

Of Waste and Waists: The Effect of Plate Material on Food Consumption and Waste

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ABSTRACT Two lab studies and three field studies indicate that plate disposability influences the amount of food wasted. The first lab study indicates that more food served on disposable (i.e., paper) plates is wasted than when the same food is served on permanent (i.e., hard plastic) plates. Study 2 employs an implicit association test (IAT) to confirm that disposable plates are strongly associated with behavior to stop eating while, simultaneously, permanent plates are more strongly associated with a keep eating behavior. Three field studies (3A, 3B, and 3C) indicate that this effect maintains when instead of being served a fixed quantity of food, participants select the amount and type of food.

Social changes like larger portion sizes, eating on-the-go, and increased dining out and takeout meals, which now account for 50% of US food expenditures (Nassauer 2012), are contributing to a great paradox of our time: the simultaneous expansion of waste and waists. American consumers are exhibiting both an unprecedented food consumption volume and, ironically, an unprecedented level of food disposal. Much attention has been paid to the increasing portion sizes and serving sizes of food in the United States, both inside the home (e.g., packaged goods) and outside (e.g., restaurants). Some estimates report a doubling or tripling of portion sizes in the last 20 years (NIH 2013); consuming today's portions of breakfast (bagel and coffee), lunch (two slices of pizza and soda), and dinner (Chicken Caesar salad and soda) would add 1,595 calories compared to the same meal 20 years ago.

The amount of available food per sitting is in large part responsible for Americans' increasing waistlines, as the more food we have on our plates, the greater our food consumption volume. Much less attention, however, has been paid to another injurious consequence of larger food resources per sitting: the larger the resources, the greater the amount of food that is thrown away or wasted. The trend toward super-sizing or "value-sized" portions, for example, is a key

contributor to increasing food wasted at restaurants (End FoodWasteNow.org 2014). It is estimated that as much as 10% of restaurant food purchases and 3 cents of every dollar spent on food outside the home is thrown away (Rotelli 2013).

Poor food management in homes adds significantly to the overall amount of food wasted. According to the Food and Agriculture Organization (FAO), the United States wastes 30% of its food, valued at \$162 billion annually (Royte 2014). Food waste is a growing problem, not only in the United States but across the world. In another great paradox of our time, approximately 870 million people are going hungry worldwide (FAO, WFP, and IFAD 2012), and yet we waste a whopping 1.43 billion tons of food—one-third of what we produce (Barclay 2013). Although some of this waste is a result of mismanagement by producers, manufacturers, distributors, and retailers, a large proportion of food waste is at the hands of individual consumers. According to the United Nations, an average consumer in Europe and North America wastes from 209 to 254 pounds (lb.) of food annually (Pandika 2013). Research suggests that the average US family wastes between 15% and 25% of the total food they buy (*Wall Street Journal* 2010), while other studies report that disposal of purchased yet uneaten food costs

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a family of four between \$500 and \$2,000 a year (Nassauer 2012).

Extant research provides more insights on why individuals overconsume than on why individuals waste food. Our objective is to contribute to the literature on food waste by providing insights on an untested factor that contributes to individual food waste. In particular, we build on the literature that examines how properties of the materials used to serve or consume food influence perceptions and consumption of food. We study the effects of a new property, material disposability, on food perceptions and food waste. Thus, our contribution is threefold. First, we investigate a hitherto untested property of serveware, whether the plate material is either permanent or disposable, on food perception and actual consumption and waste behavior. Second, we provide evidence for an undocumented effect of plate disposability such that people waste more by consuming less food when it is eaten on a disposable plate and waste less but consume more food when it is eaten on a permanent plate. Finally, our results provide preliminary evidence that the process of wasting food on disposable plates is automatic and may be related more to categorizing plate and food as disposable rather than believing that the food served is of lower quality or does not taste as good.

THEORETICAL BACKGROUND

There is ample evidence that social, environmental, and atmospheric cues influence what foods we choose, how much we eat during a consumption episode, and even how much we like it (see Chandon and Wansink [2012] for a review). Researchers have only more recently begun a systematic exploration of the role of serveware on food perception and consumption volume. Evidence is mounting that nonconsumable elements, such as cutlery, plates, and even peripheral containers (e.g., condiment containers), have the potential to alter food perceptions and how much people eat during that consumption episode (Szocs and Biswas 2016).

In the most recent review of the effects of serveware on food perception, Spence and colleagues identify a combination of physiological and psychological explanations for understanding these effects (Spence, Harrar, and Piqueras-Fiszman 2012). *Sensory transfer effects* occur when the material and shape of the serveware change the physiology or chemical composition of the food and drink (Fischer and Loewe-Stanienda 1999). *Psycholinguistic transfer effects* occur when the material of the serveware changes the psychological perceptions of the food and drink. *Automatic categorization effects* occur when people use serveware cues to

spontaneously interpret, judge, and categorize food to determine eating and stopping goals (Shimizu, Payne, and Wansink 2010). We briefly review studies that illustrate these processes, with special attention to serveware that does not touch the mouth, such as plates. Next we extend this line of theorizing to inform our hypothesis on the effects of plate disposability on food waste and consumption.

Transference Effects

Sensory Transference Effects. The literature reveals two types of transference effects: (i) sensory transference effects and (ii) psycholinguistic transference effects. Physiological or chemical changes to the food and drink itself may occur; for instance, changes to the shape of wine glasses causes varied release of organic molecules, which then can affect the taste of the wine itself (Fischer and Loewe-Stanienda 1999). In one study, for example, participants sampling cream from spoons plated with different metals (gold, copper, zinc, and stainless steel) that were otherwise identical in shape, size, and weight rated the dominant flavor, bitterness, differently dependent on materiality (Harrar and Spence 2013). Likewise, yogurt was rated as better tasting and of higher quality when tasted from a metallic spoon versus a visually indistinguishable plastic spoon (Piqueras-Fiszman et al. 2011). Sensory transference from drinking cups is also implicated in a study on haptic cues (Krishna and Morrin 2008) in which participants rated water served in a flimsy plastic cup. Only when low-autotelic participants (who do not recognize and then correct for haptic cues that they know to be nondiagnostic) touched the cup, but not when they only saw the cup, did they rate the water quality as lower. Although the sensation transfer research provides valuable insights on serveware effects on food ratings, there is no evidence on the sensory effects of different plate materials.

