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# The paradox of warmth: Ambient warm temperature decreases preference for savory foods

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ABSTRACT

Grocery stores and restaurants can control ambient temperatures using air-conditioning. Although questions about how ambient temperature affects consumers' evaluations of foods are relevant to many food-based businesses, they remain largely unanswered, and there are contradictory hypotheses regarding the influence of ambient temperature on food preferences. Embodiment theory suggests that ambient warm temperature *increases* food preferences, whereas thermoregulation theory suggests that ambient warm temperature may *decrease* food preferences to lower the body's temperature by limiting food intake. However, neither of these explanations considers food category. Given that food varies according to whether it is usually eaten warm or cool, the thermoregulation theory leads to the hypothesis that people may try to regulate their body temperature by preferring foods that should be eaten cool and avoiding those that should be eaten warm. To resolve these contradictory hypotheses, this study investigated the effect of warm ambient temperature on preferences for different categories of food. In total, 52 participants in a room with either warm or cool ambient temperature reported preferences for four categories of food images: vegetables, fruits, sweets, and savory foods. The foods were grouped into warm foods (i.e., foods perceived as having a warm temperature: savory foods), cold foods (i.e., foods perceived as having a cool temperature: fruits), and control foods (vegetables and sweets). The results indicated that ambient warm temperatures decreased preferences for savory foods but did not affect preferences for the other foods. The decreased preference for savory foods in warm ambient temperature was based on perceived food temperature but not on tastiness or healthfulness. These findings are the first to establish the effect of food temperature on food preference in warm ambient conditions. Incorporation of food temperature into thermoregulation theory can advance understanding of the sensory influences on consumer behaviors.

## 1. Introduction

Consumers view a variety of food images in grocery stores (e.g., food advertising, food packaging) and, especially in Asian cultures, are exposed to such images on the menus of restaurants as they consider what to order. Although the ambient temperature of the store may influence consumer behavior and can be controlled by store managers, neither its effects on food-group preferences nor its underlying mechanisms are understood. Thus, an understanding of the effects of ambient temperature may improve our theoretical understanding of, and practical knowledge about, sensory influences on food preferences.

### 1.1. Sensory influences on consumer behaviors

There is little evidence regarding how ambient temperatures influence consumer evaluations of foods. Sensory input (visual, auditory, olfactory, tactile, and gustatory) plays a crucial role in food-related consumer behavior (Krishna, 2012; Krishna & Schwarz, 2014; Spence, 2012). Store design, including electric lighting, background music, food smell, and ambient temperature, influences consumers' evaluations of food (Krishna, Morrin, & Sayin, 2013; North, Hargreaves, & McKendrick, 1999; Zwebner, Lee, & Goldenberg, 2013). For example, in-store national music leads to increased selection of the associated wine (e.g., German music and German wine selection; (North et al., 1999). Scents in printed food advertisements increase salivation, desire to eat, and food intake (Krishna et al., 2013). Despite research on the

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effects of sensory input on food-related consumer behavior, the effects of ambient temperature on consumer evaluations of foods are not well understood.

### 1.2. Ambient warm temperature may increase food preference

Although the effect of ambient temperature on food preferences has not been extensively investigated, the relevant theory indicates that warm ambient temperature may increase such preferences. According to embodiment theory, abstract psychological concepts (e.g., emotional warmth, positive reactions) are metaphorically grounded in concrete physical experiences (e.g., physical warmth) (Barsalou, 2010). This metaphorical logic suggests that warmth triggers positive reactions, which then induce congruent positive evaluations. In fact, physical warmth can, indeed, enhance positive assessments of others (Williams & Bargh, 2008). Based on this theory, a previous study demonstrated the existence of a *temperature premium* (warm temperatures lead to more positive evaluations of products) (Zwebner et al., 2013). Exposure to warmth increased the perceived value of products, including food (e.g., cupcakes) and beverages (e.g., milk, coffee) (Zwebner et al., 2013). These results indicate that ambient warm temperature may increase food preferences.

### 1.3. Ambient warm temperature may decrease food preferences

Thermoregulation theory suggests that ambient warm temperature decreases food preference. According to this theory, body temperature is regulated and homeostasis is maintained by adjusting food intake in response to temperature change (Terrien, Perret, & Aujard, 2011). The basic metabolic rate is lower in prolonged warm temperature, and this may lead to reduced appetite and food intake to lower the body's temperature (Terrien et al., 2011). Rats consume less during periods of prolonged warm temperature than during periods of prolonged cool temperature (Brobeck, 1948). People who live in warm climates consume less energy from food (Johnson & Kark, 1947). Although the volume of food intake is proportionate to the degree to which an individual prefers that food, higher (lower) levels of food preference before eating lead to more (less) food intake (Sørensen, Møller, Flint, Martens, & Raben, 2003). Based on this evidence, thermoregulation theory suggests that ambient warm temperature decreases food preference.

