling for the effect of participant gender, composite hunger, and average preference for the food presented was conducted to analyze the effect of manipulation on trust. Physiological and psychological differences between

genders on eating behaviors had been widely documented (Herman & Polivy, 2010), as well as gender differences in interpersonal and prosocial behaviors (Andreoni & Vesterlund, 2001; Becker & Eagly, 2004). Composite hunger and general liking for food have been found to contribute to affective or reward-related responses (Rogers & Hardman, 2015), and imagined consumption of a rewarding food may influence or be assimilated to subsequent decisions or judgments of the interaction partner or the Trust Game. Thus, these variables were included as covariates to control for to isolate the effects of the food texture manipulation on trust behavior. The results revealed no significant differences on participants' trust of their interaction partners in the first round of the Trust Game,  $F(1, 112) = .05, p = .83, n^2_p < .001$ , between the soft food condition ( $M = 5.57, SD = 3.77$ ) and hard food condition ( $M = 5.43, SD = 3.81$ ),  $d = .04$ .

Since the participants did not actually consume the foods, their orosensory experience of hardness/softness may have been largely dependent on their subjective imagery of sensory qualities associated with hard/soft texture. We conducted follow-up exploratory analyses to test how each of the imagined sensory properties that were rated to differ between the hard/soft conditions (e.g., hardness and dryness) may have mediated the effect of the hard/soft food manipulation on participants' subsequent trust. Using the Process SPSS Macro (model #4 with 5000 bootstrap samples) (Hayes, 2017), a significant indirect effect of perceived dryness was observed,  $b = -.63, [95\% \text{ CI}: -1.48, -.10]$ , such that imaging a hard food (vs. soft food) was associated with greater perceived dryness of the food ( $b = 24.44, p < .01$ ), which predicted decreased trust in the first round of the Trust Game ( $b = -.03, p = .03$ ). The total effect of imagining a hard food (vs. soft food) on trust was:  $b = -.12, p = .86$ , while the direct effect of adjusting for the mediator (perceived dryness) was:  $b = .51, p = .49$ . However, there was no indirect effect of perceived chewiness,  $b = .02, [95\% \text{ CI}: -.09, .31]$ , on the relationship between the hard/soft manipulation and participants' trust.

Using the same set of analyses, no significant result was found with the points returned in the second round of the Trust Games,  $p > .05$ .

#### **2.1.4 Discussion**

Study 1 provides initial support that orosensory signals from food texture (hardness/softness) may be metaphorically mapped to influence interpersonal behaviors (trust). Although no total effect of imagining a hard or soft food was observed on trust, an indirect effect of perceived sensory properties associated with harder foods (i.e., dryness) was observed on the relationship between imagined consumption of a food with hard (vs. soft) orosensory properties on trust.

Among the various sensory qualities associated with hard and soft foods, perceived dryness was the only characteristic that was observed to mediate the relationship between the imagined food manipulation and trust. Although the imagined hard (toasted bread) and soft (untoasted bread) foods significantly differed in perceived hardness, in the absence of any specific instructions to focus on softness-hardness of the foods, dryness may have been the most salient sensory characteristic that distinguished these two specific foods. Indeed, moisture content is one of the most discrete properties of solid food (Chen & Rosenthal, 2015), and imagined dryness of the food was also positively correlated with imagined hardness of the food in our present study.

A major limitation of the present study was the reliance on imagined sensory properties of food rather than actual consumption. This may have introduced wide levels of individual variation in the salience of hard/soft properties of the food, compared to a more controlled manipulation that involves actual food consumption. Another notable limitation of the present study was its format and design as an online survey, in which participants were

not able to actually see the other participant they were playing the Trust Game with. Consequently, this may have made the Trust Game unduly abstract and lack social salience. To address these limitations, we conducted a second study in which participants consumed standardized foods that varied systematically on the dimension of hardness/softness while directly interacting with another participant.

