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The *real deal*: Willingness-to-pay and satiety expectations are greater for real foods versus their images

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ABSTRACT

Laboratory studies of human dietary choice have relied on computerized two-dimensional (2D) images as stimuli, whereas in everyday life, consumers make decisions in the context of real foods that have actual caloric content and afford grasping and consumption. Surprisingly, few studies have compared whether real foods are valued more than 2D images of foods, and in the studies that have, differences in the stimuli and testing conditions could have resulted in inflated bids for the real foods. Moreover, although the caloric content of food images has been shown to influence valuation, no studies to date have investigated whether 'real food exposure effects' on valuation reflect greater sensitivity to the caloric content of real foods versus images. Here, we compared willingness-to-pay (WTP) for, and expectations about satiety after consuming, everyday snack foods that were displayed as real foods versus 2D images. Critically, our 2D images were matched closely to the real foods for size, background, illumination, and apparent distance, and trial presentation and stimulus timing were identical across conditions. We used linear mixed effects modeling to determine whether effects of display format were modulated by food preference and the caloric content of the foods. Compared to food images, observers were willing to pay 6.62% more for (Experiment 1) and believed that they would feel more satiated after consuming (Experiment 2), foods displayed as real objects. Moreover, these effects appeared to be consistent across food preference, caloric content, as well as observers' estimates of the caloric content of the foods. Together, our results confirm that consumers' perception and valuation of everyday foods is influenced by the format in which they are displayed. Our findings raise important new insights into the factors that shape dietary choice in real-world contexts and highlight potential avenues for improving public health approaches to diet and obesity.

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1. Introduction

Obesity contributes significantly to the global burden of disease and increases the risk of heart disease, Type II diabetes and cancer (Bean, Stewart, & Olbrisch, 2008; Brownell & Gold, 2012; Klein et al., 2007; Wellman & Friedberg, 2002; Zhang & Wang, 2004). The alarming increase in obesity over the last three decades has been linked to the availability, accessibility and affordability of inexpensive, energy-dense snack foods (Afshin et al., 2017; Drewnowski & Darmon, 2005). Although a large body of research has documented the various visual properties of foods (such as their color, size, shape, and number) that can influence appetite and consumption (Imram, 1999; Wadhera & Capaldi-Phillips, 2014), recent research efforts have focused on understanding the underlying cognitive and neural systems that regulate decision-making and dietary choice (Rangel, 2013; Schultz, 2000). In turn, research outcomes in this domain have formed the foundation for public health initiatives aimed at curbing rising obesity rates. Unfortunately, however, these initiatives appear to have met with little to no measurable success (Drewnowski & Darmon, 2005; Imram, 1999; Marteau, Hollands, & Fletcher, 2012; Neal, Wood, & Quinn, 2006).

One potential reason for inconsistencies between laboratory studies of human decision-making versus the behavior of consumers in the real-world, is that the types of stimuli used in the laboratory do not reflect those consumers typically encounter when they make daily dietary choices (Camerer & Mobbs, 2017; Ledoux, Nguyen, Bakos-Block, & Bordnick, 2013; Medic et al., 2016). In the laboratory, observers are typically required to make decisions about two-dimensional (2D) images of foods that are displayed on a computer monitor (Beaver et al., 2006; Bode, Bennett, Stahl, & Murawski, 2014; Hare, O'Doherty, Camerer, Schultz, & Rangel, 2008; Plassmann, O'Doherty, & Rangel, 2010; Polanía, Krajbich, Grueschow, & Ruff; Rangel, 2013; Tang, Fellows, & Dagher, 2014). In the real-world, however, consumers typically make dietary decisions in the presence of *real* foods, such as at the fridge, cafeteria, or supermarket.

