# From Norm to Table (and Beyond): The Cooperative Dilemma of University Food Waste

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#### Abstract

Consumer food waste in a university dining hall context represents a cooperative dilemma, where individuals must expend some costly effort (i.e. the planning required to take only what they will eat) in order to promote a public good (i.e. reducing food waste). Insights from the social sciences, particularly from the growing field of human cooperation studies, can be applied to this dilemma to improve methods of reducing food waste. This paper describes a field study conducted in the undergraduate residential dining halls at Yale University, which implemented a cooperation-inspired marketing campaign to reduce student dinnertime food waste by 3% in dining halls in which it was hypothesized to be successful. Waste in six dining halls where students scrape their own dishes was reduced by a statistically significant average of .01 pounds per person per day on days with menus that typically generate low waste, totaling an average waste reduction of 16.21 pounds per day across six dining halls. These results suggest that framing food waste as a cooperative dilemma provides a useful set of theoretical and practical tools for reducing waste. It also suggests directions for future work in the study and implementation of applying cooperative social interventions to the problem of food waste.

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#### 1 Introduction

#### 1.1 Food waste

Food waste is an unfortunately common problem. At the US level, the USDA estimates that 30-40% of produced food is wasted (USDA Office of the Chief Economist, n.d.). In 2010, 133 billion pounds of food (valued at \$161.6 billion) were wasted at the retail and consumer levels in the U.S., representing a loss of 31% of the food supply (Buzby, Farah-Wells, and Hyman, 2014). While food waste can be seen as inherently wrong or unethical simply because it is wasteful, this unused food also has a substantial environmental impact as well as a financial impact on consumers and retailers.

# 1.1.1 Costs and effects of wasted food

Agriculture in the U.S. (not including food shipping or other associated industries) accounts for 9% of U.S. greenhouse gas emissions (Environmental Protection Agency, 2017). Although a large proportion of these gases are unavoidable side effects of maintaining typical U.S. diets through our current agricultural systems, the greenhouse gases generated by the production of wasted food are not linked to any benefit to humans, and could be avoided with no reduction in consumers' quality of life. The same can be said for fertilizer and pesticide use, degradation of soil, contamination of water by animal and chemical wastes, pollution from shipping, and other common side effects of industrial agriculture that are produced by food that is never eaten. Food waste has been estimated to account for consumption of about 300 million barrels of oil annually, as well as over one quarter of total U.S. freshwater use (Hall et al., 2009). According

to an estimate by Cuellár and Webber (2010), two percent of energy use in the United States is embedded in wasted food (accounting for energy use from agriculture, transportation, processing, sales, storage, and preparation).

After it has been discarded, wasted food is usually sent to landfills: less than 3% of U.S. food waste was recycled/composted in 2010 (Buzby, Farah-Wells, and Hyman, 2014). Once in the landfill, wasted food contributes additional large amounts of methane (USDA Office of the Chief Economist, n.d.) and is the largest component of municipal landfills, making up 21.6% of total landfilled municipal solid waste by weight (Environmental Protection Agency, 2016).

Households and individual consumers also incur a variety of costs from wasted food. Buzby and Human (2012) estimate that the average American in 2008 spent \$1.07 each day on food that was thrown away, totaling almost 10% of annual per capita spending on food and over 1% of average disposable income.

But this is not merely a household problem: Food waste is also an issue for universities, including Yale University. U.S. college and university annual food waste was estimated at 3.6 million tons (7.2 billion pounds) in 1992, representing 2% of solid waste in the US (Saphire, 1995). University dining services, like households, pay for food that never gets eaten, but many, including Yale, also pay by the pound to have production and postconsumer food waste taken away and composted by a commercial composting company. In 2013, Yale Dining spent about \$72,000 on compost disposal (\$60 a ton for "nearly" 1200 tons [Yale Sustainability, 2017]). This may underestimate the true cost of disposing of food waste at Yale, since some additional food is discarded with trash rather than compost, at a higher cost of \$87.50 per ton (Yale Sustainability, 2017). Compostable waste constituted 16% of Yale's total material waste (by

weight) in 2013 (Yale Sustainability, 2017), indicating that a reduction in food waste could help reduce Yale's waste disposal budget.

# 1.1.2 Food waste as a cooperative dilemma

For financial and environmental reasons, then, it is in the best interests of many individuals and institutions to reduce the amount of food that they waste. However, reducing food waste at a consumer level is itself often costly in terms of effort and mental energy (Graham-Rowe et al., 2014), and in an institutional setting like a university dining hall, the consumer receives no direct benefits from reducing waste. Following Rand and Nowak (2013), individual efforts to reduce waste can therefore be classified as cooperative behaviors, where *cooperation* is defined as a situation in which one individual pays a cost so that another will benefit.

For households who directly purchase and cook their own food, it is easy to connect a reduction in waste to an increase in savings, and therefore in disposable income. Stancu et al. (2016) found that for households, knowledge of the personal financial effects of waste had a larger impact on waste reduction than did awareness of environmental and social negative externalities. But most students who live on their university's campus have a prepaid meal plan, and therefore assume no direct cost for wasting food. The university absorbs the cost of wastage, and the cost of the wasted food is not made salient to students. Additionally, many students' meal plans are paid for by their parents or a financial aid award, further reducing the individual student's financial responsibility. Therefore, personal economic concerns cannot be used as an incentive to reduce waste in a university context. In buffet-style dining halls, students may also

take as much food as they wish with no additional charge, and they are often discouraged from taking leftovers out of the dining hall (which could reduce waste if they eat the food later).

Because of this dining structure, not wasting food in university dining halls is a cooperation problem, or *cooperative dilemma* (Rand and Nowak, 2013).

In a cooperative dilemma, the population as a whole benefits if all individuals contribute some costly behavior. Yale and society as a whole will benefit if students reduce their wastage of food, but it is somewhat effortful and inconvenient for students to do so, and they will likely not see any direct benefits of their efforts. Graham-Rowe et al. (2013) found that a desire to minimize inconvenience and a lack of priority were two of the main types of barriers preventing household food purchasers in the UK from reducing their food waste.

Recent theories about the context-dependence of consumption and dietary choices also indicate that eating is largely an automatic behavior conducted in response to environmental cues such as portion size, food visibility, and ease of obtaining food (Cohen and Farley, 2008; Cohen and Babey, 2012). Since overriding automatic eating behaviors requires a good deal of self-control, which is highly effortful and a limited cognitive resource (Muraven and Baumeister, 2000). The large portion sizes and highly visible food layout characteristic of university dining hall settings contribute to automatic eating. If people try to interrupt their automatic eating habits after they have already taken too much food, consumption will decrease but waste will increase. Automatic eating habits must therefore be overridden before food is taken from the buffet in order to prevent waste. These studies indicate that reducing food waste in the context of university dining halls is not easy for the individual, although it benefits the university (and arguably the broader community), and can thus be classified as a cooperative dilemma.

# 1.2 Promoting cooperation

Extant social science literature suggests that it is possible to promote cooperation in real-life situations like this one. Interventions based on improving the cost-benefit ratio of cooperative actions, either through providing material rewards (e.g. cash or gifts) or increasing efficacy (e.g. through matching funds) have mixed results (Kraft-Todd et al., 2015). However, social interventions, based on either observability (making people's actions visible to others) or descriptive norms (informing people about the decisions of others), have been consistently found effective (Kraft-Todd et al., 2015). These types of intervention tap into the power of indirect reciprocity: if an individual helps others by cooperating now, other people are more likely to help that individual in the future (e.g. Rand et al., 2014; Kraft-Todd et al., 2015; Yoeli et al., 2013). By increasing the observability of people's behavior and making them aware of the behavior that is typical in a particular situation, indirect reciprocity interventions indicate to people what others expect them to do, and show them that they could gain a reputation as a cooperator if they engage in normative behavior. People want to gain a reputation as someone who contributes to the public good so that others will reciprocate in the future by contributing to their good – hence indirect reciprocity.

# 1.2.1 Descriptive norms

One method of promoting cooperation is to tell people what they should do from a moral or economic perspective, through prescriptive norms (e.g. Tankard and Paluck, 2016). However, people often knowingly fail to do what they "should," and although they may experience guilt as

a result, it is not always enough to motivate cooperation. While prescriptive norms tell people what they *should* do, descriptive norms tell people what others *actually* do in a given situation, thereby indicating what behavior is normal and therefore expected. When told that others have cooperated in a situation, people are more likely to also cooperate (see Kraft-Todd et al., 2015, for a review).