## 2.2 Study 2

Study 2 was conducted in a lab setting to assess the effects of actual hard/soft food consumption with a partner on interpersonal judgments and trust. The texture and orosensory properties of food (hard vs. soft) were manipulated to examine whether these concretely experienced properties may metaphorically transfer to interpersonal judgments. In addition to examining the effect of food texture on trust, a measure of prosocial tendencies in the form of willingness to donate personal resources (e.g., time) to charitable causes was included in Study 2. We hypothesize that oral manipulation of soft (vs. hard) foods will activate soft-related metaphorical concepts (i.e. *soft-hearted*, *tenderness*) that may subsequently promote trusting and prosocial intentions and behaviors. Furthermore, these ‘soft’ or ‘tender’ (vs. ‘hard’ or ‘tough’) metaphorical concepts may be projected onto others, producing more positive impressions of others present when soft (vs. hard) foods are being consumed. Alternately, prior studies involving touching soft/hard objects found no overall effect on positive interpersonal impressions (Ackerman et al., 2010), so it is possible that orosensory experience of softness/hardness may yield no robust effects in the domain of impression formation. In this case, activation of metaphoric concepts related to softness/hardness may instead be activated as goals or applied to self-perceptions, such that an individual’s behavior becomes consistent with these activated concepts (see Meier et al., 2012 for similar processes associated with the concept of ‘sweetness’). Thus, we hypothesize that consuming soft (vs.

hard) foods will subsequently produce greater prosocial tendencies, but present no formal prediction on whether soft (vs. hard) foods will influence overall positive interpersonal impressions.

To test our hypothesis, a between-subjects design in which texture of food was manipulated by providing hard/soft food for participants to eat in dyads while engaging in an interpersonal interaction. Following this orosensory manipulation, participants' impressions of their interaction partner, willingness to trust their partner (Trust Game; (Berg et al., 1995)), and generalized prosocial behaviors (willingness to donate time) were measured.

### **2.2.1 Participants**

Participants were 80 undergraduate students (42 female,  $M_{\text{age}} = 21.40$ ,  $SD_{\text{age}} = 2.37$ ) recruited in Singapore (self-reported ethnicities: 75 Chinese, 1 Indian, 2 Vietnamese, 1 Khmer, and 1 unspecified), who participated to fulfill partial requirement for course credit ( $N = 44$ ) or for cash reimbursement of \$5 Singapore Dollars ( $N = 36$ ). This represents the full sample (no participant was excluded from analysis) and all conditions in the experiment. There were no differences observed on any outcome variables (e.g., impressions of interaction partner, behavior on trust game, hours donated for volunteering) based on whether participation was based on course credit or payment ( $p > .10$ ). Participants completed the experiment in dyads, with 20 dyads ( $N = 40$ ) assigned to each of the hard and soft food conditions. All materials and instructions for the experiment were presented in English.

### **2.2.2 Test Foods**

Selected test foods for the hard food condition were mini toasted bread (Albatros®), tortilla chips (Mission®; original flavor) and hard fruit candies (Fox's®; assorted flavors). Selected test foods for the soft food condition were untoasted white bread (Sunshine®;



enriched soft white bread), tortilla wraps (Mission®; original flavor) and gummy bears (Yupi®; assorted fruity flavors) (Fig. A). These test foods were selected to maintain similar and matched perceptual and sensory properties (colors, sizes, shapes, flavors) across the two conditions except on the critical dimension of softness-hardness.

Each participant in the hard food condition was served 6 pieces of mini toasted bread (14.8 grams), 8 pieces of tortilla chips (15.3 grams) and 4 fruity candies (18.4 grams). Each participant in the soft food condition was served 6 pieces of white bread (16.9 grams) cut to match the size of the toasted bread in the hard food condition, 8 pieces of soft tortilla wrap (15.8 grams) cut to match the size of the tortilla chips in the hard food condition, and a packet of gummy bears (13.2 grams). All test foods were served on a single white plastic plate to each participant in a dyad. The quantity of food consumed was calculated by subtracting the weight of each food remaining after the interaction from the original weight of the initial foods.