### 1.4. The influence of ambient warm temperature on food preferences is dependent on food category

Thermoregulation theory may lead to an alternative hypothesis when considering foods that are usually eaten warm versus those that are usually eaten cool. Although food intake regulates body temperature, its effect may be influenced by the perceived temperature of the food. In animals, the intake of cold food reduces body temperature more than the intake of warm food (Nicol & Young, 1989). In humans, social exclusion (i.e., social coolness) is associated with feeling cool, leading to an increased preference for warm liquids (coffee, soup) (Zhong & Leonardelli, 2008), perhaps in an attempt at thermoregulation (IJzerman, 2015). Moreover, consumption of a cool drink reduced negative states (aggression) induced by an uncomfortably warm ambient temperature (Baron & Bell, 1976). The findings of this study also implied that people prefer cold food in a warm ambient environment. Thus, in warm temperature, humans are likely to devalue warm food and prefer cold food to efficiently regulate their body temperature. Although the categorization of food groups varies across studies, food categories generally consist of four groups: vegetables, fruits, sweets, and savory foods (Blechert, Meule, Busch, & Ohla, 2014; Epstein et al., 2015; Howard, Gottfried, Tobler, & Kahnt, 2015; Padulo et al., 2017). Fruits are generally perceived as cool, apart from a few such, as chili peppers, whereas savory foods (non-sweet and salty/umami) (Howard et al., 2015; Keast & Breslin, 2003; Olsen, Ritz, Hartvig, & Møller, 2011), such as pizza and fried potatoes, are generally perceived as warm. Fruit is often served cool, and savory foods are often cooked by heat (e.g., baking, boiling, and frying). If fruits are perceived as cool and savory foods are perceived as warm, ambient warm temperature should increase the preference for fruit and decrease the preference for savory foods.

### 1.5. The present study

To resolve the contradictory hypotheses about the effects of warm temperature on food preferences, this study investigated the effect of warm ambient temperature on preferences for different categories of food images and examined the factors that influence preference shifts. In total, 52 participants in rooms with a relatively warm or cool ambient temperature reported their preferences for four categories of food images: vegetables, fruits, sweets, and savory foods. These categories were classified as warm (savory foods: those perceived as having a warm temperature), cool (fruits: those perceived as having a cool temperature), and control groups within the overarching categories of hedonic/sinful (sweet) and utilitarian/virtuous (vegetables) groups. To identify the underlying mediators of preference shifts, participants also evaluated perceived food temperature, a candidate mediator, and the two control factors that potentially influence food preferences (tastiness and healthfulness) for each food.

Based on the different theories, we developed three hypotheses regarding the effects of ambient temperature on preferences for different categories of food images. Based on embodiment theory, ambient warm temperature increases food preferences regardless of category (H1). Based on thermoregulation theory, ambient warm temperature decreases food preferences regardless of food category (H2a). The incorporation of food temperature into thermoregulation theory suggests that ambient warm temperature may influence food preferences as a function of the temperature of the food category in question. If fruits were perceived as cool and savory foods were perceived as warm, ambient warm temperature would be expected to increase preferences for fruits and decrease those for savory foods (H2b).

- H1. Ambient warm (vs. cool) temperature increases food preferences regardless of food category (vegetables, fruits, sweets, and savory foods).
- H2a. Ambient warm (vs. cool) temperature decreases food preferences regardless of food category (vegetables, fruits, sweets, and savory foods).
- H2b. When fruits are perceived as cool and savory foods are perceived as warm, ambient warm temperature will increase preferences for fruits, which are perceived as having a cool temperature, and decrease those for savory foods, which are perceived as having a warm temperature.

## 2. Methods

### 2.1. Participants

In total, 52 healthy university students (31 females, $M_{age} = 21.02 \pm 1.90$) were recruited using a bulletin board notice and a student mailing list. This study was approved by the Ethics Committee of the School of Medicine at Tohoku University and was conducted in accordance with the Declaration of Helsinki.

### 2.2. Design

The study had a 2 (temperature: warm/cool) × 4 (food groups: vegetables, fruits, sweets, and savory foods) mixed-subjects design, with temperature as the between-subjects factor and food groups as the within-subject factor. The primary outcome was food preferences for each category of food images.