This strategy has been used most widely in the environmental domain, often in reducing resource use (Miller and Prentice, 2016), and it seems that descriptive norms are both predictive of real behavior and useful as a means of changing behavior. Nolan et al. (2008) found in a survey of Californians that perception of descriptive norms about energy conservation was more predictive of actual behavior than were other relevant beliefs about the environment, saving money, and benefiting society. Descriptive norm-based interventions have been found effective in real-world situations including increasing towel reuse in hotels (Goldstein, Cialdini, and Griskevicius, 2008), reducing energy consumption (e.g. Ayres, Raseman, and Shih, 2012; Allcott, 2011), and reducing household water use when accompanied by information about subjects' own consumption through a peer comparison message (Schultz et al., 2015). These conservation behaviors are somewhat analogous to reducing food waste in that they are either financially neutral or actually beneficial (i.e. subjects save money by conserving water), but require effort and self-control.

Interventions can also target the means of normative transmission through social interactions. Paluck and Shepherd (2012) examined social networks and collective norms surrounding harassment behavior in a public high school to determine the way norms are created, shared, and changed. They found that changing the public behavior of some highly

connected and socially salient students (called "social referents" after a theory developed by Sherif & Sherif [1964]) changed their peers' perceptions of collective norms in the school, as well as their behavior. Specifically, students believed that harassment was less acceptable and desirable, and were more likely to report incidents of harassment, after a group of social referents carried out a public anti-harassment campaign. Social referents' influence, Paluck and Shepherd (2012) discovered, was particularly strong on peers with whom they had frequent and personally-motivated interaction. These findings suggest that changing the public behavior of either widely-known people or leaders of cliques or other groups (the two types of social referents targeted by Paluck and Shepherd's [2012] intervention) could be an effective way to shape social norms towards cooperation.

However, Tankard and Paluck (2016) point out that people do not generally perceive social norms in an unbiased or fully accurate manner. Therefore, universities with a strong campus culture and unified student community may find it easier to encourage student cooperative behavior by shaping perception of norms rather than changing the behavior of social referents (which might be misperceived or ignored). Because individuals focus on select sources of normative information (such as media or their friend groups), their lack of comprehensive knowledge results in inaccurate perceptions of the actual rates of certain behavior (Tankard and Paluck, 2016). Nevertheless, people are motivated to abide by what they perceive to be the norms of their community (even if these perceived norms are inaccurate). Interventions can influence perceptions of a group's normative behavior not only by changing the public behavior of social referents, but also by presenting new summary information about the group or issuing signals from institutions that are important to the group (Tankard and Paluck, 2016). However,

an individual must identify with the group if the group's norms are to influence the individual's behavior. Prentice and Miller (1993) found that male students at Princeton University were more likely than female students to be influenced by the university's norms surrounding drinking behavior, and proposed that this could be because the prototypical Princeton student at the time was male, due to the relatively recent (1969) admission of women to the university. Perhaps, they reasoned, female students did not identify as Princeton students as strongly as male students did, and were therefore not as influenced by the prescriptive and descriptive norms encouraging drinking in this group. It may also be that there were completely separate norms around drinking behaviors for women at Princeton. It is highly likely that there are similar gender differences in norms about food waste, particularly in universities. For example, women may be made to feel uncomfortable when they finish all their food (by the comments of male friends) because of a norms requiring women to be "dainty" or refined and not eat too much (R. Lackner and A. Dutton, personal communication, April 5, 2017). This is consistent with findings that women tend to waste more food than men in university dining halls (e.g. Küng, 2015; Painter et al., 2016).

# 1.2.2 Observability

In some situations, people already know that cooperative behavior is the norm for a group with which they identify, but the inconvenience or other cost of this behavior still prevents them from engaging in it. When people know that a cooperative action will benefit their reputation, increasing the observability of their behavior will increase the likelihood that they cooperate. Increasing observability has been shown to improve rates of cooperation in a variety of

cooperative dilemmas. Participation in a blackout prevention program was nearly tripled by posting participants' names and housing unit numbers in a public place (a building lobby or shared mailbox kiosk), compared to letting participants remain anonymous (Yoeli et al., 2013). This effect was much larger for residents of apartment buildings than residents of row houses or standalone homes, suggesting that these residents interact more often with their neighbors and are therefore more concerned about their reputation in the building or neighborhood (Yoeli et al., 2013).

Another study found that feelings of pride about performing normative, cooperative behaviors and shame about failing to perform these behaviors are likely motivating factors (DellaVigna et al., 2014). This study investigated voting in a national (Congressional) election, which is theorized to be a norm-motivated behavior, and found that many people vote because others will ask whether they voted. Voter turnout was increased telling potential voters that they would later be asked whether they had voted, an indirect type of observability (DellaVigna et al., 2014).

Financially costly behaviors like donations can also be encouraged by increasing observability. Alpizar et al. (2008) showed that contributions to a national park in Costa Rica were increased by 25 percent when contributions were observed by a solicitor, compared to when they were made in private. Bateson et al. (2006) discovered that these effects of observability can even be induced by posters of human eyes that merely create an impression of being watched. This has been demonstrated in situations including contributing to an honors-system office coffee fund (Bateson et al., 2006) and increasing donations to charity in a supermarket (Powell et al., 2012), as well as reducing litter left on dining hall tables (Ernest-

Jones et al., 2011). These studies show that making the observability of people's actions salient (even if real observability is not increased, as when observability is cued with images of eyes) increases the likelihood that they will behave cooperatively. This effect is largely due to people's desire to maintain a good reputation, but is likely also motivated by a desire to avoid feeling negative emotions like shame (DellaVigna et al., 2014). Increasing observability has the potential to be a useful tool for reducing food waste, since guilt is a strong motivator for not wasting food (Quested et al., 2013; Neff et al., 2015).

# 1.2.3 Limitations of social interventions

Both of these types of social interventions – making descriptive norms more salient and increasing observability – only work if cooperative behavior is the norm, and the observable action is reputation-building. If people are already habitually cooperating more than their peers, informing them about descriptive norms can be ineffective and may actually decrease their cooperation, in what is called the "boomerang effect" (e.g. Cohen, 1962). Although Schultz et al. (2015) found that peer-comparison reports successfully reduced water use, households who already held personal norms of water conservation showed no reduction in water use following the intervention, and there was a slight increase in water usage among households with low baseline water usage. Similarly, Bhanot et al. (2015) found that when households with low water use were given neutrally-framed information about their water use relative to their neighbors, their water usage increased significantly, although a competitive framing eliminated this effect. However, competitive framing is also not universally successful: Competitively-framed ranking information increased the average water usage of households whose usage was

already high, presumably by making them think they could not possibly win the competition and thereby demotivating them to control their water usage (Bhanot et al, 2015).

Another study found that political ideology interacts with norm-based interventions, and can similarly cause them to backfire: Costa and Kahn (2011) discovered that providing feedback to householders about their own and their peers' electricity usage was 2-4 times more effective if the householders were political liberals than if they were conservatives. Furthermore, conservatives were found to actually be more likely to increase their electricity consumption if told that they were "good" with regards to electricity usage relative to their neighbors. In the realm of monetary donations, Alpizar et al. (2008) found that providing a descriptive norm of low donations (by telling guests that others donated an average of \$2) decreased donations to a national park. Similar negative effects of peer comparison have been found in non-cooperative situations, such as saving for retirement (Beshears et al., 2015).

Observability is also dependent on social desirability. Ariely et al. (2007) found that students at Princeton put forth very little effort in the lab to donate to a charity considered "bad" by most students (the National Rifle Association) compared to a charity considered "good" (the American Red Cross), and while observability increased effort in donating to the "good" charity, it did not affect contribution to the "bad" charity. This study also found that extrinsic motivation (in the form of a monetary incentive) insignificantly decreased effortful contribution to both "good" and "bad" charities when donations and incentives were made public, but increased contribution when students' actions were private (Ariely et al., 2007). This indicates that Princeton students' contributions to charity are likely driven by reputational or image concerns. When the public knows that students are receiving a monetary incentive, charitable actions no

longer confer the same reputational benefits. Therefore, combining social interventions with monetary rewards is likely to be counterproductive. Fortunately, social interventions have been proven more effective than modest monetary incentives – in some cases, four times more effective (Yoeli et al., 2013). There is rarely occasion for monetary incentives in the case of reducing food waste, but these results indicate that we must ensure that not wasting food is a socially desirable behavior if observability-based interventions are to work. Additionally, it would be prudent to avoid informing people of the rates of food waste in their community if these rates could possibly be construed as high, because normalizing high levels of waste is likely to have a boomerang effect, increasing the waste of individuals who typically waste less.