### **2.2.3 Procedure and Materials**

Two participants arrived at the laboratory for each session of the experiment. After providing informed consent, participants individually completed a series of hunger-related questions in separate cubicles.

#### **2.2.3.1 Baseline Hunger Assessment**

First, participants completed the baseline hunger assessment used in Study 1. A composite index of baseline hunger ( $\alpha = .94$ ) was computed by averaging the three ratings with fullness reverse-scored. There was no significant difference in baseline hunger between conditions,  $t(78) = 1.21, p = .23, d = .27$ .

#### **2.2.3.2 Interpersonal Interaction and Food Consumption**

Next, participants were invited to move and sit opposite each other at a table where they were served the hard or soft test foods (depending on their assigned condition) to consume freely while interacting with each other for 10 minutes. Participants were encouraged to finish eating the food provided during the interaction. Participants in the hard food condition were specifically told to chew and not suck on the fruit candies to ensure tactile sensation of their hardness. To provide participants a basis for interpersonal engagement and interaction during food consumption, participants were provided a set of 12 questions to take turns asking each other (Costa & McCrae, 1992) while eating (e.g., “Given the choice of anyone in the world, whom would you want as a dinner guest?”). The interaction was capped at 10 minutes. Participants who finished interacting before 10 minutes proceeded to the next section of the experiment. The experimenter provided prompts for participant to continue their discussion when the interaction was stalled by personally answering one of the questions listed.

After the interaction, participants returned to their individual computer cubicles to answer questions about the sensory characteristics (used in Study 1) of test foods they consumed.

### **2.2.3.3 Impressions of Interaction Partner**

Next, participants answered questions regarding their impression of their interaction partner. Participants were provided a list of positive and negative traits associated with personality characteristics of Extraversion (*friendly, sociable, unassertive, optimistic, passive, gloomy, warm*) and Agreeableness (*hard-hearted, unhelpful, humble, forgiving, selfish, accommodating, untrustworthy*) from the Revised NEO-Personality Inventory (NEOPI-R; (Costa & McCrae, 1992)). Participants rated how well these traits described their interaction partners on a Likert scale of agreement (*1=strongly disagree, 5=strongly agree*).

Following this, participants completed a measure assessing feelings of closeness to their interaction partners. First, participants completed seven items adapted from the Revised Social Connectedness Scale (Lee, Draper, & Lee, 2001) on a 6-point Likert scale ( $1 = \textit{strongly disagree}$ ,  $6 = \textit{strongly agree}$ ). A sample item includes, “At the present moment, I feel close to my interaction partner.” These items were averaged to form a composite score of closeness ( $\alpha = .93$ ).

#### **2.2.3.4 Trust Game**

Participants were then asked to play the Trust Game (Berg et al., 1995). Participants were provided similar instructions used in Study 1. However, participants were informed that they would be playing the game with their interaction partner (referred to as “the other participant” during the session to minimize expectations or suggestions of trustworthiness) and the number of points earned at the end of the Trust Game would be converted to entries in a raffle drawing for a \$50 (Singapore dollars) gift voucher to a shopping mall at the conclusion of the entire study. It was also communicated to the participants that the data used to calculate the number of entries entered into the raffle drawing will be based on the actual decisions made by them and the other participant.

To minimize any undue pressure for trusting behavior, concerns of backlash from the other player for distrustful behavior, and socially-desirable responses, participants were not be informed of each other’s decisions. All decisions were written on an envelope and provided to the experimenter instead. In round 2, participants were shown an array of all possible amounts of points that could be received from the other player during round 1, and asked to indicate how much he or she would return to the other player based on each possible amount that could have been received in round 1.

