



Research report

Proximity of foods in a competitive food environment influences consumption of a low calorie and a high calorie food



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ABSTRACT

The objective of this study was to test if proximity of a food or preference for a food influences food intake in a competitive food environment in which one low calorie/low fat (apple slices) and one higher calorie/higher fat (buttered popcorn) food was available in the same environment. The proximity of popcorn and apple slices was manipulated and 56 participants were randomly assigned to groups. In Group Apples Near, apple slices were placed near (within arms reach) a participant and popcorn was placed far (2 m away). In Group Popcorn Near, buttered popcorn was placed near and apple slices were placed far. As a control for the absence of a proximity manipulation, Group Both Near had both test foods placed near. Although participants rated the popcorn as more liked than apples, the food that was placed closer to the participant was consumed most in the two experimental groups, regardless of preference ($R^2 = 0.38$). Total energy intake was reduced most when popcorn was placed far from a participant compared to when it was placed near ($R^2 = 0.24$). The effects reported here were not moderated by BMI and did not vary by sex. In all, the results support the hypothesis that making a low calorie food more proximate will reduce total energy intake and increase intake of a low calorie food, even when a higher calorie and more preferred food is also available, but less proximate.

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Introduction

Factors in an eating environment can directly influence food intake and can lead to overeating and increased risks of obesity (Drewnowski, 2004; Hill & Peters, 1998; Swinburn et al., 2011). Obesity is one of the most serious and fastest growing public health problems worldwide with an estimated 63% of the adult U.S. population being overweight or obese (Kaiser Family Foundation, 2011), and a significant contributing factor to obesity being increased intake of high fat and high calorie foods (Dalton, Blundell, & Finlayson, 2013; Nijs, Muris, Euser, & Franken, 2010). Recent focus has been to characterize the nature of eating behavior in settings where people eat food most, such as in a kitchen, and to identify ways in which that environment can be restructured to promote healthier eating (Hill & Peters, 1998; Sobal & Wansink, 2007).

One major contributing factor to the rising obesity rates, and a key factor of interest in the present work, is to identify how the proximity of foods in a *competitive* food environment (i.e., an environment in which more than one food is made available at one time) influences food choice and energy intake. The kitchen setting

or *kitchenscape* (Sobal & Wansink, 2007) is one type of a competitive food environment, and is where an increasing number of meals are consumed (Bernard, 1991; Privitera, 2008; Privitera, Cooper, & Cosco, 2012). The kitchenscape is one of four microscale food environments (i.e., an environment where food is typically consumed; Sobal & Wansink, 2007) that influences food intake. The other environments are the furniture (i.e., tablescape; Privitera et al., 2012; Wansink, Painter, & Lee, 2006), the container (i.e., platescape; Wansink & Kim, 2005), and the food object (i.e., foodscape; Kral & Rolls, 2011; Spill, Birch, Roe, & Rolls, 2010).

The kitchenscape includes the relative locations or proximity of foods within a bounded environment. Buffet-style studies, and studies that isolate a single food, show that foods that are more proximate, or closer to the individual, are consumed in greater quantities (for review, see Sobal & Wansink, 2007). For buffet-style studies, total energy intake and food choice is typically measured, but to our knowledge the foods themselves (such as their proximity to a participant) have not been specifically manipulated (Allirot et al., 2012; Gregersen et al., 2008). For studies that isolate a single food, most studies that manipulated the proximity of food in a microscale food environment have used “junk” foods, such as candies (Painter, Wansink, & Hieggelke, 2002; Wansink et al., 2006). In a pair of experiments, a more recent investigation showed for the first time that placing apple slices (fruit) or carrot sticks

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(vegetable) closer to a participant, increased intake of those healthier foods in a microscale food environment (Privitera & Creary, 2013). This more recent investigation established a potential way in which a food environment can be structured to increase intake of fruits and vegetables.

One limitation of studies that have investigated how the proximity of foods in an environment influences intake is that only one food was made available to a participant at a given time (Painter et al., 2002; Privitera & Creary, 2013; Wansink et al., 2006). For studies with candies, fruits, or vegetables, only that one food type was available to eat at the time of the proximity manipulation. The standard manipulation of proximity is to place a food near (within arms reach) or far (2 m) from a participant (Painter et al., 2002; Wansink et al., 2006). However, it is unclear if such a manipulation would work in a more natural *competitive* setting where other foods are also made available in that same environment, such as in a typical buffet-style setting, which is known to influence food choice, often for preferred, high calorie foods (Privitera, 2008; Stroebe, 2008).

Only about 25% of Americans (Serdula et al., 2004), and fewer college students (American College Health Association, 2006), consume the recommended five servings of fruits and vegetables per day. One explanation for this outcome is that other more preferred, but higher calorie food options are usually available in a setting in which fruits and vegetables are an option. While survey-based research with children (French & Wechsler, 2004; Hearn et al., 1998; Rovner, Nansel, Wang, & Iannotti, 2011) and college-aged adults (Nelson, Larson, Barr-Anderson, Neumark-Sztainer, & Story, 2009) suggests that the proximity of fruits can influence intake of these foods, this outcome has never been demonstrated in an experimental setting in which the proximity of low and high calorie foods are manipulated in the same setting. Identifying if such an outcome is possible is important because such an understanding could be used to promote healthier eating and reduce energy intake.