A final aspect of social interventions that is thought to interact with observability and norms in a way that improves cooperation (though it has not yet been explicitly tested) is the concept of "categorical asks." This means asking people to do something that has clear categories of response, making it easy for them to determine whether they have cooperated (E. Yoeli, personal communication, February 9, 2017). For example, in asking people to sign up for a blackout prevention program (as in Yoeli et al., 2013), there are only two possible responses, compliance or noncompliance: either signing up, or not. Asking for clearly categorical responses is thought to be clearer and more effective in inducing behavior change than more nebulous "asks" like asking people to reduce their electricity consumption.

# 1.3 Past food waste interventions

Although these findings have not yet been explicitly applied to the problem of food waste, a large number of studies have found a significant social modeling effect of eating behavior (Cruwys et al., 2014). This means that people base their own eating behaviors (e.g. what foods to eat and how much to eat) on others' eating behaviors, indicating that descriptive norms are both salient and highly relevant in this domain. The few studies that have investigated ways to reduce food waste in university dining halls (e.g. Painter et al., 2016; Whitehair et al., 2013) have mainly used informational campaigns based on statistics about food waste, or simple directives not to waste. One study at a university in the American Midwest found a 15% reduction in food waste with just a simple prompt: "All Taste...NO WASTE / EAT WHAT YOU TAKE / DON'T WASTE FOOD" (Whitehair et al., 2013). In a senior thesis project, Montanez (2013) conducted a study of food waste in two Yale dining halls and found a reduction in waste of 19.7-54% (varying by dining hall and category of food) after implementing an informational campaign. However, this study did not examine the effects of different menus on waste, and only measured waste in two dining halls for six days each. It is likely that these effects are based partly on menu-based variation in waste. The intervention campaign created by Montanez (2013) also prominently featured environmental messages. However, people do not tend to be strongly motivated by environmental concerns to prevent food waste; instead, financial concerns and guilt are among the primary motivations for reducing waste (Quested et al., 2013; Neff et al., 2015).

Moreover, information-based interventions are not always successful. One study at an American university found no significant changes in attitude or knowledge about food waste after a text-message based informational intervention, and average food waste actually increased (Luecke, 2015). Buckley (2015) identifies the rationale behind knowledge-based campaigns as a model of proactive pro-environmental behavior that indicates a gap between values and practices that can be filled through education. However, findings from social science indicate that behavior change is complex and not easily induced through mere education (e.g. Miller and Prentice, 2016). The world of food waste reduction has yet to benefit much from such findings.

Some food waste interventions have used strategies directly counter to insights from social science. For example, Whitehair et al. (2013) implemented a "feedback-based" message describing the average amount of waste students generated in the dining hall (2.15 oz. per meal, totaling over 32 pounds per semester; the signs also reported average total waste for each meal at the dining facility). This creates a descriptive norm of wasting food: students see that it is normal to waste food in their dining hall, and can therefore be expected to actually waste more (e.g. Bhanot, 2015). In this particular study, a prompt-type message was implemented first, and the feedback-based message was implemented a few weeks later. While the prompt-type message reduced waste by 15%, the feedback-based message had no further effect (Whitehair et al., 2013). The feedback-based message also included the phrase "All taste... NO WASTE" (Whitehair et al., 2013); thus the implicit norm of wasting may have been counteracted with an explicit imperative not to waste.

One study went a little further than plain education: Kallbekken and Sælen (2013) found that "nudging" hotel guests with a sign encouraging them to make return visits to the buffet reduced consumer plate waste by 20.5 percent, while customer satisfaction remained essentially constant. Other non-educational "nudges," including reducing plate size (Wansink and can

Ittersum, 2013) and eliminating the use of trays (Thiagarajah and Getty, 2012), have also been found effective in reducing consumer plate waste.

The present study's intervention uses a similar sign encouraging return trips as a concrete action for students to take, but also includes values-based statements. This study is an effort to use social science methods of promoting cooperation to reduce food waste in Yale University dining halls, where this reduction poses a cooperative dilemma.

The intervention aims to shape prescriptive and descriptive norms by presenting messages relevant to values and issues that students care about. Paluck and Shepherd (2012) used a similar strategy to identify and then shape norms around harassment behavior in a high school. By relating messages to students' values, we hope to show that reducing waste is a socially desirable behavior and thereby increase student effort to prevent waste (following Ariely et al., 2007). We avoided using statistics about waste at either Yale or national levels, which could backfire by normalizing waste as in the intervention conducted by Whitehair et al. (2013). We also used a hashtag and the concept of a "clean plate club" to create an implicit descriptive norm of not wasting food.

We did not directly manipulate observability, but some dining halls at Yale require students to scrape and sort their own dishes in a fairly public dish return area, which makes their waste more visible (see section 2.1 for details). We hypothesize that the method of waste disposal in each dining hall (self-disposal or staff-disposal) will impact the amount of waste as well as the effectiveness of the intervention, since it is more effortful for students to discard waste when they have to scrape their plates themselves, and it is likely that students' waste is more observable when they are scraping their own plates. Although these dining halls may also have different

demographics, which could affect overall waste levels, we also expect overall per capita waste levels to be lower in self-disposal dining halls.

We further hypothesize that the intervention will only have an effect on menus that already generate low levels of waste before the intervention, because high levels of waste may be due to bones in the compost (which means some of the waste is unavoidable) or a disliked menu (which means people would have to make much larger sacrifices in order to avoid waste, by eating food they strongly dislike).

Therefore, we hypothesize that a values-based intervention encouraging reduction of food waste will reduce per capita food waste in highly observable (self-disposal) dining halls for low-waste menus.

#### 2 Methods

The present study is a field experiment in the Yale University undergraduate residential college dining halls. It consists of a pre-intervention survey to determine student values and attitudes toward food waste, a baseline measurement period to determine average waste in the dining halls, an intervention consisting of signs with three different messages placed in the dining halls, a post-intervention measurement period, and a post-intervention survey. Details may be found below.

# 2.1 Subjects and dining context

The subjects of this study include up to 5646 Yale undergraduate students, and likely a small number of graduate students and non-student Yale affiliates. Since this is a field study, we are unable to control who eats in the dining halls. An average of 3,011 students used a meal swipe for dinner in one of the 12 residential college dining halls each day during the 41 days of data collection, indicating that many students do not eat dinner in the residential college dining halls every day. A non-negligible fraction of Yale students live off-campus – a 2009 *Yale Daily News* article estimated that 600 students live off-campus each year (Gordon, 2009). These students may purchase an off-campus meal plan, and are invited to eat Sunday dinner in the dining hall of their residential college affiliation for free. Therefore, students living off-campus are included in this sample, although they almost certainly eat fewer than seven dinners a week in the dining halls.

All undergraduates who live on campus are required to buy a meal plan that includes at least 14 meals a week, which is purchased at the beginning of each semester. There are three meal

plans: the Full Meal Plan (21 meals a week; \$6650 per academic year), the Any-14 Meal Plan (14 meals a week plus \$150 in dining points to spend at retail locations; \$6650 per academic year), and the Anytime Meal Plan (unlimited swipes into meals – technically still 21 meals a week, plus \$70 in dining points; \$6790 per academic year). These meal plans are fairly expensive – the Full Meal Plan costs about \$30.93 per day for a 215-day academic year. In contrast, the average US household (2.5 people) spent \$7023 on food in 2015, including meals away from home (U.S. Bureau of Labor Statistics, 2017): \$19.24 per day for a household, or \$7.70 per person per day. The USDA also estimates the average cost of a healthy diet at the highest spending level for a male aged 19-50 years (the most expensive gender/age bracket) to be \$2601.14 a year, or \$12.10 a day (USDA Center for Nutrition Policy and Promotion, 2017). The Yale Full Meal Plan costs over 2.5 times as much as the USDA's most liberal estimate of the cost of a healthy diet, and over four times as much as average per capita food spending nationally.

Off-campus undergraduates who eat in the dining hall typically do so through either the Off-Campus 5-Meal Plan (5 meals per week plus 30 extra meals per semester; \$2200 per academic year) or the Off-Campus 150-Block Undergraduate Meal Plan (150 meals plus 6 bonus meals per semester; \$5100 per academic year). A few guests or faculty members may eat in dining halls on any given day, but this is assumed to have a negligible impact on food waste. All Yale Dining meals are therefore assumed to be prepaid. A vast majority of these meals are eaten in dining halls, although lunch meals may be redeemed in a number of retail locations on campus. Meals in dining halls are all buffet-style (all-you-care-to-eat), and all residential college dining halls are trayless – diners may pick up plates of two sizes, bowls, cups, and mugs from a number

of different locations around the servery, but there are no trays available. There are sometimes a few items that are not self-serve, such as grill station items and special-occasion foods.

