



Validating the plate mapping method: Comparing drawn foods and actual foods of university students in a cafeteria



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ABSTRACT

To examine effects of plate size on meals, I developed a method I label plate mapping. To validate plate mapping, a quasi-experimental between participants study was conducted that asked university students to accurately draw their lunch meal. Participants were randomized into groups where they were asked either pre-consumption or post-consumption to draw their lunch on either a 9" or 11" paper plate. Coding plate drawings for total meal size revealed that students drew bigger meals on larger plates and participant meal size drawings were more accurate when the plate provided was the same size as the meal plate used. Gender moderated meal size drawings, with women generally drawing meals that were more highly correlated and similarly sized to actual meals when compared to the drawings of men. Overall, the size of plate drawings was highly correlated with the size of actual foods, which provides support for the validity of the method of plate mapping. These findings suggest that plate mapping can be applied to estimate meal size and assess sensitivity to plate size. Gaining a better understanding of the mechanisms and processes that influence food consumption habits can help increase awareness of these cues for both academics as well as for consumers of food and benefit short- and long-term health goals.

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1. Introduction

While the U.S. Department of Agriculture offers guidelines that educate the public about recommended eating practices (U.S. Department of Agriculture & U.S. Department of Health and Human Services, 2010), there is a dissonance between nutrition education and personal behavior. Environmental variables can influence food consumption (Sobal & Wansink, 2007). Plate size and portion size may influence the amount of food an individual consumes, with increases in plate or portion size consistently correlated with increased food intake (Diliberti, Bordi, Conklin, Roe, & Rolls, 2004; Fisher & Kral, 2008; Van Ittersum & Wansink, 2012). Some environmental modifications such as making healthy foods more visible, putting unhealthy treats in out of reach or opaque containers, or changing the size of the serving dish require little additional effort from participants to impact dietary behaviors (Cowan & Devine, 2013; Engbers, van Poppel, Chin A Paw, & van Mechelen, 2005; van Kleef, Shimizu, & Wansink, 2011). One potential environmental influence is the size of the vessel in which food is served (Kallbekken & Sælen, 2013).

While prior research finds evidence for a relationship between portion size and energy intake, recent literature reviews report mixed findings about the relationship between vessel size and real or imagined portion size (Libotte, Siegrist, & Bucher, 2014; Wadhwa & Capaldi-Phillips, 2014). Prior studies have generally shown a relationship between three dimensional vessels, such as drinking glasses and bowls, and portion sizes where even individuals considered "experts" in portion or serving sizes like bartenders (Wansink & van Ittersum, 2005) and nutrition faculty (Wansink, van Ittersum, & Painter, 2006) self-served differently sized portions depending on the shape or size their vessel. Drinking glasses have been shown to promote size misestimating depending on whether the participants were given a tall, thin glass or a short, wide glass (Wansink & van Ittersum, 2005). A majority of the studies that do identify an effect of vessel size on portion size and food consumption utilized bowls as the dishware in which food is served (Van Ittersum & Wansink, 2012; Wansink & Cheney, 2005; Wansink & van Ittersum, 2007; Wansink et al., 2006). These studies suggest that there may be an association between vessel size and food consumption. Like larger bowls, larger plates increase the size of food that people can serve themselves, and having more food available on a plate increases the opportunity for a person to consume more food.

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While bowls and glasses have generally been shown to influence portion size, there have been mixed reports about the capacity for plates to influence portion size in a similar fashion. [Shah, Schroeder, Winn, and Adams-Huet \(2011\)](#) performed a pilot study to observe if plate size influenced food consumption in normal and overweight or obese women. They utilized two different size plates (8.5" and 10.8") and used a crossover study design to observe potential differences in total energy intake from a single food item. This pilot study found that plate size did not affect food intake in normal weight and obese women. Similarly, [Yip, Wiessing, Budgett, and Poppitt \(2013\)](#) found that using a smaller plate did not decrease food consumption in overweight women eating in a buffet setting. Additionally, [Koh and Pliner \(2009\)](#) found that plate size did not influence food consumption when women ate in pairs in bivariate analysis, but plate size altered consumption when a secondary measurement, degree of acquaintance, was added to the equation.

A meta-analysis of relevant randomized controlled trials concluded that people consistently consumed more foods and drinks when offered larger-sized tableware than when offered smaller-sized versions and suggested that policies and practices aimed at reducing tableware size could contribute to immediate or short term reductions in the quantity of consumed food ([Hollands et al., 2015](#)).