#### **2.2.3.5 Donation of time**

After the Trust Game, both participants completed a measure of prosocial donation of personal time at their respective computer cubicles. Participants were told that this research was conducted in collaboration with a charity organization that distributes food to less-fortunate members of the community. They then read background information about the organization and about an upcoming charity event that required volunteers completing various roles and responsibilities. Participants were informed that they had the opportunity to sign up as a volunteer and indicate how much time (between 0 to 10 hours) they were willing to donate as a volunteer for the charity event.

#### **2.2.3.6 Self-Reported Personality**

Given that participants who are relatively more extraverted and agreeable may elicit more favorable responses from interaction partners or may be predisposed to prosocial tendencies, potential sampling bias in which relatively more agreeable or extraverted participants may have been assigned to the soft (vs. hard) food condition was assessed using items from the extraversion and agreeable subscales of the International Personality Item Pool (IPIP; (Goldberg, 1999)).

#### **2.2.3.7 Food Preferences and Demographics**

Finally, the participants completed some questions regarding their general preference of consumption of each of the foods they consumed using a 5-point Likert scale of liking, before completing general demographic measures. A composite score for liking was computed by averaging the liking for all three foods ( $M_{\text{hard}} = 3.33$ ,  $SD_{\text{hard}} = .69$ ;  $M_{\text{soft}} = 3.19$ ,  $SD_{\text{soft}} = .65$ ). There was no significant difference between the conditions,  $t(78) = -.95$ ,  $p = .35$ ,  $d = .21$ .

At the end of the experiment, participants were thanked and thoroughly debriefed. The leftover test foods (if any) were weighed separately and the respective weights of the foods were recorded.

## 2.2.4 Results

### 2.2.4.1 Manipulation Check

*T*-tests were performed to confirm systematic differences between evaluations of hard and soft food on hardness, chewiness and dryness. There were significant differences observed in participants' rating of hardness, chewiness and dryness of food between the hard and soft food conditions. Participants in the hard food condition ( $M_{\text{hardness}} = 75.05$ ,  $SD_{\text{hardness}} = 15.83$ ;  $M_{\text{chewiness}} = 30.17$ ,  $SD_{\text{chewiness}} = 21.33$ ;  $M_{\text{dryness}} = 60.80$ ,  $SD_{\text{dryness}} = 23.38$ ) rated the food as being significantly harder,  $t(78) = 10.22$ ,  $p < .001$ ,  $d = 2.29$ , and drier,  $t(78) = 2.20$ ,  $p = .03$ ,  $d = .49$ , than did participants in the soft food condition ( $M_{\text{hardness}} = 39.53$ ,  $SD_{\text{hardness}} = 15.26$ ;  $M_{\text{chewiness}} = 56.71$ ,  $SD_{\text{chewiness}} = 15.69$ ;  $M_{\text{dryness}} = 50.82$ ,  $SD_{\text{dryness}} = 16.59$ ). Conversely, participants in the soft food condition rated the food as being significantly chewier than did those in the hard food condition,  $t(78) = 6.34$ ,  $p < .01$ ,  $d = 1.42$ . On the other hand, no significant differences were observed on ratings on sweetness of food between the hard ( $M = 47.50$ ,  $SD = 15.83$ ) and soft ( $M = 50.06$ ,  $SD = 13.44$ ) food conditions,  $t(78) = .78$ ,  $p = .44$ ,  $d = .17$ , suggesting that any differences observed in prosociality across the hard and soft food conditions may not be attributable to incidental variations in sweetness of the foods between the two conditions. Furthermore, the self-reported ratings agreeable and extraverted traits from the IPIP did not differ between the hard ( $M = 3.02$ ,  $SD = .46$ ) or soft ( $M = 3.13$ ,  $SD = .42$ ) food conditions,  $t(78) = 1.04$ ,  $p = .30$ ,  $d = .25$ , confirming no differences between participants in the two conditions on personality traits that may predispose own-prosociality or elicit prosocial tendencies from others.