Yale has 15 dining halls: 12 residential college dining halls, the Hall of Graduate Studies dining hall, Commons Dining Hall at Schwarzman Center, and the Lindenbaum Kosher Kitchen at Slifka Center (Slifka Dining). Commons serves a large number of students, but is only open for lunch. The Hall of Graduate Studies is a small dining hall that primarily caters to graduate students, but is also open to undergraduates. Slifka Dining provides kosher breakfasts, lunches, and dinners. Only the 12 residential college dining halls were included in this study, and waste was only measured at dinner, so retail and Commons lunches do not affect the results.

Throughout this paper, "college" and "dining hall" both refer to residential college dining halls.

A daily menu for each dining hall is available online (see Appendix for a sample and link to the online menu). Menus are usually very similar (if not identical) across dining halls, although actual offerings sometimes vary from the online menu when replacements or substitutions are necessary.

The methods of dish return and plate scraping differ between residential college dining halls. Seven colleges (Berkeley, Branford, Davenport, Grace Murray Hopper, Saybrook, Timothy Dwight, and Trumbull) require students to clear the waste from their own dishes into a compost bin and liquid bucket, and then sort the dishes into different bins (e.g. a plate bin, a cup and mug bin, a silverware bin). The remaining five colleges have a dish return area where students pass their dishes to dining hall staff, who then scrape and sort the dishes. The Ezra Stiles/Morse dish return consists of a rotating shelf system and does not afford any contact between students and staff. The other three dining halls with staff waste disposal (Jonathan Edwards, Pierson, and

Silliman) have a window area where students pass their dishes through to staff in a dishwashing area on the other side, allowing students and staff to see and interact with one another.

#### 2.2 Measurement

To measure postconsumer waste, heavy-duty digital shipping scales (Smart Weigh ACE200) were distributed to each residential college dining hall at Yale. These scales, along with a standardized weighing protocol, were tested for reliability and feasibility in Silliman College for 15 days before their introduction to the other colleges. Each dining hall manager assigned two or more staff members to weigh the student-generated waste only from dinner each night, using an empty compost bin and excluding all liquids. Methods of plate-scraping and waste collection vary among the colleges, as described in section 2.1: some students scrape their own plates into a large bin, with a bucket for liquids, and some students pass off their plates to staff members to scrape. Several dining halls introduced a bucket for liquid disposal on the first night of measurement, with an explanation to students who were at dinner; one dining hall had already been using this procedure. All colleges collect leftover food along with other types of compost, including inedible items like bones, shells, and fruit peels as well as napkins, wooden coffee stirrers, teabags, and similar items. Previous studies have had various approaches to sorting food waste from other compost items: some exclude inedible food (e.g. Montanez, 2013; Whitehair et al., 2013), some separate food and non-food (e.g. Wilkie et al., 2015, Sarjahani et al., 2009, Luecke, 2015), and some do not sort at all (e.g. Küng, 2015; Painter et al., 2016). Lebersorger and Schneider (2011) discussed methodology for measuring food waste in households and determined that including food packaging in measurements does not significantly influence

results and can therefore be ignored. We therefore are not concerned about the presence of non-food items like napkins in the compost stream, as the effects of these items should be negligible. We also did not exclude bones or other inedible food items, but we have taken the menus into account and considered meals that include bones (e.g. ribs, fried chicken) in our analysis – this is why reductions in waste are expected only for low-waste menus. In the remainder of the paper, "waste," and "food waste" will be used to refer to all student-produced compost measured in the dining halls.

Among the studies that do sort food waste, liquids are also treated differently. Luecke (2015) measured non-water beverages; Sarjahani et al. (2009) excluded all liquids, including nacho cheese; and Wilkie et al. (2015) measured milk separately because they were studying waste in K-12 school cafeterias. We have attempted to exclude all liquids, although it is possible that students could inadvertently put liquids into the compost bin rather than the liquids bucket.

Baseline data were gathered at dinnertime in the twelve dining halls from February 15 to until the dining halls closed for spring break on either March 8 (1 dining hall), March 9 (5 dining halls) or March 10 (6 dining halls), 2017 (22-24 days). Means for each dining hall can be found in the Appendix. Note that Ezra Stiles/Morse have somewhat separate dining halls (students must swipe into one or the other, but the servery is partly shared and students can move freely between the dining halls except in case of special events), but are weighed as one because they share kitchen facilities.

# 2.2 Pre-intervention survey

A Qualtrics survey was designed to collect information about students' personal values as well as their opinions and attitudes about food waste. The survey was distributed via email to a random sample of 209 Yale undergraduate students December 2016 (before measurement began). Of this sample, 67 students (32.06%) completed the survey. The survey randomized the order of the first two blocks, "Wasting food is..." and "Values," and always presented "Openended message" and "Norm statements" as the third and fourth blocks, respectively. These blocks are described in more detail in section 2.4.1.

#### 2.4 Intervention

The intervention phase consisted of a marketing campaign, implemented by placing signs throughout the dining halls, and a follow-up survey. Details are discussed below.

# 2.4.1 Message development

Following Paluck and Shepherd (2012), we asked students about their beliefs and perceptions of norms on the pre-intervention survey, in order to develop an effective intervention. The first food waste-related item on the survey consisted of the text "In my opinion, wasting food is..." followed by a free-response field. The responses from this question included the general categories "bad/awful" (the most common response), "inevitable," "a privilege," "irresponsible," "thoughtless/inconsiderate," "unfortunate," "fine," "lazy/selfish," and "common."

A second free-response field asked respondents "What would you say to a friend if you wanted them to waste less food?" Categories of response and examples can be found in Table 3 below. A few respondents also said that they would not be comfortable encouraging their friends to waste less food. Many statements were humorous, and one respondent explained a social strategy rather than a message: "I would mock them in a friendly way that still got the point across."

Category of response	Example response
Reputational concerns	"Wasting that much food kind of makes you look like a jerk"
Advice to take less food	"Yo, don't take so much, you think you can eat all that?"
Pointing out waste	"wow, look at all that food in the trash"
Privilege or disadvantage concerns	"Think about all the people out there who
	struggle to find something to eat or to provide food for their children"
Environmental concerns	"It's not good for the environment"
Exhortations to thoughtfulness	"Hey friend, be mindful of the food you waste"
Personal emotional statements	"I always end up getting more food than I need and feeling bad, so I'm gonna try to stop doing that"
Direct commands	"Finish your food chump"

*Table 1*. Categories and examples of responses to the question "What would you say to a friend if you wanted them to waste less food?"

These messages gave insight into the ways students would go about encouraging behavior change in their own friends. One complex response created guilt, tapped into the idea of proscriptive norms, issued a command, and provided a solution, by saying "Why are you

throwing that away? If you weren't going to eat it you shouldn't have taken it. Don't do that.

I will eat that for you." These responses indicate the many facets of students' intuitive thoughts

about food waste reduction, as well as the sense of responsibility and motivation that some students feel to reduce food waste. Buckley (2015) found that 60% of surveyed Yale students said that reducing food waste was the responsibility of the students themselves, and that 46% of surveyed students said that campus food waste reduction efforts should have high priority.

We also asked about values that were important to the respondents, important to the respondents' friends, and "most inconsistent or incompatible with the behavior of wasting food." Students were asked to select the four most important values from a list of 22 values taken from the World Values Survey (WVS, 2012) and the Rokeach Values Survey (Rokeach, 1973) and supplemented with additional values that were thought to be potentially important to Yale students.

Table 2 reports the top three values selected by respondents as being important to themselves and their friends as well as being incompatible with food waste (with rank determined by sum across the three categories): Respect, responsibility, and thoughtfulness. Responsibility was a value selected by a majority (63.24%) of respondents as being incompatible with food waste. Respect was the most-selected value for both self and friends, though it was ranked lower in relevance to food waste. Finally, thoughtfulness was modestly important in all domains, ranking

Value	Important to self	Important to friends	Incompatible with waste
Respect	41.79% (28)	43.28% (29)	33.82% (23)
Responsibility	29.85% (20)	23.88% (16)	63.24% (43)
Thoughtfulness	32.84% (22)	29.85% (20)	47.06% (32)

*Table 2.* Values selected as being important to the respondent, important to the respondent's friends, and incompatible with wasting food. Each cell reports the percentage (raw number) of respondents selecting a particular value for a particular category.

between  $2^{nd}$  and  $4^{th}$  most commonly selected in each category. These three reported values (respect, thoughtfulness, and responsibility) were therefore identified as being both relevant to food waste and important to students.

