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A review of visual cues associated with food on food acceptance and consumption

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ABSTRACT

Several sensory cues affect food intake including appearance, taste, odor, texture, temperature, and flavor. Although taste is an important factor regulating food intake, in most cases, the first sensory contact with food is through the eyes. Few studies have examined the effects of the appearance of a food portion on food acceptance and consumption. The purpose of this review is to identify the various visual factors associated with food such as proximity, visibility, color, variety, portion size, height, shape, number, volume, and the surface area and their effects on food acceptance and consumption. We suggest some ways that visual cues can be used to increase fruit and vegetable intake in children and decrease excessive food intake in adults. In addition, we discuss the need for future studies that can further establish the relationship between several unexplored visual dimensions of food (specifically shape, number, size, and surface area) and food intake.

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1. Introduction

We live in a world where we are constantly bombarded with food and food images either through media or through the proliferation of eating locations that advertise and sell large portions of palatable, energy-dense foods. So it is not surprising that efforts to reduce the

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incidence of obesity have been largely unfruitful. According to the World Health Organization, about 1.4 billion people were overweight and nearly 500 million people were obese in 2008. In the United States alone, about 35% of adults and 17% of children were obese from 2009 to 2010 (Ogden, Carroll, Kit, & Flegal, 2012). If the current trends in obesity continue, it is expected that almost half the American population will become obese by 2030 (Finkelstein et al., 2012). The simplest cause of obesity is an increase in energy intake or a decrease in physical activity. Since physical activity has not changed much in the past two decades (Finkelstein, Ruhm, & Kosa, 2005), most of the research is now focused on energy intake as a plausible target for obesity prevention and treatment. Several internal and external food cues act independently, additively, or interactively to affect food intake. The focus of this review article, however, is on external cues directly associated with food and its effects on food intake.

Although many people cite taste as the most important factor affecting food intake (Glanz, Basil, Maibach, Goldberg, & Snyder, 1998) in many cases the first sensory contact with food is through the eyes. In fact, the mere sight of food can facilitate the subjective desire to eat the target food (Cornell, Rodin, & Weingarten, 1989; Hill, Magson, & Blundell, 1984; Marcelino, Adam, Couronne, Koster, & Seiffermann, 2001) and activate brain areas and neural pathways associated with reward (Beaver et al., 2006; LaBar et al., 2001; Morris & Dolan, 2001; Stoeckel, Cox, Cook, & Weller, 2007). In addition, before a food is consumed, the appearance of the meal provides expectations about the taste quality, flavor, and palatability of food which may ultimately affect food acceptance and consumption (Hurling & Shepherd, 2003).

1.1. Why are visual cues from food important?

Visual exposure to a novel food before consumption is shown to be particularly effective in introducing new foods to children. Neophobia or the "fear of something new" is an adaptive trait that typically peaks between two and five years of age and can decrease the consumption of fruits, vegetables, and meats (Cooke, Carnell, & Wardle, 2006; Cooke, Wardle, & Gibson, 2003; Pliner, 1994). Visual exposure to a novel food can reduce neophobia and facilitate acceptance. When children were exposed to novel food pictures or actual foods before trying them, children showed a greater willingness to try those foods than those not visually exposed (Birch, McPhee, Shoba, Pirok, & Steinberg, 1987; Houston-Price, Butler, & Shiba, 2009). Similarly, children presented with a visually similar, familiar fruit before a novel fruit showed a greater willingness to try the novel fruit than those exposed only to the novel fruit (Dovey et al., 2012).

Second, not only can visual exposure increase willingness to try a novel food, but enhancing the visual appeal of a novel food can also encourage consumption. Jansen, Mulkens, and Jansen (2010) enhanced the visual appeal of a novel fruit by presenting it in an attractive fashion (i.e. pieces of fruit were pierced with a toothpick and displayed on a watermelon slice). They found that children ate more of the visually appealing fruits than a simple mix of fruits served on a white plate (Jansen et al., 2010). In addition, Zampollo, Kniffin, Wansink, and Shimizu (2012) found that children preferred to have more food items, empty space, and variety of foods and colors on their plates than adults, showing that a varied, attractive meal are important determinants of preference in children (Zampollo et al., 2012).