### 2.2.4.2 Trust

Similar to Study 1, an independent samples *t*-test revealed no significant effect of food texture on participants' trust of their interaction partners in the first round of the Trust

Game,  $t(78) = .73, p = .47, d = .16$ , such that no differences were observed on points entrusted between the soft food condition ( $M = 6.78, SD = 2.83$ ) and hard food condition ( $M = 6.28, SD = 3.28$ ). An ANCOVA was conducted to examine the effect of consuming hard/soft food on social tendencies while controlling for the same variables as Study 1 (participant gender, composite hunger, and average preference for test foods), in addition to whether participants were already acquainted with their interaction partner. The results of the ANCOVA revealed a marginally significant effect of food texture on participants' trust of their interaction partners in the first round of the Trust Game,  $F(1, 74) = 3.84, p = .05, n^2_p = .05$ . Participants in the hard food condition ( $M = 5.88, SD = 3.28$ ) entrusted less points to their partner compared to those in the soft food condition ( $M = 7.17, SD = 2.83$ ),  $d = .42$  (Fig. B.1).

Unlike Study 1, we did not observe significant indirect effects of any of the perceived sensory characteristics (softness, chewiness, dryness) on the relationship between the food texture manipulation and participants' trust,  $p > .10$ .

Using the same set of analyses, no significant results were observed on the points returned in the second round of the Trust Game as a function of the food texture condition,  $p > .05$ .

#### **2.2.4.4 Donation of time**

*T*-test revealed that participants in the soft food condition ( $M = 5.40, SD = 2.91$ ) did not choose to donate more time to charity compared to the participants in the hard food condition ( $M = 4.33, SD = 2.55$ ),  $t(78) = 1.76, p = .08, d = .39$ . However, when controlling for the covariates (participant gender, composite hunger, and average preference for test foods, and whether interaction partners were acquainted), the ANCOVA indicated a significant effect of food texture on participants' willingness to engage in prosocial donation of their time,  $F(1, 75) = 4.28, p = .04, n^2_p = .05$ , such that participants who consumed soft

foods ( $M = 5.51$ ,  $SD = 2.91$ ) intended to donate more hours to volunteer at an upcoming charity event compared to participants who consumed hard foods ( $M = 4.22$ ,  $SD = 2.55$ ),  $d = .47$  (Fig. B.2).

The perceived chewiness of food items was positively correlated to the number of hours participants chose to donate,  $r(78) = .23$ ,  $p = .04$ . However, there was no indirect effect of perceived chewiness on the relationship between the texture manipulation and the willingness to donate more time,  $b = -.58$ , [95% CI: -1.68, .25].

### **2.2.5 Discussion**

Study 2 provides further support for the hypothesis that oral haptic experiences of food texture (hardness/softness) may be metaphorically mapped to influence prosocial tendencies. After oral processing and ingestion of soft (vs. hard) textures, participants were more likely to entrust greater amounts of resources to another participant they consumed the food with and intend to donate greater amounts of personal time to support a charitable cause. These findings support and extend prior studies on metaphorical-mapping of both concrete sensory inputs from tactile manipulation (e.g. hard/soft, rough/smooth) and gustatory experiences linked to flavour (e.g., sweet, spicy) to abstract social judgments and behaviors. Specifically, the current study demonstrates that 1) social metaphors based on hard/soft sensory inputs may be activated from oral processing of foods rather than touch exclusively, and 2) conceptual metaphors linked to hardness/softness extend to prosocial behavior and are not limited to interpersonal judgments of stability or rigidity see (Ackerman et al., 2010).

Notably, these prosocial outcomes were observed as a result of hard/soft food ingestion without changes in participants' overall positive impressions or feelings of closeness with their interaction partners. Prior studies on effects of touching hard/soft surfaces also found no effects on overall positive impressions of others, although other

conceptual metaphors were activated and applied in interpersonal judgment (e.g., rigidity, emotional-stability) (Ackerman et al., 2010). Given that conceptual metaphors activated from sensory inputs may be applied to self-perception and behaviors (Ackerman et al., 2010; Meier et al., 2012), oral processing of soft (vs. hard) textures may be conceptually activating prosocial mindsets and motivations directly, rather than operating through increased perception or projection of affiliative or prosocial traits associated with others.