After this initial survey, intervention messages were brainstormed with input from several Yale students. Messages were brainstormed incorporating student values and responses about reducing waste as well as social science principles of observability, categorical asks (an emerging intervention strategy based on asking for clearly defined responses), and creating prescriptive social norms. The themes of these messages were thoughtfulness, respect (specifically, respect for the dining hall staff and their work in cooking), responsibility, creating norms, and explicitly encouraging return trips to the buffet. Five final messages were chosen (see Appendix), but only three messages were approved by Yale Dining staff. The final messages and their purposes are summarized in Table 3, below.

	Message	Location	Goal
1	"Wasting food is a privilege. / More than 1 out of every 8 US households is food insecure. Source: Feeding America"	Tables	Invoke values of thoughtfulness, love/compassion, responsibility
2	"Some extra food from Yale Dining goes to soup kitchens in New Haven unless you throw it away. Please take just as much as you'll eat."	Tables	Invoke values of thoughtfulness, responsibility, respect; create awareness of other uses of food
3	"Second time's a charm / Take only as much as you can finish, and go back for seconds if you're still hungry. #cleanplateclub"	Entrance to dining hall or servery	Present action step of encouraging return trips; create a social norm or "movement" feeling

*Table 3.* Messages, display locations, and goals of each sign used in the intervention.

The first two messages were made into signs to be displayed in napkin dispensers on dining tables (see Figures 1 and 2). Message 1 taps into values of responsibility and thoughtfulness and the messages of privilege mentioned by students in the survey. The "take what you'll eat" imperative clearly defines what success looks like by asking for a categorical response. There are only two possible responses, compliance or noncompliance: either eating what you take, or leaving some food behind. This is thought to be clearer and more effective in inducing behavior change than a more nebulous "ask" like "take less food" (E. Yoeli, personal communication, February 9, 2017).

Message 2 taps into values of responsibility and respect for the community, and attempts to connect with existing norms of charity. It also creates awareness of other uses of leftover trays of dining hall food, which many students may assume is simply composted.



Figure 1. Pierson College dining hall.

Finally, Message 3 provides a concrete step for action, and attempts to create a descriptive norm with the hashtag #cleanplateclub by implying that not wasting food is something others are doing in this "club." The presence of a hashtag (pound sign) is also thought to construe this message as a movement or trend rather than merely an isolated slogan. While research on hashtags has not yet extended into offline campaigns, research on Twitter has found that the presence of a hashtag is associated with high likelihood of a tweet being retweeted (Suh et al., 2010). We hypothesize that this effect may carry over into real life "retweetability" (salience and sharing) through an association between hashtags and trends or movements.

The final poster designs can be found in the Appendix. This message development phase was a balance between strongly conveying the values-based messages that had been identified, and creating signs that would not be too off-putting for students, since Yale Dining managers/directors (and all other parties involved in the project) want students to enjoy their meals and not feel guilty about what they eat.

## 2.4.2 Intervention implementation

Signs were placed in all 12 dining halls during Yale College's spring break. Examples of the two types of display can be seen in Figures 1, 2, and 3. The two distinct 5.5" x 6.5" signs were



Figure 2. A napkin holder sign in Morse College dining hall.

placed in alternating napkin holders throughout each dining hall, so that the distribution of the two signs was approximately equal. These sins were placed on only one side of each napkin holder, while the other side contained a neutral "Welcome to \_\_\_\_\_ Dining Hall" sign. The visibility of these signs varied between dining halls, as some dining halls put plants in front of the signs or placed the napkin holders against a wall, where only one side of the holder was visible.



Figure 3. A "second time's a charm" sign (upper left) in the Yale Dining display at the entrance to Grace Murray Hopper College dining hall.

The large (8.5x11-inch)

"Second time's a charm" signs were placed in a display holding three other Yale Dining signs, one per dining hall. The location and exact contents of this display varied slightly in each dining hall, but the display was always placed near either the entrance to the dining hall or the entrance to the servery. The other three signs in the display usually contained either daily menus or information about plant-based protein (see Figure 3 at left).

Waste weighing proceeded in the same manner after Yale College's spring break. Waste from dinner was weighed in each college from March 26 to April 11, 2017 (17 days).

# 2.4.3 Post-intervention survey

After 17 days of intervention and measurement, a follow-up survey was conducted to determine changes in attitudes and perception of norms surrounding food waste. This survey was sent to a new random sample of 417 Yale undergraduates. Sixty (60) responses were received, resulting in a response rate of 14.4%.

The post-intervention survey included all items from the pre-intervention survey. The survey also included nine items about students' awareness of the intervention campaign, their perception of its main message and effectiveness, and its impact on their behavior, as well as its perceived impact on the behavior of their friends. Students were first asked if they were aware of the campaign; if they answered "no" they were shown the intervention signs and asked questions about behavior change posed as hypotheticals (e.g. "Do you think you would change your behavior after seeing this campaign?" instead of "Did you change your behavior after seeing this campaign?"). The complete survey can be found in the Appendix.

#### 3 Results

Grace Murray Hopper College was excluded from our analyses because the average perstudent waste in this dining hall was more than two standard deviations above the mean for waste in all colleges. This anomaly results from a 200% increase in per capita waste after March 5 (before M=.19 lbs, SD=.07; after M=.59 lbs, SD=.14; t=10.66, p<.001). The Hopper dining hall manager attributed this increase to inclusion of more liquid (G. Gentile, personal communication, April 16, 2017). Since we planned to exclude all liquids from measurement, we have excluded Hopper dining hall for deviation from the measurement protocol, leaving 10 discrete dining halls (counting Ezra Stiles/Morse as one dining hall) in our analysis – four with staff waste disposal and six with self waste disposal. Results were analyzed with Stata statistical software.

## 3.1 Changes in food waste weight

We obtained the menu schedule for dinner, which is a four-week rotation. Each daily menu was assigned a number and letter for week and day, respectively, starting on Monday (e.g. Week 1 Friday dinner is 1E). The pre-intervention period included the menus for Week 1 D-F, Week 2, Week 3, and Week 4 A-E (or A-F in some cases, and A-D in one case). The post-intervention period included the menus for Week 3, Week 4, and Week 1 A-E. A meta-analysis (Figure 4, below) revealed significant food waste across all daily menus (M = 0.25 lbs per capita, 95% CI [0.24, 0.26], Z = 39.63, p < .001), and significant heterogeneity in waste among the menus ( $\chi^2(27) = 73.07$ , p < .001). This heterogeneity supports our hypothesis that some menus have higher overall levels of waste.

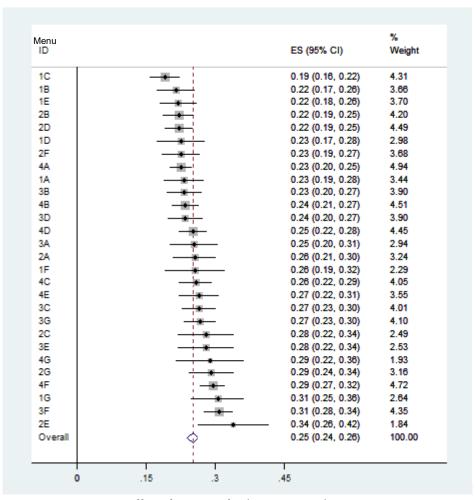


Figure 4. Effect of menu on food waste (pounds per capita).

A meta-analysis of the intervention showed no significant effect across dining halls (Z=0.77, p=0.442), but revealed that there is also significant heterogeneity among dining halls ( $\chi$ )  $^2$ (9)=20.37, p=0.016) (Figure 5, below). This supports our hypothesis that the intervention may work in some dining halls but not others. There was a significant effect of the intervention on waste in Saybrook (SY) dining hall (M=-.05, 95% CI [-.09, -.02], t=-2.97, p=.005). Marginally significant decreases were also found for Silliman (SM) dining hall (M=-.07, 95% CI [-.14, .00], t=-1.94, p=.060) and Berkeley (BK) dining hall (M=-.03, 95% CI [-.06, .00], t=-1.91, t=-1.94. There was also a marginally significant increase in waste in Pierson (PC) dining hall (t=-.05, 95% CI [.00, .10], t=1.84, t=-.073).