Real foods differ from their images in a number of respects that could have a critical influence on behavior and neural responses. Perhaps most importantly, real foods (but not their images) have actual caloric content. At a more fundamental level, when viewed with two eyes, real objects have a definite distance, location, and size relative to the observer, whereas for 2D computerized images only the distance to the computer monitor is known. When real objects are perceived to be within reach, they activate dorsal brain networks involved in reaching and grasping, in humans (Gallivan, Cavina-Pratesi, & Culham, 2009; Gallivan, McLean, & Culham, 2011) and monkeys (Iriki, Tanaka, & Iwamura, 1996; Mountcastle, Lynch, Georgopoulos, Sakata, & Acuna, 1975). Similar dorsal motor networks have been shown to be engaged when laboratory animals are confronted with real food rewards (Bruni, Giorgetti, Bonini, & Fogassi, 2015; Platt & Glimcher, 1999; Schultz, Tremblay, & Hollerman, 2000; Sugrue, Corrado, & Newsome, 2004; Volkow, Wang, & Baler, 2011). Although image interaction is becoming increasingly common in the modern world, humans have presumably evolved to perceive and grasp real objects and to consume real foods, not images (Cisek & Kalaska, 2010; Heft, 2013). Moreover, the size of food images in most human decision-making studies has not matched the typical real-world size of the foods, possibly making portion size ambiguous. Although three-dimensional (3D) stereoscopic images more closely approximate the visual appearance, distance, and size of their real-world counterparts, it is the case that only real objects afford genuine physical interaction and have actual caloric content. Indeed, the physical presence of a food may be a powerful trigger for automatic Pavlovian (Bushong, King, Camerer, & Rangel, 2010; Pavlov, 2010; Rangel, 2013) and habit-based (Lally, van Jaarsveld, Potts, & Wardle, 2010; Neal et al., 2006) decision control systems that may place little if any weight on the long-term health consequences of poor food choices. It is possible, therefore, that studying responses to artificial displays has left important gaps in our understanding of the mechanisms that drive naturalistic decision-making, with detrimental flow-on effects for public health programs and policy.

The extent to which stimulus format influences decision-making has received surprisingly little systematic investigation. Classic early studies conducted at Stanford University by Walter Mischel and colleagues (Mischel & Moore, 1973; Mischel, Ebbesen, & Zeiss, 1972) showed that display format can have a dramatic influence on decision-making behavior in young children. In an initial study, Mischel et al. (1972) measured how long preschool children were able to wait alone in a room for the chance to consume a preferred food reward (i.e., a sweet biscuit). During the delay period, the children sat at a table facing either the preferred (but delayed) reward, a less preferred reward (e.g., a pretzel) that was immediately available, both food rewards, or neither reward. The authors found that if the snack foods were absent from view during the waiting period, the children were able to wait longer for the delayed (preferred) reward than if the snacks were in view. However, in a subsequent follow-up experiment, Mischel and Moore (1973) found that preschool children *were* able to wait for a preferred delayed reward when the stimuli were displayed as realistic color images (rather than real foods) during the delay period. The authors concluded that real foods have a more powerful influence on young children's behavior than abstract representations, and they speculated as to whether real food displays would have a less pronounced influence on adult behavior (Mischel & Moore, 1973).

Only a few studies have examined whether the format in which a stimulus is displayed influences valuation in adults (Bushong et al., 2010; Gross, Woelbert, & Strobel, 2015; Müller, 2013). In the first of these studies, Bushong et al. (2010) measured college-aged students' 'willingness-to-pay' (WTP) for a range of appetitive (i.e., desirable) snack foods using a Becker DeGroot Marschak (BDM) bidding task (Becker, DeGroot, & Marschak, 1963). In the main experiment, participants were divided into three separate groups; one group viewed text descriptors of the snacks (e.g., "Snickers bar"), another group viewed the foods in the form of high-resolution colored photographs and the remaining participants viewed the stimuli as real snack foods. Students who viewed the real snacks bid 61% more for the foods than those who viewed the same items as images or text displays —a phenomenon the authors termed the 'real-exposure effect' (Bushong et al., 2010). The effect was

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