Psycholinguistic Transference Effects. Psycholinguistic transference occurs when attributes of the plate, such as the weight, color, or shape of plates is transferred to the food itself without direct sensation transfer to the mouth. In a series of studies, Piqueras-Fiszman and her colleagues show that the attributes of plate weight are transferred to perceptions about the food (Piqueras-Fiszman et al. 2011; Piqueras-Fiszman and Spence 2012a, 2012b). For example, when participants sampled yogurt from visually identical yet differentially weighted bowls, ratings of perceived density, expected satiety, and liking increased as the weight of the bowls increased (Piqueras-Fiszman et al. 2011; Piqueras-

Fiszman and Spence 2012b). We next review research that suggests that serveware can influence not only perceptions of taste and quality but also, more importantly for the present research, food consumption volume.

Automatic Categorization Effects

Automatic categorization occurs when stimulus properties serve as cues to the membership of the object in one or more categories (Bruner 1957). The process of automatic categorization is supported by ample literature on implicit associations, where consumers categorize pairs of stimuli faster when the association between the pairs is stronger (Greenwald, McGhee, and Schwartz 1998; Greenwald et al. 2009). Indeed, the literature suggests that the level of food consumption may result from how people spontaneously categorize food and food consumption as good versus bad (Rozin, Ashmore, and Markwith 1996; Oakes and Slotterback 2001), healthy versus unhealthy (Raghunathan, Naylor, and Hoyer 2006), and forbidden versus not forbidden (Knight and Boland 1989). In addition to these often-studied and well-established categories, Shimizu et al. (2010) explored whether categorizing food as a meal versus a snack influenced consumption volume. In their investigation, they manipulated environmental and situational cues to create either an atmosphere of a meal or one of a snack. In addition to manipulating the permanence of the serveware (ceramic/paper plates, glasses/plastic, cloth/paper napkins), the researchers also varied the presence (vs. absence) of utensils, tables, and seating to activate a meal or a snack categorization. Their findings indicated greater consumption of ambiguous foods (e.g., pizza, chicken wings) when participants thought of it as a meal compared to a snack. While the effect of material disposability cannot be disentangled from the other situational and environmental cues, to the best of our knowledge, this is the only study that incorporates material disposability as a partial means of activating categorization. Note that related work by these authors and their colleagues demonstrates the significant impact that serveware can have on an automatically activated perceptual readiness to consume larger quantities of food. For example, studies indicate that larger plates or bowls serve as a perceptual cue for food fill levels and lead to larger portion sizes and subsequent consumption volume (Rozin, Ashmore, and Markwith 1996; van Ittersum and Wansink 2012; Wansink and van Ittersum 2013).

The literature described above indicates two processes that may influence the effect of plate disposability on food consumption and waste. The transference explanation would be supported if plate disposability affects food perceptions

(e.g., taste and quality), which in turn influences amount of food wasted. The automatic categorization explanation would be supported by a perceptual readiness to dispose of food eaten from a disposable plate. This would be evidenced by (a) observing the implicit associations of the category pairs and/or (b) obtaining a direct link between plate disposability and food waste. Accordingly, we examine potential transference effects and automatic categorization effects with a bias toward the categorization explanation. Support for this perceptual-readiness explanation can be found in the relevant cultural norms related to eating on disposable plates. Specifically, social norms established by repeated associations over time favor the perception-categorization process: consumers are conditioned to throw away disposable plates and the food that remains on them; at picnics, seminars, parties, and even at home, we bring our disposable plates to the trash can and toss the entirety—food and all. By contrast, while we might also toss leftover food from a permanent plate, the plate itself is not discarded. In addition, there is an extra step required to remove food from permanent plates that is not required when using temporary plates. Thus, when eating on a permanent plate, waste may be more salient and motivate consumers to eat more and waste less. Over time, consumers' experiences with this difference in food disposal between permanent versus disposable plates may further strengthen the perception-behavior associations we propose here. Taking all this into account, we suggest that consumers are more likely to associate permanent plates with consumption and disposable plates with food waste in part as a result of their experiences with food disposal processes; this perception-behavior link activates automatically—even when people are not expected or required to throw away the plate.

In sum, we expect that the material of the plate (disposable vs. permanent) will affect food waste and consumption. Accordingly, we hypothesize that a greater amount of food will be wasted when consumers eat from disposable plates compared to when they eat from permanent plates. The coincident flip-side to this hypothesis is that people will consume a greater amount of food when eating from permanent plates (vs. disposable plates).

OVERVIEW OF THE STUDIES

We conducted five studies that test our hypothesis that plate disposability affects food waste and consumption. Two lab studies and three field studies indicate that people waste more food when eating on disposable compared to perma-

nent plates, even when they are not responsible for plate disposal. Our studies also provide insight into why plate disposability impacts food waste and related consumption. The first controlled study tests our main hypothesis and explores the process underlying the relationship between plate disposability and food waste (study 1). Our second study (study 2) provides process-level support for the automatic categorization explanation via an implicit association test (IAT) that measures associations between a choice to keep or stop eating food on permanent or disposable plates. Three field studies (studies 3A, 3B, and 3C) were conducted at a buffet lunch to provide evidence that plate disposability influenced the amount of food wasted in a natural real-world setting and, importantly, when people self-selected the amount and type of food. We also find that our results hold when the food is a snack (donuts) and a meal (lunch buffets).

STUDY 1: PLATE MATERIAL EFFECTS ON FOOD WASTE AND PLATE CATEGORY PERCEPTIONS

Study 1 tests our main hypothesis and explores the process underlying the relationship between plate disposability and food waste. We selected donuts because they are plate neutral: donuts are typically taken from a plate or a box but not consumed on the plate.