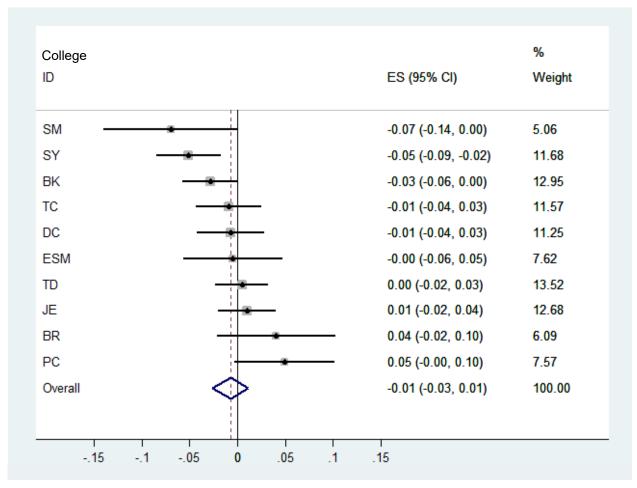


Figure 5. Effect of intervention on food waste (pounds per capita).

Consistent with our hypothesis, we found a significant negative effect of the intervention on per capita waste for the six self-disposal dining halls on low-waste menu days (where menus are categorized as low-waste if waste is below the median for all menus), controlling for college fixed-effects (M=-.01, b=-.155, 95% CI [-.02, -.001], p=.039). This reduction in waste totals to an average of 16.21 lbs per day across the six self-disposal colleges. Also consistent with our hypothesis, no effect was found for self-disposal dining halls on high-waste days, controlling for college fixed-effects (b=.14, 95% CI [-.01, .05], p=.155). A two-way ANOVA investigating the interaction of the intervention with self-disposal dining halls on waste is significant (F(1,231)=6.50, p=.0115,  $\eta^2_p$ =.03).

The intervention also had no effect on staff-disposal colleges on either high-waste days (b=.11, 95% CI [-.05, .015], p=.264) or low-waste days (b=.14, 95% CI [-.01, .03], p=.301), controlling for college fixed-effects.

A three-way ANOVA revealed that the interaction of intervention with high waste and self-disposal is significant, controlling for college fixed-effects (F(1,387)=6.12, p=.014,  $\eta^2_p=.016$ ). In addition, there was a small-to-moderate main effect of self-disposal such that self-disposal dining halls had less food waste (M=.24, SD=.07) than staff-disposal dining halls (M=.28, SD=.10) F=19.12, p<.001,  $\eta^2_p=.047$ ). There was also a very large main effect of high waste (F=230.51, p<.001,  $\eta^2_p=.373$ ), which further supports our hypothesis that there is differential effectiveness of the intervention between low- and high-waste menus.

A table detailing the mean waste weight in each college dining hall before and after the intervention can be found in the Appendix.

# 3.2 Survey results

There was a significant increase in self-reported intention to not waste food between the preintervention survey (M=3.98) and the post-intervention survey (M=4.32, t(121)=-2.05, p=.043), without regard to awareness of the intervention campaign (Figure 6).

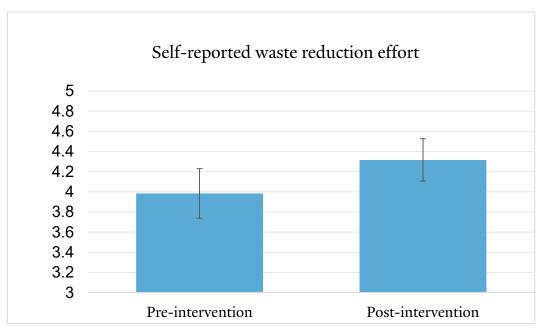
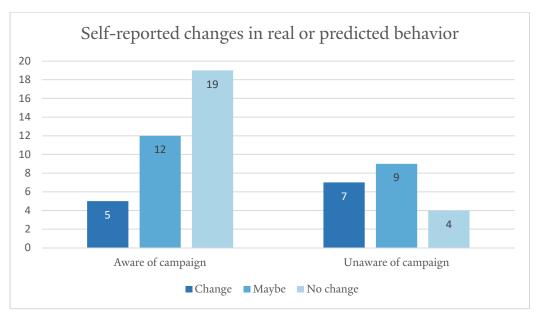


Figure 6. Self-reported effort to not waste food before and after the intervention, disregarding awareness of intervention. Error bars indicate 95% confidence intervals. The difference between pre- and post-intervention is significant (p=.043).

Of the 60 post-intervention survey respondents, 60% (36) said that they were aware of the intervention campaign, 33.33% (20) said they were unaware of the campaign, and 6.67% (4) said they were unsure. Of the students who reported being aware, 13.88% (5) said that they had changed their behavior based on the campaign, 33.33% (12) said that they had "maybe" changed their behavior, and 52.77% (19) said they had not changed their behavior. The overwhelming reason respondents gave for not changing their behavior was that they already wasted little or no food, suggesting a possible response bias (but see section 4.1 for discussion). When students who reported being unaware of the campaign were introduced to the three intervention signs and asked if they thought they would change their behavior after seeing the campaign, 35% (7) said yes, 45% (9) said maybe, and 20% (4) said no. Figure 7 summarizes these findings.



*Figure 7*. Self-reported changes in real behavior (if aware of campaign) or predicted changes in hypothetical behavior if campaign had been seen (if unaware of campaign).

These results show that although there was a significant increase in self-reported effort to reduce food waste (and a significant reduction in real waste, in some dining halls) after the intervention, students were not aware of the change in effort or behavior. A two-sample t-test with equal variances revealed a significant difference in reported/predicted behavior change between the aware and unaware groups, with the unaware group more likely to report (predicted) change than the aware group (t(58)=2.09, p=.041).

We also conducted an exploratory factor analysis in order to better understand how self-reported perceived norms predict behavior. The analysis yielded two factors explaining 62% of the variance in responses. We labeled Factor 1 *Prescriptive Norms* due to the high loadings (>.3) by items about feeling guilty when wasting food, judging others who waste food, and believing that others should not waste food for a variety of reasons. We labeled Factor 2 *Descriptive Norms* due to the high loadings (>.3) by items describing how much food Yale students waste, how

much food respondents' friends waste, the extent to which food waste is a problem, and the expectations of respondents' friends that respondents will not waste food. Self-reported effort to not waste food loads almost equally on both factors (0.37 on Prescriptive Norms and 0.39 on Descriptive Norms), suggesting that both types of norms are relevant to waste behavior and predictive of increased effort. Belief that "wasting food is not really a problem" has a high loading on Descriptive Norms and a high negative loading on Prescriptive Norms. This suggests that considering food waste to be a problem is associated with strong prescriptive norms or moral feelings about waste, while considering it to not be a problem is associated with descriptive norms of not wasting food. Belief that "Yale students generally waste a lot of food" has a high negative loading on Descriptive Norms, indicating that perceiving waste levels to be generally low both reduces the perception of a food waste problem and increases effort to reduce one's own waste. Representative items and their loadings are listed in Table 4, below.

Te	Prescriptive	Descriptive
Item	Norms	Norms
I feel guilty when I waste food.	0.65	0.01
(1)some people do not have enough food.	0.76	-0.10
(1)it is a waste of valuable resources.	0.71	-0.07
(1)it is a waste of good food.	0.64	0.13
(1)it is unethical.	0.79	0.09
(1)the dining hall staff work hard to produce it.	0.63	0.03
I sometimes judge others who waste food.	0.56	0.27
(2) Yale students generally waste a lot of food.	0.22	-0.54
(2)most of my friends don't waste very much food.	0.10	0.50
(2)my friends expect me to not waste food.	0.06	0.44
Wasting food is not really a problem.	-0.62	0.41
I try not to waste food in the dining halls.	0.37	0.39

*Table 4.* Factor analysis of normative statements and self-reported behaviors. Statements labeled (1) begin with "Yale students shouldn't waste food because..." and statements labeled (2) begin with "I think that..."

#### 4 Discussion

This is the first empirical test of the efficacy of an intervention designed to treat food waste as a cooperative dilemma. The data resulting from this study indicate that this values-based framing may be a useful way to approach the issue of food waste in university dining halls where reputational concerns are likely to be active due to observability.