Method

In the present study, the proximity of one low calorie (apple slices) and one higher calorie (buttered popcorn) food was varied in a kitchen setting to test the hypothesis that participants will consume more of a food that is closer, regardless of the healthfulness or preference for foods in the environment.

Participants

A total of 60 participants were recruited through university classroom visits and sign-up sheets. Of those recruited, 56 participants (26 men, 30 women), were included in data analyses. Participant self-reported characteristics were ($M \pm SD$) age (19.4 ± 0.9 years), weight (75.3 ± 11.0 kg), height (170.2 ± 6.1 cm), and BMI (26.0 ± 3.8 kg/m²). The BMI of participants ranged across the full spectrum: healthy ($n = 20$), overweight ($n = 21$), and obese ($n = 15$)—this distribution of BMI range matches the distribution of BMI in the general U.S. population (Kaiser Family Foundation, 2011). BMI was also included as a covariate because higher BMI is associated with eating a higher fat diet and thus may influence intake of a low vs. higher fat food (Privitera & Freeman, 2012) in the present study. In an initial screening phase, participants reported that they were in general good health with no physical or doctor diagnosed food allergies, medical conditions including pregnancy, or dietary restrictions. Participants were told during this initial screening phase not to eat within two hours of the study. Because hunger states can influence food intake (Fedorchak & Bolles, 1987; Yeomans, 2006), participants who ate within two hours of the study were excluded from data analyses. A total of

four participants were excluded for this reason, leaving 56 total participants observed.

Setting and stimuli

Kitchen setting. All experimental foods were consumed in the natural setting of a kitchen (6 m length \times 2 m width \times 3 m height). As each participant entered the kitchen area, he or she was seated in a chair at a small round table (circumference: 1 m) located across from him or her along the north wall. The kitchen area was located along the east wall and consisted of a faucet, sink, counter (2 m length \times 0.6 m width \times 1 m height), four cabinets, and a refrigerator. As shown in previous analyses in this kitchen setting (e.g., Privitera et al., 2012; Privitera & Creary, 2013) participants reported that this setting looks (mundane realism) and feels (experimental realism) like a real kitchen. This kitchen setting is a space that is used for the purposes of preparing and eating foods only and is a designated eating area.

Materials and foods. The low calorie food was sweet red apple slices (Country Fresh, Inc., Houston, TX, wt/vol); 70 calories and energy density is 304 kJ (kilojoule) per serving. Macronutrients per serving of apple slices were: 0 g fat, 19 g carbohydrate, and 0 g protein. The higher calorie food was movie theatre butter microwavable Orville Redenbacher's[®] popcorn (ConAgra Foods Inc., Omaha, NE, wt/vol); 158 calories and 734 kJ per serving. Macronutrients per serving of buttered popcorn were: 12 g fat, 16 g carbohydrate, and 2 g protein. Pre-sliced apples were used to avoid bruising. Foods were placed in position before a participant sat down and he or she was verbally reassured that the foods had “just been prepared” to ensure that each participant knew the foods were fresh and good to eat. A low calorie and high calorie food that is familiar (i.e., apples and buttered popcorn) was chosen for this study to ensure that the foods would be consumed in each session.

Procedures

All procedures were conducted in a laboratory setting between 2:00 PM and 5:00 PM EST. Participants were seated one at a time at the kitchen table and the two foods were placed in the kitchen just prior to their arrival. All foods were served in an open clear bowl with a serving of 130 g of apple slices and 37 g of popcorn. These amounts gave the visual appearance of a similar portion size in terms of volume of the bowl filled. The proximity of foods to the participant was the manipulation. Using a between-subjects design, participants were randomly assigned to a condition depending on where the bowls were located. In the Apples Near group ($n = 17$), apple slices were placed within arms-reach or 0.3 meters (near) of the participant on the kitchen table and popcorn was placed 2 m (far) from the participant on a counter where it could be seen; in the Popcorn Near group ($n = 18$) the popcorn was placed near and the apple slices were placed far; in the Both Near group ($n = 21$) both foods were placed near a participant. This last group was included to identify intake of apple slices and popcorn in the absence of a proximity manipulation. For the near location, the bowl was placed toward the center of a participant, so handedness was not a factor. The far location required participants to get up and walk to the bowl in order to reach the foods.

Once a participant was seated and the food bowl was placed in a location, the researcher gave the following cover story (same as that given in a previous study in the same experimental setting; Privitera & Creary, 2013): “I will be right back with some questionnaires. By the way, there are foods in the bowls if you would like something to eat.” This cover story ensured that all participants knew that the food was in the room and that they were allowed to eat the food. The researcher left the kitchen area immediately. After 6 min passed, the researcher returned to the kitchen area,

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