Method

Sixty-eight participants (49.3% female, $M_{\text{age}} = 19.25$ years) in an undergraduate business program at an East Coast university who were taking the same class but at different times (i.e., sessions) served as the sample for this study. Participants were assigned to either a permanent or a disposable plate condition, according to their class session. Class session did not impact the results and will not be discussed further.

Each participant was given two plain donuts on a plate that was either permanent or disposable. Because the donuts were machine-made, each donut was the same size and shape, and each two-donut serving offered the same amount of food. All plates were 10" diameter, plain borderless white; to control for plate weight, thick, heavy-stock paper plates were matched as closely as possible to the weight of thin, light plastic plates. To control for the actual plate weight, the plate with donuts was placed on each desk prior to participants entering the classroom; no participant carried or held any plates of food.

Upon entering the classroom, participants were told that the donuts were an end-of-semester treat. To control

for associations related to the act of throwing away the plate and food, the participants were told to raise their hand when they were finished eating, and a classroom assistant would collect their plate. A mini-lecture about business internships was used to conceal that participants were taking part in a study; they were unaware their food intake was measured. Once the lecture was over and their plates were collected, the participants were informed that they would receive course credit in exchange for their voluntary participation in a survey. Once all participants completed the survey and left the classroom, the wasted donuts were weighed and recorded. Plates and surveys were pre-numbered so that the plate waste could be matched with the corresponding survey response. To assess whether participants were aware of how much they ate and wasted, we asked them to respond to two open-ended questions, "How many servings of donuts were on your plate today?" and "How many servings of donuts did you eat today?" The differences between responses to these two measures were used to reflect participants' perceptions of how much food they wasted.

The survey queried participants on measures of food quality and taste perceptions (1 = very bad, 7 = very good), overall satisfaction with the food (1 = very dissatisfied, 7 = very satisfied; Krishna and Morrin 2008), overconsumption/underconsumption ("Today, I ate donuts past the point of being full," and "I wish I could have eaten more donuts"; 1 = disagree and 7 = agree), and postconsumption satiety ("After eating my food, my level of hunger was . . .," 1 = very full, 7 = very hungry; Mishra, Mishra, and Masters 2012). Perceptions of value were measured by asking participants how much they were willing to pay for the donuts (open-ended) and their likelihood of purchasing the donuts they received (1 = very unlikely, 7 = very likely).

We also collected several measures as potential covariates. General attitudes toward waste were measured on two items: "I wish I could have saved my leftover donuts for later," and "I feel guilty about not eating all my donuts" (1 = disagree, 7 = agree). We measured preconsumption hunger by asking students to respond to the statement "Before eating my food, my level of hunger was" on a 7-point scale (1 = very full, 7 = very hungry; Mishra et al. 2012). We also asked participants to report their perception of the weight of the food and the weight of the plate, each on a 7-point scale (1 = light, 7 = heavy; Piqueras-Fiszman et al. 2011; Piqueras-Fiszman and Spence 2012a, 2012b). Specific dieting was measured by asking participants to rate whether they are currently dieting to lose weight (1 = dis-

agree, 7 = agree). General eating habits were assessed on two items: "I monitor what I eat in order to be healthy," and "I usually eat whatever I want (reverse coded)."

In addition to these measures, participants also provided ratings of visual appeal ("The food on my plate seemed crowded" [1 = disagree, 7 = agree]; "How appealing was your food when you first saw it on the plate/when you decided to stop eating?" [1 = very unappealing, 7 = very appealing]), and perceptions of healthfulness and indulgence on 7-point scales ("Compared to similar foods, the food on my plate was . . ." [less healthy/more healthy, less indulgent/more indulgent, lower calorie/higher calorie]; "How much did you care about the caloric content of your donuts today?" [not at all/very much]; "The impact of eating the donuts on your overall well-being will be . . ." [negative/positive]; "The overall healthiness of my food was . . ." [very unhealthy/very healthy], and on an open-ended scale ("How many calories do you think were in one donut on your plate today?" [Knight and Boland 1989; Raghunathan et al. 2006]). Participants reported perceptions of the disposability of the plate and the donuts (1 = nondisposable, 7 = disposable) and two indirect measures of plate quality, purchase likelihood (1 = very unlikely, 7 = very likely), and willingness to pay (open-ended). Finally, we asked for the participant's age and gender.

Results

Participants who consumed at least part of the donut were included in the results. Thirteen participants (six in the disposable condition and seven in the permanent condition) who declined to eat any part of the donut because they do not eat donuts in general or for dietary restrictions were excluded from the analyses, resulting in 56 usable surveys for subsequent analysis ($N_{\text{disposable}} = 31$, $N_{\text{permanent}} = 25$).

Results confirm our hypothesis that people waste more (thus consume less) when eating on a disposable plate than on a permanent plate. ANCOVA with preconsumption hunger and current dieting behavior as covariates and plate condition as the independent variable revealed a significant main effect of plate condition on the amount of food wasted ($M_{\text{disposable}} = 1.30$ ounces (oz.), $M_{\text{permanent}} = .64$ oz., $F(3, 52) = 4.54$, $p < .05$), a significant effect of preconsumption hunger ($F(3, 52) = 5.72$, $p < .05$), and a nonsignificant effect of current dieting behavior ($p > .10$). The effect of plate condition on waste remains marginally significant when covariates are removed from the analysis ($M_{\text{disposable}} = 1.27$ oz., $M_{\text{permanent}} = .67$ oz.; $F(1, 54) = 3.55$, $p < .07$).

Results of perceived waste mirror that of objective waste. The effect of condition on perceived food wasted is significant when controlling for preconsumption hunger $F(2, 53) = 6.66$, $p < .01$, where those eating from a disposable plate reported more food wasted than those eating from a permanent plate ($M_{\text{disposable}} = .58$ servings, $M_{\text{permanent}} = .28$ servings; $F(2, 53) = 4.76$, $p < .05$). The effect of plate condition remains marginally significant when hunger is removed from the analysis ($M_{\text{disposable}} = .57$ servings, $M_{\text{permanent}} = .30$ servings; $F(1, 54) = 3.52$, $p < .07$).