#### 4.1 General discussion

The post-intervention reductions in food waste weight confirmed our hypotheses that the intervention would be successful in dining halls where students are required to scrape their own dishes, and on days with menus that typically generate below-median waste. The difference between self-disposal and staff-disposal colleges could very well be due to an effect of observability, because there is more opportunity for students to see others' waste when they must empty each dish into a compost bin in a relatively public dish return space. However, it is also possible that this effect is due to other factors. It could be due to students' increased awareness of their own waste, since students must physically interact with the food they waste by scraping it into a compost bin. It could also be due to laziness or a desire to avoid a stressful situation: Some dish return areas are fairly small, and it can be stressful for students to scrape and sort their dishes while others are waiting. It is also easier for students to sort their dishes without having to scrape them, which is possible if they have no leftover food.

It is also unclear whether the effect of menu is entirely attributable to students' dislike of some foods. Since the Yale Dining menu rotation consists of four week-long menu blocks, each menu is always prepared on the same day of the week. It is possible that some days are busier

than others in the lives of students who eat in the dining halls, meaning they have less time to finish their food. This could contribute to an effect of menu where the actual food being served is not the cause of a high level of waste. However, lunches tend to be more rushed than dinners in the dining halls (because dinners are typically not bookended by classes in the way lunches may be), so we may have avoided this type of hurriedness effect by only measuring waste at dinnertime.

The difference in self-reported/predicted behavior change between students who were aware versus unaware of the intervention campaign suggests that students who were aware of the campaign were biased against reporting a change, even though self-reported effort to reduce food waste did in fact increase significantly after the intervention. This could indicate that priming students with awareness of the campaign triggered a negative social desirability motive, making them reluctant to admit that they had been influenced by the intervention. Additionally, many of the students who reported no change in their behavior after seeing the campaign said that they had already tried not to waste food before seeing the campaign. This could be evidence of response bias (i.e., the people who choose to complete surveys about food waste try harder to reduce their own waste), but out of the four unaware students who said they would not change their behavior had they seen the campaign, none claimed to already not waste food. Although a sample size of four is not enough to provide strong evidence against response bias, it suggests the possibility of a social desirability effect biasing the responses of the aware students.

It is also possible that effort to prevent food waste is not the most important factor in explaining the observed reductions in waste (although they are correlated in this study). Stancu et al. (2016) found that in a household context, intention to not waste food is less explanatory of

food waste behavior than either food-related routines or perceived behavioral control. Although intention is not the same as effort, this suggests that unconscious adoption of new eating routines (such as taking a smaller amount of food initially and going back for seconds, as our intervention suggested) could lead to a reduction in waste.

The factor analysis of normative statements revealed that both prescriptive and descriptive norms are strongly associated with effort to not waste food. While most social science interventions focus on descriptive norms, many people have strong moral feelings or judgments about the issue of food waste, which explains the importance of prescriptive norms. The common feelings of guilt that result from violating prescriptive norms (81.3% of our survey respondents agreed that they feel guilty when they waste food) are a strong motivator to reduce food waste (Quested et al., 2013; Neff et al., 2015). However, this does not mean that all waste-reduction campaigns should be based on making people feel guilty: Thøgersen (2006) provides evidence that moral norms enforced by guilt tend to be weaker than those not enforced by guilt. Graham-Rowe et al. (2014) also note that inducing guilt could result in compensation behaviors like denial of the severity of food waste or refusal to accept personal responsibility for it. It is possible that our intervention was too heavy-handed with regards to making people feel guilty, which may have decreased the intervention's effectiveness and even contributed to the marginal boomerang effect observed in Pierson dining hall.

#### 4.2 Limitations

This study has several limitations, most of which are natural consequences of studying food waste in a naturalistic dining hall setting. First, the limited time available to conduct the study made it necessary to introduce the intervention into all of the dining halls at the same time, rather than using a more ideal staggered (or phased) rollout design. Because the undergraduate spring break occurred right before the intervention, the interruption in dining hall eating could also have affected results. The differences in dining hall demographics, sizes, and food preparation methods could also present a problem, although controlling for menus and college fixed-effects and analyzing weight per capita data rather than weight per dining hall mitigates these potential problems. The differences between dining halls extend to methods of collecting waste, including potentially inconsistent inclusion of liquids in the weighings due to liquid separation practices being recently introduced in some dining halls. There is also potential for inconsistency between the various staff who weighed the waste each night, despite the standardized weighing protocol intended to prevent this. Indeed, failure to adhere to the weighing protocol resulted in one dining hall having to be excluded. Working within the existing dining hall structure also introduced some limitations on the content of the interventions, due to concerns about professional standards and Yale Dining's reputation. Finally, the nature of this study as a senior thesis necessitated some activities that are generally considered bad form in research, namely discussing the project with students informally in everyday contexts, as well as formally in two required presentations while data collection was still taking place.

The pre- and post-intervention surveys may also have been subject to response bias, since people who are more interested in food waste would be more likely to voluntarily take a survey

about food waste. It is also possible that there was response bias simply due to differing availability of students at the times of year at which the surveys were administered – the first during winter recess and the second a few weeks before the end of the semester.

## 4.3 Potential for scaling and directions for future research

This study continues the work of many others in effecting real-world change through findings from social science (e.g. Yoeli et al., 2013; Kraft-Todd et al., 2015). However, others (e.g. Kraft-Todd et al., 2015) have pointed out that lasting behavior change generally requires habit formation. Many people who do not waste food do so habitually, both as a matter of personal principle and because it represents the way they were raised. It would be useful, then, for future research to investigate the long-term effectiveness of this type of intervention, including the rate of effect decay after the intervention has ended. Since the post-intervention measurement period was only [two weeks], there was also not enough time to see a reduction in effectiveness of the intervention over time due to habituation (or simply an increase in ignoring the signage). Future research could illustrate the longevity of this type of intervention.

There is reason to believe that, provided the effectiveness of the intervention does not drop off sharply after a few weeks, a longer-term intervention would have lasting impact on students' habits. Allcott and Rogers (2014) found that the effects of a descriptive norm-based (peer comparison) home energy use reduction program were quite persistent: when intervention ended after two years of peer comparison reports, the effects of this program decayed at a rate of 10 to 20 percent per year. The authors also found that household members continued to respond to ongoing intervention even after two years (Allcott and Rogers, 2014). This slow habituation

suggests that a longer post-intervention measurement period in the present study would likely have revealed stronger effects of the intervention.

Additionally, an intervention similar to the one described in this study is easily scalable. This type of signage-based intervention requires relatively little initial effort and virtually no ongoing maintenance. In the context of Yale Dining, it relies on existing signage infrastructure, and therefore also requires little material investment. Therefore, it could be readily replicated in university dining programs with similar infrastructure, and would easily scale to a broader university dining context, perhaps through centralized distribution by a college food service provider (e.g. Aramark, Sodexo, Compass Group).

It would be interesting to implement a similar signage-based intervention with different messages, perhaps messages sharing descriptive norms of low waste. Manipulating observability by placing pictures of eyes in dish return areas (following Bateson et al., 2006) would be an interesting future study, although this would require that the desired behavior of eliminating waste already be clearly established as a prescriptive norm. It may also not be a strong enough manipulation in this situation, since all dining halls except Ezra Stiles/Morse either require students to scrape their own dishes in the presence of other students or have students give their dishes directly to dining hall staff, who can see the students and their waste.

In their study of high school harassment behavior, Paluck and Shepherd (2012) found that changing the behavior of social referents is a highly effective way to shape descriptive norms.

Research teams with extensive resources and networks of influential community members would likely have more capacity to investigate this type of resource-intensive social intervention, but it could be very effective and therefore worth the effort.

During the course of this project, many students and dining hall managers also suggested creating a competition between residential colleges to reduce waste. Yale is the perfect context for this type of competitive framing, and it would be interesting to see if real-life descriptive norms about college waste levels would have an effect. However, it is possible that colleges with very low waste would exhibit a boomerang effect (e.g. Cohen, 1962; Schultz et al., 2015; Bhanot et al., 2015), or that colleges with very high waste would despair of ever winning the competition and just give up (Bhanot et al., 2015). Any competitive intervention would have to be carefully implemented to avoid these effects.

In summary, there is ample room to further explore applications of a cooperative dilemma framing to the problem of university food waste, and there is strong potential for this framing to lead to important insights about food waste behaviors and methods of reducing waste.