Unlike Study 1, the effect of food texture on trust was observed directly rather than through an indirect or mediating influence of sensory properties (e.g., dryness or chewiness) associated with the test foods. This discrepancy may be due to the consumption of real, rather than imagined, food in Study 2, which provided all participants with actual soft or hard orosensory inputs and may have consequently made the effects less dependent on the extent to which one is able to imagine or perceive the food as having sensory properties associated with hardness. When these sensory inputs are only imagined, as in Study 1, their effect on subsequent cognitive and behavioral processes may be especially contingent on the extent to which participants imagined the food as having soft (hard) sensory qualities, such as dryness.

### **3 General Discussion**

Across 2 studies, we demonstrate that the metaphorical-mapping of tactile or sensory inputs to social cognition and behavior is not constrained exclusively to touch, but can also operate through orosensory signals. Specifically, sensory inputs associated with consuming soft (compared to hard) foods was associated with increased willingness to trust others and donate personal time for prosocial purposes (when adjusting for factors such as gender, appetite, prior acquaintance with interaction partner and preferences for the soft and hard foods consumed). Additionally, our findings reveal that conceptual metaphors linked to



hardness/softness extend to prosocial behavior and are not limited to interpersonal judgments of stability or rigidity (see Ackerman et al., 2010). This increase in prosociality were found in both actual and perceived social interaction.

While orosensory properties of the foods consumed influenced trust for another participant, there was no effect of food hardness/softness on points reciprocated to the other player in the second round of the Trust Game. Given that participants' trust, and not reciprocation, was the primarily focus of the present study, we modified the Trust Game to prioritize the accurate assessment of trusting behavior while minimizing bias from social desirability or concerns of backlash from one's partner. Accordingly, participants were provided no feedback on how many points were entrusted to them by the other player in the first round. Thus, the second round may not be a robust measure of reciprocation of another's trusting or prosocial behavior, since participants were not actually aware of how trusting their partners had been in round 1.

A limitation of the present study is variations in the designs between the two studies. In addition to differences in whether consumption of hard/soft foods were imagined (Study 1) or real (Study 2), the studies also differed in how the Trust game was implemented. As an online study, Study 1 lacked actual interaction or exposure to the other participant involved in the Trust Game, whereas Study 2 involved actual interactions with the other participant, which may have made the consequences of one's trust decisions more salient and meaningful. Furthermore, the potential rewards across the two studies differed, with Study 1 using points with monetary value, while Study 2 involved raffle entries for a large prize. These variations in design between the two studies may also explain why they produced somewhat different patterns of results, as well as results that may not have been especially robust with relatively modest effect sizes. Given that the present studies served as initial explorations into the metaphoric transfer of soft/hard orosensory signals to social behavior, further studies on this

topic are required that employ more consistent and sensitive measures of prosocial tendencies.