We find no support for transference effects of plate disposability on food perceptions. Although participants in the permanent plate condition perceived the plate as heavier than those in the disposable plate condition ($M_{\text{disposable}} = 2.81$, $M_{\text{permanent}} = 4.64$; $F(1, 54) = 14.07$, $p < .001$), perceived plate weight did not influence food waste ($F < 1$) or perceived weight of the donuts ($F < 1$). Plate condition did not significantly influence participants' perceptions of taste and quality ($F < 1$), overall satisfaction with the donuts ($F < 1$), participants' satiety ($F < 1$), perceived overconsumption ($p > .10$), perceived underconsumption ($F < 1$), or any of the measures of donut healthfulness or indulgence ($F < 1$). Although the food on the disposable plate appeared more crowded ($M_{\text{disposable}} = 3.48$, $M_{\text{permanent}} = 2.46$; $F(1, 54) = 5.04$, $p < .05$), this did not affect food consumption ($F < 1$) and the food did not differ between conditions on visual appeal before or after eating the food ($F < 1$).

Results provide some preliminary support for an automatic categorization effect of plate disposability on food waste. ANOVA revealed a main effect of condition, such that participants in the disposable plate condition perceived their plate as more disposable and participants in the permanent condition perceived their plate as more nondisposable ($M_{\text{disposable}} = 6.06$, $M_{\text{permanent}} = 2.36$; $F(1, 54) = 73.45$, $p < .001$). Importantly, and suggestive of an automatic categorization process, perceptions of plate disposability significantly influenced perceptions of donut disposability ($\beta = .20$, $t(54) = 2.87$, $p < .01$). However, perceptions of donut disposability do not have a direct effect on waste ($F < 1$); there is no evidence that perceptions of donut disposability mediate either the effect of plate condition or perceptions of plate disposability on food waste.

Plate disposability did not influence participant's general eating habits (e.g., "I monitor what I eat in order to be healthy"; $F < 1$) nor did their habits influence donut wastage ($F < 1$). Plate disposability had no effect on how

guilty participants felt about not eating all their donuts or whether they wished they could have saved their donuts for later ($F < 1$). Finally, plate disposability did not change purchase likelihood ($F < 1$) or willingness to pay ($F < 1$) for the food.

Discussion

Study 1 confirms our theorizing that plate disposability influences food waste. Importantly, findings demonstrate that more food is wasted when it is served on a disposable plate than a permanent plate, despite being perceived as equally appealing. We found no evidence to support transference effects as the explanation for our observed effects of plate disposability on food waste or consumption.

To test the generalizability of our findings, we replicated the results we observed for donuts, a snack food, in a different study with a meal food—pizza. Following the same procedure as above, students were given three equal-sized servings of pizza on either a paper or permanent plate (authors can be contacted for details). Results replicate that participants in the disposable plate condition wasted more/consumed less pizza than participants in the permanent plate condition ($M_{\text{disposable}} = .29$ oz. vs. $M_{\text{permanent}} = .10$ oz.; $F(1, 47) = 9.55, p < .01$). Plate condition did not affect participant's perceived weight of the pizza, perceptions of taste and quality, overall satisfaction with the pizza, satiety, perceived overconsumption, or perceived underconsumption ($F < 1$).

Our preliminary evidence suggests that the link between plate disposability and food waste may depend on automatic categorization. Direct support for automatic categorization can be obtained by accessing implicit associations, where consumers categorize pairs of stimuli faster when the association between the pairs is stronger (Greenwald et al. 1998, 2009). Study 2 tests the automatic categorization process by measuring response times for the hypothesized pairs: disposable plates and food waste, and permanent plates and food consumption versus the nonhypothesized combinations: disposable plates and consumption, and permanent plates and waste.

STUDY 2: PLATE MATERIAL EFFECTS VIA AUTOMATIC CATEGORIZATION

Study 2 was designed to provide more evidence for the effect of automatic categorization on the material-behavior link between plate disposability and food waste. We conducted an implicit association test (IAT) to measure the strength of mental associations between a choice to keep

or stop eating with the concepts of material permanence versus disposability. The IAT is consistently supported as a reliable and valid categorization task that measures response time in categorizing stimuli as a proxy for the strength of associations between two concepts (Greenwald et al. 1998), where a faster response time suggests a stronger association. Support for our theorizing would be obtained if we find stronger associations (i.e., faster response times) between consumption (i.e., keep eating) and permanent plate materials (vs. disposable plate materials) and stronger associations between wasting (i.e., stop eating) and disposable (vs. permanent) plate materials.

Method

One hundred US masters-level (highly experienced and vetted) panelists (54% female, $M_{\text{age}} = 37$ years) were recruited from Amazon Mechanical Turk and compensated \$2 for participation in the survey. In order to conduct this experiment online, we used a web platform for the IAT (Mason, Allon, and Ozturk 2012). To represent the concepts of consumption and waste, our target categories were assigned as (A) keep eating and (B) stop eating, where the stimuli was a series of 20 images of the same foods on either disposable or permanent plates; the foods ranged in general healthiness and type (i.e., meal, snack, dessert; see the appendix, available online, for sample stimuli). By labeling our waste concept as “stop eating,” we presented the opposite behavior to “keep eating” and also avoided using the word *waste*, which could elicit a social desirability bias. The association categories for plate materials were assigned as (i) permanent and (ii) temporary, where the stimuli was a series of 10 words that were either permanent or disposable materials. To avoid explicitly priming the concept of disposal, we chose the category “temporary” for our disposable material words; by using the category “temporary,” we presented the opposite of “permanent” and also intended to help participants focus on the food when choosing “keep eating” versus “stop eating” as opposed to focusing on categorizing the actual plate as disposable.