#### Conclusion

Food waste is a complex context-dependent behavior (Buckley, 2015) that has widespread economic and environmental ramifications (e.g. EPA, 2017; Vermeulen et al., 2012). The present study has indicated the potential of a cooperative dilemma framing to explain ways of motivating a reduction in food waste. Through a field study in Yale University's residential college dining halls, this study found that an intervention created in the context of a values-based framing significantly reduced food in dining halls where students dispose of their own waste, on days with low-waste menus. This suggests that cooperation-based interventions have potential to reduce food waste. Methods of applying descriptive norms and increasing observability have been effective in a variety of real-world settings (e.g. Kraft-Todd et al., 2015), and future research is needed to further explore the potential to increase the effectiveness of food waste reduction strategies through these same methods.

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## **Appendix**

1. Yale Dining sample dinner menu. Full daily menus for each dining hall can be found at http://hospitality.yale.edu/menu-selector.

# Dinner



2. Pre-intervention survey. Block respondents.	titles (e.g. "Wasting food is" or "Values") were not visible to
Wasting food is	
Please complete this sentence:	In my opinion, wasting food is
Values	
Which of the following values as	re most important to you? Select up to four.
Obedience	Determination
Loyalty	Thoughtfulness
Fairness	☐ Creativity
Unselfishness	Trustworthiness
Commitment	Independence
Responsibility	Respect
Love	Courage
Humility	Tolerance
☐ Imagination	☐ Thrift
Open-mindedness	Honesty
Efficiency	Patience
Which of the following values do to four.	o you think are most important to your friends? Select up
Unselfishness	Commitment
Creativity	Honesty
Trustworthiness	Fairness
Obedience	Patience
Love	Determination

☐ Tolerance	Respect
☐ Independence	Responsibility
Loyalty	Open-mindedness
Courage	Humility
Efficiency	Thrift
Thoughtfulness	☐ Imagination
Miliah af the faller in a set of a security of	
Which of the following values do you think are most inc food? Select up to four.	consistent or incompatible with the behavior of wasting
Obedience	Patience
Unselfishness	Fairness
Loyalty	Respect
☐ Imagination	Thrift
Tolerance	Love
Commitment	Honesty
Responsibility	Trustworthiness
☐ Thoughtfulness	Courage
Humility	☐ Independence
Open-mindedness	Determination
Creativity	Efficiency
Open-ended message	
If you wanted to encourage a friend to waste less food	, what would you say to them?
Norm statements	
Please rate your agreement with the following stateme	nts

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I feel guilty when I waste food.	0	0	0	0	0
Yale students shouldn't waste food because it is unethical.	0	0	0	0	0
I try not to waste food in the dining halls.	0	0	0	0	0
Yale students shouldn't waste food because some people do not have enough food.	0	0	0	0	0
Yale students shouldn't waste food because it is a waste of good food.	0	0	0	0	0
I sometimes feel judged by others when I waste food.	0	0	0	0	0
I sometimes judge others who waste food.	0	0	0	0	0
Yale students shouldn't waste food because it is a waste of valuable resources.	0	0	0	0	0
Yale students shouldn't waste food because the dining hall staff work hard to produce it.	0	0	0	0	0
I feel worse about wasting food I purchase directly than food I pay for through a meal plan.	0	0	0	0	0
I think that my friends expect me to not waste food.	0	0	0	0	0

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree	
Wasting food is not really a problem.	0	0	0	0	0	
I think that Yale students generally waste a lot of food.	0	0	0	0	0	
I think that most of my friends don't waste very much food.	0	0	0	0	0	

3. Post-intervention survey additions. This survey consisted of the entire pre-intervention survey plus the following material. The "Aware Block" or "Unaware Block" were presented based on each respondent's reported awareness of the campaign, and follow-up questions ("If so, how?" and "If not, why not?") were presented based on each respondent's responses to questions about behavior change.

#### Campaign awareness block

In which residential college dining hall do you eat most of your meals?
O Berkeley
O Branford
O Davenport
O Ezra Stiles
O Grace Murray Hopper
O Jonathan Edwards
O Morse
O Pierson
O Saybrook
O Silliman
O Timothy Dwight
O Trumbull
O I live off campus and never eat in a dining hall

Are you aware of the food waste reduction campaign Yale Dining has been carrying out in the college dining halls since spring break, involving signs of the type pictured above?

0	Yes
0	No
0	Unsure

# Aware Block

What would you say the main message of this campaign was?
Did you change your behavior in the dining hall based on this campaign?
O Yes
O Maybe
O No
If not, why not?
If so, how?
Are you more likely to say something about food waste to a friend after this campaign?
O Yes
O Maybe
O No
Do you think others were likely to change their behavior in the dining hall based on this campaign?
O Yes
O Maybe
O No
If so, how?

lf	not,	why	not?	
_				

Do you think others were more likely to say something about food waste to a friend after this campaign?

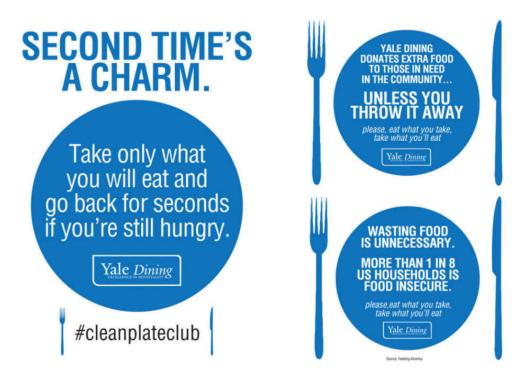
O Yes

Maybe

O No

### **Unaware Block**

This campaign consisted of the following three messages, displayed on signs in every college dining hall.



Do you think you would change your dining hall behavior after seeing this campaign?
O Yes O Maybe O No
If so, how?
If not, why not?
Would you be likely to say something about food waste to a friend after seeing this campaign?
O Yes O Maybe O No
Do you think others would be likely to change their behavior in the dining hall based on this campaign?
O Yes O Maybe O No
If so, how?

If not, why not?	
Do you think others would be after this campaign?	e more likely to say something about food waste to a friend
O Yes	
O Maybe	
O No	

# 4. Dining hall signs





# SECOND TIME'S A CHARM.

Take only what you will eat and go back for seconds if you're still hungry.



#cleanplateclub

# 5. Mean compost (food waste) weights per dining hall

Dining hall	Before	After	Change
	intervention	intervention	(after -
	(lbs)	(lbs)	before)
Berkeley total compost	83.70	74.22	-9.48
Compost per capita	0.24	0.21	-0.03
Branford total compost	72.28	77.20	4.91
Compost per capita	0.29	0.33	0.04
Davenport total compost	52.32	46.38	-5.94
Compost per capita	0.20	0.19	-0.01
Ezra Stiles/Morse total compost	203.15	183.10	-20.05
Compost per capita	0.31	0.30	-0.01
*Grace Murray Hopper total compost	67.59	172.62	105.04
Compost per capita	0.23	0.61	0.38
Jonathan Edwards total compost	46.61	47.10	0.49
Compost per capita	0.20	0.21	0.01
Pierson total compost	66.27	76.98	10.71
Compost per capita	0.25	0.30	0.05
Saybrook total compost	55.69	42.49	-13.20
Compost per capita	0.25	0.19	-0.05
Silliman total compost	114.35	93.06	-21.28
Compost per capita	0.39	0.32	-0.07
Timothy Dwight total compost	45.70	46.99	1.29
Compost per capita	0.23	0.23	0.00
Trumbull total compost	71.94	64.90	-7.04
Compost per capita	0.25	0.24	-0.01

Table 8. Mean compost weight, in pounds, from dinner before and after the intervention. Pre-intervention weight was measured between 2/15/17 and 3/9/17 for each dining hall. Post-intervention weight was measured between 3/26/17 and 4/11/17. Weights have been rounded to nearest hundredth of a pound. \*Grace Murray Hopper was excluded from analyses because mean weight was more than 2 standard deviations above the mean for all dining halls.

# 6. Descriptive norm agreement (pre-intervention)

Message	Mean	SD
"I try not to waste food in the dining halls."	3.97	0.97
"I feel worse about wasting food I purchase directly than food I pay for through a meal plan."	3.86	1.17
"I think that Yale students generally waste a lot of food."	3.81	0.92
"I sometimes judge others who waste food."	3.54	1.11
"I think that my friends expect me to not waste food."	3.21	1.10
"I think that most of my friends don't waste very much food."	3.19	0.98
"I sometimes feel judged by others when I waste food."	2.98	0.90
"Wasting food is not really a problem."	1.63	0.82

*Table 9.* Pre-intervention survey descriptive norm statements and mean agreement ratings (1-5, "strongly disagree" to "strongly agree").