2. Plate mapping

Plate mapping is a new method to measure an individual's meal conceptualization ([Sharp & Sobal, 2012](#); [Sharp, Sobal, & Wansink, 2014](#)). The plate mapping method was developed by the Built Environment and Nutrition Lab in the Division of Nutritional Sciences at Cornell University. Plate mapping measures meal conceptualization by asking participants to draw foods on a paper plate that corresponds with their estimation of a meal that they have eaten, will eat, or are currently consuming. Plate mapping was developed as a method for eliciting an individual's personal conceptualization of a meal while being sensitive to influences from internal scripts and external environmental cues without increasing the overall burden of time on participants and expense that is seen in more direct observational methods such as the 24-h food recall and food frequency questionnaires.

An initial study by [Sharp and Sobal \(2012\)](#) reported that the Plate Mapping could be used as a tool to understand meal portrayals by asking college students to draw what they would like to eat for dinner on a paper plate that was either 11" or 9" in diameter. They found that college students given an 11" plate drew an average total area of food that was 26% greater than those given a 9" plate. The largest food drawn on each size of plate was found to be the primary factor in the difference in area between plate sizes, with 70% of the total difference in meal size coming from the largest food drawn on plates. While the area of the largest food increased when comparing 11" plate drawings to 9" plate drawings, the relative percentage of plate area covered by the largest food on each size of plates remained the same. Gender was found to influence portrayals of meals in plate maps, with women drawing bigger vegetable portions than men when given larger plates.

The present study examines the construct validity ([Markus & Lin, 2010](#)) of plate mapping measurement by investigating the capacity of college students to draw their meal in two-dimensions on two differently sized plates just prior to or just after consuming a lunchtime meal at a cafeteria on their campus. Construct validity is a process that measures the degree to which a test or experiment actually measures what it claims to measure ([Markus & Lin, 2010](#)). Using a plate mapping protocol to compare actual food portions and meals sizes to participant generated drawings of food portions and meal sizes can examine construct validity of plate mapping and

quantify the degree that plate mapping can precisely measure participant perceptions of meal size in the context of a particular plate. By showing that participants are capable of using two-dimensional drawings to accurately portray their three-dimensional meals, we suggest that two-dimensional drawings can be used as a cheaper and/or faster method of collecting data about a participants prior, current, or future meal portion sizes. Results of mathematical modeling to examine how dish size affects the potential energy available in a meal suggests that a small increase in dishware size can lead to a substantial increase in energy available to be consumed ([Pratt, Croager, & Rosenberg, 2012](#)). This reinforces the need to consider dishware size when developing strategies to prevent over-consumption.

Better understanding the effects of plate size on food portion and overall meal size may not only help explain our nation's current struggle with weight related health issues but may also lead to the creation of more accurate nutrition research and more effective and more personalized nutrition interventions for dieticians and nutrition educators. Researchers who are aware of the environmental effects of micro-built environments ([Sobal & Wansink, 2007](#)) such as plate size can specify and control these mechanisms in their research to increase the accuracy of their results.

I propose four hypotheses about how participants respond to the plate size and pre-versus post-meal temporal variations in this study. 1) Participants will be able to accurately draw the overall estimated sizes of the meal and food components they are about to consume. 2) Participants drawing their meals post-consumption will be less accurate in drawing on plates than participants drawing their meals pre-consumption. This hypothesis implies that individuals looking at what that they are drawing will be more accurate, on average, than individuals who need to recall their meals when they had no prior knowledge that they would be tasked to do so. 3) Participants drawing on plates larger than the ones their meals were served on will be less accurate in drawing their food portions and meal size as participants drawing on plates that were identical in size to the ones their meals were served on. This hypothesis underpins the importance of plate size by suggesting that food recall is subjective and can be manipulated by a subtle environmental influence such as a larger plate. 4) Gender will moderate the accuracy of plate drawing, with women producing more accurate plate drawings than men.

3. Methods

In a large university in Northeastern United States, a quasi-experimental design was performed at an on-campus dining facility. A paper plate and a questionnaire was administered to students who had purchased a meal. For sixteen weekdays, students were approached between the hours of 11:30 am and 1:30 pm either 1) as soon as they sat down to eat but before they had started eating (pre-consumption) or 2) after they had finished their meal but before they had gotten up from the table to leave the dining hall (post-consumption). The questionnaire consisted of a consent form and requested basic student demographics. When the questionnaires were completed, researchers instructed participants to "please accurately draw and label the foods in the meal that you (are about to/have just) consume(d). Please be as realistic as possible with the sizes of the foods on your plate".

Each participant received one size of plates of identical material, design, and color, but one plate was 9" in diameter and the other plate was 11" in diameter. The 9" plate was selected to match the size and color of the plates currently used in the dining facility. Only one size of plate and pre- or post-meal assessment was used to collect data on any given day with each plate size and meal time being collected on four out of the sixteen total days. A random

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