Participants were instructed to “Imagine that you are eating a meal. You will be presented with a number of images of foods on a plate. For each image, please imagine that you have been eating that food. Your task is to categorize the meal accordingly. Please do this as quickly as possible while also making as few mistakes as possible.” Then, over a series of seven blocks, the stimuli (either images or words) were presented in the middle of the screen. To the upper-left and right of the stimulus were the target and/or associ-

ation categories. Participants were instructed to categorize the stimuli by using their keyboard (when the stimulus belonged to a category on the left, they pressed the “E” key; when it belonged to a category on the right, they pressed the “I” key). As a dependent variable measure, their reaction time (in milliseconds [ms]) was recorded for each stimuli. At the end of the IAT, participants were instructed to follow a link to the second part of their task, a Qualtrics survey, where we measured age and gender.

The IAT followed a traditional seven block design. Blocks 1 and 2 were “training blocks,” where participants were asked to categorize a single association between images of food on disposable or permanent plates and “keep eating” or “stop eating” (block 1) and material words as “permanent” or “temporary” (block 2). In blocks 3 and 4, participants saw the pairings of target and association categories, which we hypothesized were congruent, and they were asked to categorize the food images and material words as either “keep eating or permanent” versus “stop eating or temporary.” Block 5 was another training session, where the target categories were presented on reverse sides of the screen. In blocks 6 and 7, the pairings used in blocks 3 and 4 were reversed; participants saw category pairings that we hypothesized were incongruent (“keep eating or temporary” vs. “stop eating or permanent”). We predicted that response time for categorization would be faster when category pairings were congruent versus incongruent.

Results

A comparison of mean response times between congruent and incongruent categories shows that response latencies are significantly lower when the pairs are congruent (“keep eating and permanent” and “stop eating and temporary”; $M = 961.32$ ms, $SD = 205.38$ ms) than when they are incongruent (“keep eating and temporary” and “stop eating and permanent;” $M = 1,084.93$ ms, $SD = 266.08$ ms; $t(99) = -5.55$, $p < .001$). Results indicate that the D score (Greenwald, Nosek, and Banaji 2003) is positive and significantly different from zero, suggesting a stronger implicit association among our congruent pairs than our incongruent pairs ($D = .25$, $SD = .05$; $t(99) = 4.72$, $p < .001$). This supports our theorizing that associations between temporary materials and stop eating, as well as permanent materials and keep eating, elicit a stronger perception-behavior link than their incongruent counterparts.

In order to better understand the implicit associations for each of our congruent pairs, we further investigated the response latencies among our categorical pairings. We

observed that response times for both congruent pairs were faster than their incongruent counterparts. We find support for the association between “stop eating” and disposable materials; specifically participants’ response times for categorizing words and images as “stop eating or temporary” in block 4 was significantly faster ($M = 985.33$ ms, $SD = 210.47$) than for the incongruent pairing “stop eating or permanent” in block 7 ($M = 1,072.28$ ms, $SD = 262.23$; $t(99) = -2.68$, $p < .001$). Further, we find the same support for participants’ response times for categorizing words and images as “keep eating or permanent” in block 4 ($M = 937.30$, $SD = 219.67$ ms) versus the incongruent pairing “keep eating or temporary” in block 7 ($M = 1,097.59$ ms, $SD = 283.73$; $t(99) = -6.55$, $p < .001$).

Discussion

Study 2 demonstrates that people hold implicit associations between plate materials and waste, as well as consumption. As hypothesized, the IAT supports a stronger association as revealed by faster response times when pairing “keep eating” and permanent materials compared to “keep eating” and disposable materials, and a stronger association (faster response times) between “stop eating” and disposable materials compared to “stop eating” and permanent materials. Results of this study support an automatic categorization explanation for the effects of plate disposability on food waste and consumption. It is worth noting that we did not counterbalance the order of critical blocks 4 and 7 between subjects. Thus, one potential limitation of this study is that participants may have suffered some degree of cognitive inertia, although this limitation is minimized when using aggregate data (Messner and Vosgerau 2010).

Thus far we have demonstrated in controlled lab settings that people waste more food when eating on disposable plates. The three field studies described next were conducted to replicate the effect of plate disposability on food waste in a more natural setting and, importantly, when people could serve themselves their preferred type and quantity of food.

FIELD STUDIES: THE EFFECT OF PLATE MATERIAL ON WASTE AT BUFFET LUNCHEONS

In three field studies, we tested our hypothesis in a lunch buffet setting; studies 3A and 3B were conducted in an executive education program at an East Coast university and study 3C was conducted in a school lunchroom at an East Coast high school. These buffet dining contexts provided

a setting where participants were free to take as much food as they wanted on their plate or bowl and had a choice among a variety of foods.

Field Studies 3A and 3B:

Common Procedure and Method

In the first two field studies, we tested our hypothesis in a lunch buffet setting in an executive education program at an East Coast university. Participants enrolled in this executive education program are always served a buffet lunch in the dining area and were unaware their behavior was being observed. Further, we were able to observe differences in consumption and waste behavior between restaurant-quality permanent plates and disposable plates of the same size and color.

In both field studies, we collected aggregate data on food waste by plate materiality; we were unable to measure amount taken and consumed/wasted for each individual. The total weight of the buffet food was measured in the kitchen prior to being served. After getting their own food, participants sat with each other at tables and ate their lunch. As per their customary tradition, the dining staff removed diners' plates when they were finished eating. However, rather than immediately discarding the food waste, the dining staff brought all the used plates to the kitchen, where a researcher scraped any food that was left on the plates or bowls into a large bin and weighed the cumulative waste on a sensitive cafeteria-grade scale. None of the participants were aware that their intake or food waste was being measured in either of the field studies.

The manipulation for plate materials was carried out by placing either disposable plates (paper plates and bowls) or permanent plates (ceramic plates and bowls) at the beginning of the buffet line. All bowls and plates, both disposable and permanent, were plain white and of equal sizes and volumes.

After finishing their lunches, the participants returned to their lecture; a few minutes prior to the end of this lecture, participants were asked if they would provide brief feedback about the meal for future meal planning. Specifically, participants rated the taste and quality of the meal (1 = very bad, 7 = very good) and satisfaction with the meal (1 = very dissatisfied, 7 = very satisfied; Krishna and Morrin 2008), whether they were currently restricting their food intake and whether they had any food restrictions that prevented them from eating items from the meal (yes/no), whether they usually eat a meal for lunch (yes/no), and their level of hunger before and after the meal

(1 = very full, 7 = very hungry; Mishra et al. 2012). Participants also indicated their age and gender.

