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An evaluation of a consumer food waste awareness campaign using the motivation opportunity ability framework

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ABSTRACT

As awareness around the issue of food waste has grown, various types of interventions to reduce food waste have emerged, many of which tackle waste at the household level. The most popular type of intervention is the awareness campaign, where information and tips are provided to individuals in order to motivate and improve the abilities of households to reduce the amount of food waste they generate, and to better manage food in general. This study is the first to apply the Motivation Opportunity Ability (MOA) framework to assess the experience of households who participated in an awareness campaign intervention study. Specifically, it highlights how the intervention impacted their motivations, opportunities and abilities to reduce food waste. Using two focus groups engaging a total of 44 participants in the City of Toronto, we found that the awareness interventions had positive impacts in improving motivation and ability. They were less impactful in providing opportunities to reduce food waste but we did find that interventions that act as nudges can help provide some opportunities, albeit at a micro-scale. The study also found that despite the campaign, there were many barriers that resulted in households not acting in accordance with their motivations and abilities, mainly due to challenges around store promotions. This paper contributes to an emerging body of literature applying the MOA framework in the field of food waste studies and recommends that future interventions are designed in a manner that addresses all three factors.

1. Introduction

Food waste occurs throughout the food supply chain, impacting farmers, processors, retailers and consumers (Gustavsson et al., 2011). The resources and energy used for producing food that goes to waste is a major contributor to greenhouse gas emissions, loss of biodiversity, water scarcity, and food insecurity (Food and Agriculture Organization, 2013; Kummu et al., 2012). To address the issue of food waste, numerous organizations and public institutions have developed national food waste strategies (National Zero Waste Council, 2018), and set targets to halve food waste as per Sustainable Development Goal 12.3 (Lipinski et al., 2017). Countries through their respective governments have also coordinated internationally to seek policy solutions (Commission for Environmental Cooperation, 2017).

In Canada, the issue of consumer food waste is especially pertinent as 21% of the country's avoidable food waste can be attributed to households (Nikkel et al., 2019). Municipal governments have launched educational initiatives to engage stakeholders and particularly consumers in food waste prevention and reduction (Love Food Hate Waste Canada, n.d.). These campaigns are considered information-based interventions, whereby information is provided to the target audience (consumers) to change their behaviors (Reynolds et al., 2019). Information can be provided in a mix of formats, including advertisements (Septianto et al., 2020), leaflets (Shaw et al., 2018), social media (Young et al., 2016), online platforms (Schmidt, 2016), or "swag" such as fridge magnets, postcards, stickers, and grocery list pads (van der Werf et al., 2019). However, the success of information-based household food waste interventions is mixed, with some studies demonstrating a 31% decrease in avoidable food waste (van der Werf et al., 2019), while others found no statistically significant differences (Shaw et al., 2018). This study is the first to apply the Motivation Opportunity Ability (MOA) framework (MacInnis et al., 1991; MacInnis and Jaworski, 1989) when testing the application of interventions designed to reduce food waste and contributes to an emerging body of literature applying this framework in the field of food waste studies (van Geffen et al., 2020; von Kameke and Fischer, 2018). This study is also the first to use a

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qualitative approach for understanding the impact of household food waste interventions. It builds on previous research by the authors to assess effectiveness of interventions by using quantitative methods (Soma et al., 2020).

1.1. Theoretical background

Information-based intervention studies thus far have focused on psychological-based behavior change (Schmidt, 2016; Shaw et al., 2018; van der Werf et al., 2019; Young et al., 2016). These studies use theoretical frameworks such as the Theory of Planned Behavior (TPB), which uses attitudes toward a behavior, subjective norms, and perceived behavioral control to predict an individual's intention to perform a behavior (Ajzen, 1991). While non-motivational factors are acknowledged, TPB relies heavily on the assumption that intention is the central factor to performance of a behavior; the stronger the intention, the more likely the behavior will be performed (Ajzen, 1991). TPB has been used to explain some causes and drivers of household food waste (Graham-Rowe et al., 2015; Stefan et al., 2013; Visschers et al., 2016; van der Werf et al., 2019). However, Stefan et al. (2013) found that planning and shopping routines were stronger predictors of food waste than intention, which suggests the importance of factors such as daily routines, skills, and resources in explaining how food is wasted. Like other pro-environmental behaviors, intention alone does not necessarily lead to desired actions; there exists a value-action gap in preventing food waste that needs to be overcome (Lee and Soma, 2016).