The lack of a neutral control condition is another potential limitation. Although differences in prosocial tendencies were observed as a function of orosensory processing of soft and hard foods, it is unclear whether these effects are due to stimulation of prosociality by soft foods, its suppression by hard foods, or a combination of both processes. Although future studies involving a control condition are required for confirmation, we speculate that these findings may asymmetrically be driven by prosocial concepts metaphorically associated with softness for the following reasons. First, consuming hard foods may inhibit trust, which inherently involves adopting a position of vulnerability, by activating metaphors related to firmness, rigidity, and stability (Ackerman et al., 2010). Yet, activation of these concepts do not clearly explain why orosensory signals of hardness would lead to withholding of help on the time donation measure. Conversely, the metaphorical effect of soft orosensory experiences (e.g., “soft-hearted”, “tenderness”) more readily accounts for both increased trust and willingness to volunteer more time to help others. Second, meta-analysis of the Trust Game has indicated that participants on average entrust about 50.88% of their initial endowment to the other player in round 1 (Johnson & Mislin, 2008). This is comparable (in Study 2) to the endowment entrusted in round 1 by participants in the hard food condition (58.8%), but notably less than the endowment entrusted by participants in the soft food condition (71.7%), suggesting an enhancement of trust by consuming soft foods rather than suppression of trust by consuming hard foods. Another limitation of the study is lack of a direct measure to assess the activation of concepts related to social/interpersonal ‘softness’ and ‘hardness’ as a result of consuming foods with corresponding textures, which may subsequently guide trust and prosocial behavior. Future studies should seek to include such measures, such as a Lexical Decision Task (Meyer & Schvaneveldt, 1971).

Based on the present findings that not only flavor, but also the texture of food may serve as a basis for conceptual mapping of prosocial tendencies, one promising avenue for future research is to investigate the additive effects of multiple sensory signals that may metaphorically activate affiliative or prosocial tendencies. For instance, foods that are simultaneously soft, sweet and warm (e.g., a warm fudge brownie) may be an especially powerful medium for generating prosociality among people who consume these foods together. This presents some practical implications of the present research. Shared meals are common contexts for fostering bonding and affiliation. Trust and prosocial intentions may be more readily facilitated among people who eat together through the selection of foods that not only involve thermal or flavor characteristics that have previously been identified to metaphorically activate affiliative tendencies, but also foods with soft textures. This may be particularly effective in contexts that are contingent on trust and prosociality (e.g., willingness to make donations), such as negotiations, reconciliation after conflicts, fundraising, or seeking investments from consumers. Furthermore, future studies may also obtain new insights from examining whether preferences for soft (vs. hard) foods may also be partially motivated by social needs. If soft foods indeed metaphorically contribute to abstract subjective experiences of tenderness and prosociality, then such foods may be especially sought during periods of insecurity of social support and belonging. Consistent with this notion, many prototypical “comfort foods” (in the context of Western cuisine) are also soft, smooth, and rich in texture (e.g., macaroni and cheese, chicken and dumplings, ice cream), and may provide post-ingestive comfort not only due to their palatability and energy density, but also through activated concepts linked to interpersonal security.

Given the centrality of eating to human social experience, it is likely that properties of food and patterns of human sociality may bi-directionally influence and mutually co-construct one another. Indeed, eating practices such as food sharing may contribute to

behaviors in social and interpersonal domains, such as prosociality (De Backer, Fisher, Poels, & Ponnet, 2015). While much research has been dedicated to the role of social experiences (e.g., norms, social learning, modelling, conformity) in shaping diets, food preferences, and eating behaviors (Cruwys et al., 2015; De Castro, 1994; Birch, 1980), there has been substantially less attention to the properties of food and eating contexts in shaping social and cultural processes. Although the study of functional foods has revealed that some foods may have functional properties over and above nutrients delivered (e.g., health benefits), the present study suggests that some characteristics of foods may have *socially-functional* benefits by promoting cognitions and behaviors that may be adaptive at a group-level, such as trust and prosociality.

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**Fig. A** Hard (top row) and soft (bottom row) foods consumed by participants during the interpersonal interaction.



**Toasted Bread**



**Tortilla Chip**



**Hard Fruit Candy**



**All Hard Foods**



**Untoasted Bread**



**Tortilla Wrap**



**Gummy Bears**



**All Soft Foods**

**Fig. B.** Effects of food texture on prosocial tendencies in Study 2. Oral processing and consumption of soft (vs. hard) food produced intentions to donate marginally greater amounts of points entrusted to another participant in the Trust Game,  $p = .05$  (Fig. B.1), and greater numbers of hours to volunteer at a charity event,  $p = .04$  (Fig. B.2).