Assuming a uniform distribution, that is, food waste would occur in both conditions with equal frequency, we calculated an independent samples *t*-test to compare the aggregate proportion of food wasted in the disposable versus permanent conditions. Because food waste was measured on an aggregate level, we could not match survey results with food waste. However, consistent with our experiments, results of ANOVAs on the survey items indicated that there were no differences in perceived taste, quality, or satisfaction with the meal, hunger before or after the meal, meal behavior, or food restrictions across conditions of plate permanence for either of the field studies ($F < 1$).

Field Study 3A

Forty participants (52.5% female, $M_{\text{age}} = 43.5$ years) were observed over two consecutive days during lunch time. All participants were assigned to the permanent plate condition on day 1 and to the disposable plate condition on day 2.

This study allowed us to measure the amount of food taken from the buffet for each day. Using this information, we calculated the proportion of food wasted as the total amount of food left uneaten on the plates (Permanent = 5.25 lb., Disposable = 8.5 lb.) divided by the total amount of food taken from the buffet (Permanent = 62.5 lb., Disposable = 54.7 lb.). Results showed a significant difference ($t(39) = 9.36, p < .001$) between the proportion of food wasted in the disposable condition (15.5%, $SD = 0.05$) and the permanent condition (8.4%, $SD = 0.02$). As predicted, participants wasted a greater proportion of the total food taken when lunch was eaten from disposable plates. Interestingly, participants took more food in the permanent condition ($M_{\text{permanent}} = 1.57$ lb.) compared to the disposable condition ($M_{\text{disposable}} = 1.37$ lb.); this difference could be due to menu variation and is accounted for in study 3B.

The results of our first field study provide corroborating evidence that plate materials influence the volume of food wasted. Specifically, we show that participants waste more food when their meal is consumed from disposable plates (plate and bowls), compared to a permanent one, even when participants chose their food items and served themselves. Although we did not observe any differences in food quality and satisfaction, one limitation of this study is that the menu was different for each condition, as we could not

offer the same lunch options to participants 2 days in a row. Thus, in our next field study, we control for this by manipulating plate material within one lunch period (i.e., same menu items).

Field Study 3B

Forty participants (38.2% female, $M_{\text{age}} = 39$ years) were observed for this study. To control for menu, all participants ate lunch from the same buffet line on the same day. The procedure followed that used in study 3A with one exception: 20 permanent plates and bowls were placed at the beginning of the buffet line, allowing the first 20 participants to use permanent plates. After the last permanent plate was used, a member of the dining staff restocked the buffet table with paper plates and bowls, apologizing to the remaining 20 people in line that “the foodservices’ dishwasher has broken.” All plates and bowls were white in color and matched for size and volume. Participants were not made aware of the field study, and none of the participants questioned the replacement of the buffet line with disposable plates nor reported suspicions regarding it.

Results show a significant difference ($t(19) = 2.58, p < .01$) between the amount of food wasted in the disposable condition (1.2 lb., $SD = 0.69$) and the permanent condition (0.8 lb., $SD = 0.46$). As hypothesized, participants in the disposable plate condition wasted more food taken from the buffet than did participants in the permanent plate condition.

The results over two field studies among executive MBA students support our findings from the controlled consumption studies, as participants wasted more food when it was served on disposable plates. In study 3A, we could not control for the menu items between conditions. This was corrected in study 3B. However, in this study we could not account for the amount of food taken in each condition. In our next field study, we both keep the menu consistent and account for the amount of food taken. Further, while we have thus far observed that plate material affects food waste among younger and older adults, we sought to determine if this effect would surface with a teenage population.

Field Study 3C

Approximately 240 high school students (ages 14–18) and 10 faculty (ages 24–55) were observed during two lunch sessions. Participants were unaware that their behavior was being observed, and they proceeded with their customary routine of requesting hot food from a staffed buffet line

and then visiting a cold-food buffet (salad bar) and serving themselves. The food service director worked with us to choose two dates approximately 1 month apart that he could serve the exact menu and that there were no special school activities scheduled that would meaningfully alter the student population on that day (e.g., grade-level class trips).

All food was weighed before service, and any uneaten food was scraped into a waste bin. On the first observation day, participants ate on their usual permanent serveware (plates, bowls, cups, and utensils) and scraped their food waste into a garbage bin, per their usual procedure. Since we ultimately needed to calculate average waste per plate, we stationed two student monitors near the garbage bins with a counter. These monitors recorded the number of plates from which garbage was being disposed. Approximately 4 weeks later, we returned to the lunchroom for the second observation, in which we replaced the usual serveware with disposable serveware; any participant who asked the dining staff about the disposable serveware was told “the dishwasher is broken.” The student monitors recorded the number of plates, cups, and utensils that participants discarded. The weight of the discarded serveware was subtracted from the total garbage weight to provide our subsequent measure of food wasted.

We calculated the proportion of food wasted as a difference between amount of food taken and amount of food scraped into the garbage. Results are reported as an average of total plates used during service ($N = 271$) and show a significant difference ($t(270) = -3.47, p < .001$) between the proportion of food wasted in the disposable condition (19.5%) and the permanent condition (10.8%). As predicted, participants wasted a greater proportion of the total food taken when lunch was eaten from disposable material.

Further, and in support of field study 3A, participants wasted more yet took less food in the disposable condition ($M_{\text{taken}} = 7.71$ oz., $M_{\text{wasted}} = 1.5$ oz.) and wasted less yet took more in the permanent condition ($M_{\text{taken}} = 10.13$ oz., $M_{\text{wasted}} = 1.09$ oz.). This result suggests that people may be equally satiated on less food when consuming with disposable serveware. Future work could explore the process behind this result and the contexts under which it could be helpful versus harmful. For example, in a school lunchroom setting where students often get their main nutrition for the day, we may hope to see higher levels of consumption and lower levels of waste. On the other hand, in commercial foodservices such as fast casual dining, managers may be inclined to cut costs by serving smaller portions

on disposable serveware if consumers are just as easily satiated with less food.