Third, arranging foods on a plate can affect our expectations and ultimately, liking of the food. For example, strawberry-flavored mousse placed on a white plate was judged to be more flavorful, sweeter, and palatable than the same food presented on a black plate (Piqueras-Fiszman, Alcaide, Roura, & Spence, 2012). The authors hypothesized that the color-contrast produced with the food on the white plate may have enhanced expectations about the taste, increased perceived flavor intensity, and facilitated acceptance of the food (Piqueras-Fiszman et al., 2012). Similarly, arranging the foods on a plate in an orderly way can enhance intake. When meal ingredients were presented in a neat and orderly fashion, subjects liked the taste of the meal more than when meal ingredients were presented in a random, messy way (Zellner et al., 2011). Even "balancing" i.e. perceived heaviness of the ingredients on a plate can affect intensity ratings and liking of a food. A multicolored "balanced" food plate was rated higher in attractiveness than a single-colored, "balanced" plate (Zellner, Lankford, Ambrose, & Locher, 2010).

Fourth, visual exposure to food elicits the physiological release of saliva and other regulatory peptides required for digestion. For example, the mere sight of food (or food pictures) and smell stimulates the physiological release of saliva (Christensen & Navazesh, 1984; Klajner, Herman, Polivy, & Chhabra, 1981; Wooley & Wooley, 1973). The release of saliva is the first step in the digestive process as it contains key enzymes required for the breakdown of nutrients before complete digestion in the stomach (Pedersen, Bardow, Jensen, & Nauntofte, 2002). Blood insulin levels also peak when exposed to the sight and smell of food in response to an anticipatory increase in blood glucose following food consumption (Johnson & Wildman, 1983; Sjostrom, Garellick, Krotkiewski, & Luyckx, 1980; Woods, 1991). Woods (1991) argued that this anticipatory increase in insulin levels (called the cephalic phase insulin response) may be an adaptive response to protect the organism from drastic changes in glucose levels and to maintain homeostasis. In addition, the sight of food can increase subjective sensations of hunger and appetite which are partially responsible for initiating food intake (Bossert-Zaudig, Laessle, Meiller, Ellgring, & Pirke, 1991).

Fifth, varying the appearance of a portion of food can affect perceptions of variety in a meal, and ultimately affect energy intake. Seeking a variety of foods may be an adaptive trait to protect the organism from nutritional deficiencies (Rolls, 1981). Levitsky, Iyer, and Pacanowski (2012) for example varied the presentation of a vegetable-stir fry and pasta meal by presenting the ingredients of these meals either separately or mixed together. The results showed that when the ingredients were presented separately, subjects ate more than when the ingredients were mixed together. The authors suggested that segregating food into discrete units increases energy intake by increasing the perceived variety of foods available for consumption (Levitsky et al., 2012).

Lastly, the food portion served on a plate may serve as a visual benchmark or guide to determine the appropriate amount of food to consume. These visual benchmarks or guides are referred to as "consumption norms" that can dictate the amount of food consumed in a meal (Wansink & Van Ittersum, 2003b). For instance, without the empty bowl as a visual cue to stop eating, subjects ate about 70% more soup than those who were able to view the empty bowl. These results show that people use the emptying of food from a bowl or plate to make decisions about the quantity of food to consume (Wansink, Painter, & North, 2005).

Since the appearance of a food can determine the amount of food consumed and eating behaviors, the purpose of the present review is to identify the various visual cues associated with food and their effects on eating behaviors. While previous reviews have addressed the effects of the sight of food on physiological processes (Mattes, 1997; Van der Laan, De Ridder, Viergever, & Smeets, 2011), no review article has addressed the effects of sight of food on the amount of food consumed. Here, we provide an extensive review on several visual cues such as proximity, visibility, color, height, number, shape, surface area, size, number, variety, and portion size and their effects on dietary behaviors in children and adults. Table 1 summarizes results from studies on visual cues from food and their effects on food acceptance and consumption.

1.2. Sources of review

Studies included in the review were obtained from Medline, PsycINFO, Nutrition, and Marketing databases and included those conducted on both children and adults. We used a combination of dietary intake and visual cue keywords to generate scientific, peer-reviewed