GENERAL DISCUSSION

The results of two lab studies and three field studies confirm our hypothesis that plate disposability affects food waste. We show that people waste more food when eating on disposable compared to permanent plates, even when they do not have to throw away the plate after they finish eating. This effect is obtained when the food is unambiguously a snack (donuts) or a meal (lunch buffets). Our findings maintain when people are served a fixed quantity of food and when people self-select the amount and type of food.

We also provide evidence that an automatic categorization process underlies the effect of plate disposability on food waste and consumption. The automatic categorization process is implicated by the direct links found between plate disposability and food waste. More direct evidence for automatic categorization is from an implicit association test revealing that people have a stronger association between “keep eating” and permanent materials compared to “keep eating” and disposable materials, and a stronger association between “stop eating” and disposable materials compared to “stop eating” and permanent materials.

We do not find support for transference effects; plate disposability did not alter food perceptions and overall satisfaction with the food. Although plate disposability affected weight perceptions in study 1, these perceptions were not transferred to food consumption, as in the study by Krishna and Morrin (2008). The difference between our study and theirs is that participants “handled” the cups serving the liquid, whereas we did not permit our participants to carry their plates with or without food (study 1). Along the same lines, transference effects may be stronger when the serveware materials touch the lips, as in glasses and spoons (Piqueras-Fiszman et al. 2011; Harrar and Spence 2013), than plates or other serveware that does not come into direct contact with the mouth. Our lab study was limited to serving commercially produced donuts. It is possible that this standardization might inhibit transference effects. For example, transference might arise more readily for foods that have a larger variation in quality, taste, or health perceptions. To this extent, we did find the same result in our field study (3A) where foods varied and participants served themselves. More research is needed to understand when and how transference effects determine waste and consumption.

Despite our null results, we nonetheless view our findings as informative in building a systematic understanding of the conditions under which transference would and would not obtain. The inconsistency between food perceptions and food consumption volume is not surprising given the well-established literature on the instability of the attitude-behavior link. Considerable research indicates that attitudes are temporarily constructed judgments and that contextual factors, in our example, plate disposability, may undermine the consistency between attitudes and behaviors (Wilson and Hodges 1992).

People eating on permanent plates consumed more food but did not feel fuller compared to people eating on disposable plates. In contrast to the “mindless eating” that seemed to occur here, some serveware does cue satiety. For instance, compared to larger forks, smaller forks serve as a perceptual cue that more bites are required to get full; consequently, consumers are shown to eat more food when using smaller forks (Mishra et al. 2012). Future work is needed to provide an understanding of when and what types of serveware may influence perceptions of and expectations for satiety.

Consumers and marketers can benefit from a deeper understanding of the antecedents and consequences, as well as interventions, for wasteful behavior. For example, future investigations could explore alternatives to wasting food. There are two general scenarios where a choice to dispose of food would occur: those where consumers can save their leftover food and those where they cannot. In contrast to our research, where consumers cannot not save their uneaten food, there is an unexplored alternative where consumers can save their uneaten food, and the choice set is extended: eat more, throw it out, or save it for later. Certain scenarios might even signal the perceived appropriateness of wasting. For example, perhaps a certain amount of wasted food is actually the expectation on a first date, at a business function, or at an interview lunch. We view the current research as important in identifying one driver of food waste, but we encourage the development of a deeper and more systematic mapping of contextual factors that influence food waste.

THE LARGER THEME: RESOLVING THE WASTE-WAIST DILEMMA

As consumer food waste has been increasing, so has the rate of food insecurity (underfed consumers) and the rate of obesity (overfed consumers); while US consumers throw out enough food each year to feed 25 million Americans

(Gunder 2012), 17.5 million households were food insecure in 2013 (Coleman-Jensen, Gregory, and Singh 2014), and more than two-thirds of US adults are overweight or obese (Ogden et al. 2014). Despite efforts to reduce food waste, insecurity, and obesity, these three factors remain prevalent across the globe.

These paradoxes of food waste—insecurity and obesity—raise a larger question about food acquisition. According to a 2014 report by the Food Marketing Institute, every \$1,000 generated by grocery retailers results in 10 lb. of food wasted. According to the FAO, one out of seven Americans goes grocery shopping nearly every day (Goodman 2008), and consumers are preparing twice the amount of food they need, overconsuming by 25% and throwing the other 25% away (Giesler 2012). Thus, while it could be advantageous to encourage consumers to waste less of the food on their plates, we must also consider the alternatives—including an unintended outcome of consuming more food in order to waste less of it. In addition, overacquisition by some consumers may exacerbate food insecurity among other consumers by shifting accessibility of resources along the supply chain.

Our research findings suggest that plate material may contribute to this waste-waist dilemma, where plate disposability can lead to increased food waste, while plate permanence may produce increasing waistlines through increased consumption. We therefore suggest that one solution is to better match plate materiality to consumption goals. For example, permanent plates should be used in contexts where the goal is to consume nutrition as well as reduce food waste, as the case may be in lower-income schools, elder care facilities, and hospitals.

We hope that the current research stimulates more discussion and research on the development of a deeper and more systematic mapping of contextual factors that influence food waste. The context in which food is supplied and demanded has a significant impact on the amount wasted. In the following sections, we address a few main contexts where our particular contextual cue, serveware material, reveals itself in the waste-waist dilemma.

Food Waste in Schools

Food waste is particularly high among school lunchrooms, and it has been increasing significantly in recent years. According to the Environmental Protection Agency, the average American child throws away 67 lb. of lunch food per year (Reuseit 2013). Coincidentally, over the past 15 years, USDA-funded public school lunchrooms have been transi-

tioning from permanent to disposable serveware due to budgetary limitations for labor, replacements, and storage. As our findings demonstrate, plate disposability can affect food waste. However, the question remains as to how the effect can be attenuated.

While the superficial answer in this context is for public schools to revert back to permanent serveware, the reality is that infrastructure for public school food services do not support such a transition. A more cost-efficient method would be to make people aware of the link between disposable plates and food waste with the hope that they will take less and waste less food. Or, given the option for students to return for second helpings, food cafeteria staff could serve less food on disposable plates if they know students tend to waste more. This is an important issue to address, as millions of students get their main nutrition for the day through public school foodservices. Wasted food in this context is also wasted nutrition. Further research is required to test these hypotheses to provide public policy makers guidance for economical solutions that mitigate the waste effects of plate materials among institutional foodservice settings while also encouraging consumption of healthy foods. One contextual cue with promising evidence is that of cafeteria trays; Aramark reports that food waste was reduced by 25%–30% when trays were removed from foodservice (Davis 2008). While tray-related waste may be a result of overacquisition, further investigation is needed to determine when and where trays may encourage consumption. Our results suggest the possibility that trays made from permanent materials may encourage consumption, while disposable trays may encourage waste. The USDA school lunchrooms may use this information to determine when and where to place trays; for example, permanent trays could be placed beside the salad bar to encourage students to take and consume more.

Food Waste in Restaurants and Convenience Stores

Our field study results contribute to the debate on food waste in restaurants and convenience stores selling prepared foods in open format (e.g., salad bars and buffet counters). The sources of food waste in restaurants vary greatly, but, on average, a restaurant can produce 150,000 lb. of garbage per year (EndFoodWasteNow.org 2014). The abundance of food, the unlimited consumer access to the food, and the amount of food thrown out that is never served makes food waste especially pronounced in cafeterias and buffets. As Americans, we frequently seek out establishments that offer more for our money, as well as enjoy the

variety and abundance presented by buffets and cafeteria-style eating, both of which innately generate large amounts of food consumption and food waste.

In an effort to avoid any potential health risks or lawsuits, real and imagined legal concerns from health regulations often prevent cafeterias and buffets from donating leftover (displayed but not taken) food, which leaves a large portion of the visually abundant food to ultimately be thrown away. The National Restaurant Association, the Food Marketing Institute, and the National Grocers' Association have taken a leadership role in reducing food waste by introducing a "Best Practices" toolkit for manufacturers, wholesalers, retailers, and foodservices (Food Waste Reduction Alliance 2014). While the toolkit provides solutions for location- and process-specific waste reduction, food policy adjustments are an essential part of the landscape in order to address the waste that occurs through consumers' demand for visual abundance. Further, practitioners should be encouraged to look to the consumer behavior literature for guidance on how contextual cues could influence consumers' perceptions of abundance. In retail and foodservice landscapes, such cues might suggest how food could be presented to maintain perceptions of abundance, yet reduce actual food displayed and thus wasted.

Postconsumer restaurant plate waste (the food you neither eat nor doggy-bag) presents a complex waste-waist dilemma. Finishing the food served by restaurants, which often times is an oversized portion, would reduce food waste but might lead to consuming more than one's caloric daily requirements. Many diners who decline to doggy-bag their leftovers share the guilty experience of requesting the waiter to take their extra food away, knowing it is destined for the dumpster. We recommend restaurants actively encourage consumers to take home food remaining on their plates. In an effort to do so, food services that utilize disposable plates should provide tightly fitting disposable covers. Additionally, signage could encourage doggy-bagging behaviors, particularly in fast-food or to-go restaurants. And composting initiatives should be further encouraged among restaurant staff.

Environmental Impacts

There is a direct link between disposable plate materials and negative environmental impact. A growing number of companies have adopted "green" or environmentally friendly policies and practices in response to consumer demand for more conscientious eating (Forbes 2014). For foodservices, in particular, the National Restaurant Association launched

a Green Restaurant recognition program in 2010; although the meaning of the green movement might be understood in broad terms (sustainable, eco-friendly, renewable), the actual requirements for a restaurant to acquire a Green Restaurant designation point to our waist-waste dilemma (Fast Casual 2010). Points toward certification are awarded for restaurants that offer smaller portions of entrees at a reduced price, compost post-consumer (food and packaging) waste, and donate to a food bank every week. Additionally, restaurants must compost and recycle serveware materials such as plastics, glass, aluminum, cardboard, and paper, and compost food where the local sanitation infrastructure allows. Our research provides important evidence to suggest that part of the Green Restaurants program might include provisions for serveware material uses, as a reduction in the use of disposable materials would decrease not only wasted food but also the environmental impact of the materials themselves.

Overall, Americans throw away enough serveware each year to circle the equator 300 times (Wills 2010). In fact, consumers who regularly use disposable serveware for lunch may generate up to 100 lb. of trash per year (Reuseit 2013). As our findings suggest, consumers may waste more food yet eat less food on disposable materials; here we find a waste-waist dilemma for the environmental impact of using disposable serveware as an intentional measure to eat less food. Increased use of these materials is an increased impact on the environment. Such an impact of disposable plates on landfill space must be addressed throughout the supply chain and by appealing to "green" consumers. Studies show that consumers who demonstrate waste avoidance practices also demonstrate greater concern for the environment (Haws et al. 2012) and product disposal (Webb, Mohr, and Harris 2008), as well as a stronger likelihood of environmentally friendly behaviors (Balderjahn 1988). Further, serveware materials exist on a continuum of environmental impact (e.g., compostable, recyclable). Might plates that evoke different categorical associations, like environmental friendliness, influence wasteful behavior?

The magnitude of the food waste problem should be a calling card for consumer researchers. In his call for greater attention from consumer researchers on the topic of food waste, Porpino offers several categories of topics and specific research questions that await investigation. For example, the intersection of social connectedness and food waste is largely unexplored (Porpino 2016). Since we know that social monitoring influences consumption volume (Holden, Zlatevska, and Dubelaar 2016), it stands to rea-

son that lack of social monitoring increases food waste. In fact, ample literature has examined the effect of social and contextual cues on consumption volume, but these same social and contextual cues are presently unexamined from a food waste perspective. These and other ideas await formal investigation.

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