To account for additional explanatory factors that contribute to the wasting of food such as routines and skills, this study uses the MOA framework that originated from the field of consumer marketing (MacInnis et al., 1991). The MOA framework explains consumer behavior using three classes of determinants: motivation, opportunity, and ability. Central to the MOA framework is that a new behavior or change in behavior is more likely to be performed if a consumer perceives it will support their interest and is aware of the consequences of not acting (motivation), has the options available and accessible to encourage the behavior (opportunity), and the skills and competencies to perform the behavior (ability) (de Jonge et al., 2014; van Geffen et al., 2020). Other interpretations of the MOA framework expand the definition of motivation beyond self-interest and include elements from the Theory of Planned Behavior such as behavioral intentions, values, attitudes, subjective norms, needs, habits, as well as goals that can be shifted through awareness (Baumhof et al., 2018; van Geffen et al., 2020; Thøgersen, 2009; MacInnis and Jaworski, 1989). This broader definition is the one used for this paper. The framework has been adapted to understanding pro-environmental behaviors (Olander and Thøgersen, 1995), selecting interventions to change behaviors related to public health and social issues (Rothschild, 1999), sustainable consumer behaviors (Baumhof et al., 2018; de Jonge et al., 2014; Thøgersen, 2009; Zhu, 2016), and more recently, household food waste (van Geffen et al., 2020; von Kameke and Fischer, 2018).

Empirical studies in sustainable consumer behavior that applied the MOA framework include home energy conservation (Baumhof et al., 2018), organic food consumption (Zhu, 2016), and using public transportation (Thøgersen, 2009). Baumhof et al. (2018) noted positive correlations between the motivation (desire to make refurbishments to conserve energy) and ability (skills and resources to make refurbishments) constructs with the number of energy-related refurbishment efforts. However, the opportunity construct (ease of regulations and refurbishment efforts, incentives) had a negative correlation. In other words, homeowners with less opportunity undertook more energy-related refurbishment efforts, which was a counterintuitive finding. Using MOA, Zhu (2016) found that concerns around food safety was the leading issue for consumers' motivation to purchase organic foods. Health-related issues were also a dominant theme for tapping into the opportunity (availability of organic food at retail outlets and marketing that garnered the most attention) and ability (awareness and knowledge of organic food, financial resources to purchase organic food). The study also identified potential interventions to increase motivation, opportunity, and ability. A third study applied the MOA framework in assessing an intervention on increasing use of public transportation by people that normally travel by car through offering participants a free travel card for one month, which was expected to increase motivation and opportunity to ride transit (Thøgersen, 2009). While significant changes in behavior (using public transit) and behavior intentions (motivation) were observed between the baseline and end of the intervention, as well as five months following the intervention, the actual long-term increase in use of public transit was only 5% to 7% (Thøgersen, 2009). The change in motivation alone did not overcome other structural barriers to opportunity such as the fixed cost of owning a car, prepaid parking, and commute distances. Ability, measured as a respondent's habit of using their car, did not significantly change. This study reinforces the need to address motivation, opportunity, and ability together when designing an intervention.

1.2. Motivation, opportunity, ability framework on consumer food waste

The MOA framework has had limited application thus far in the field of consumer food waste research and was only found in two published studies (van Geffen et al., 2020; von Kameke and Fischer, 2018). One study explored the drivers and causes of food waste by analyzing focus group responses through the lens of the MOA framework (van Geffen et al., 2020) and found that consumers have a desire to reduce food waste (motivation), but due to competing goals, the intentions do not always translate into action. Van Geffen et al. (2020) noted that consumers are constantly balancing competing goals related to food, including concern for health, saving money, food storage space, and taste preferences.

The second study used the MOA framework to assess the potential for nudging to reduce household food waste (von Kameke and Fischer, 2018). Nudging is important when considering information-based campaigns for changing food wasting behavior because these campaigns only contribute to motivation and ability (de Jonge et al., 2014; von Kameke and Fischer, 2018), not opportunity. They are unable to address the structural, systemic, and material changes (e.g., redesigning retail environments, enactment of food waste laws, accessing household appliances for food preservation) that are typically categorized as interventions in the opportunity category. Nudging steers a consumer towards the desired behavior (e.g., increasing the availability or accessibility of a product or decision) while preserving the liberty of choice of the consumer to engage in the behavior (de Jonge et al., 2014; von Kameke and Fischer, 2018). While nudging is not as strong as a structural, systemic, or material change, it can still contribute to overcoming the lack of opportunity. Nudges can include a range of approaches such as automatic enrollment in programs (default actions), advice on how to simplify complex tasks, information about the impact of past behavior, learning what others do (social norms), increasing convenience, and providing reminders about desired behavior (Sunstein, 2014; Hummel and Maedche, 2019). Von Kameke and Fischer (2018) found that consumers were most receptive to nudges that offered feedback on the cost and amount of food that they were wasting, opportunities for personal challenges or exchange of experiences on reducing waste with neighbors and friends, and advice on meal planning. While von Kameke and Fischer (2018) demonstrated conceptually that nudging could be a useful tool for food waste prevention interventions, the effectiveness of these nudges was not tested empirically on consumers.

This is the first study to apply the MOA framework to better assess the efficacy of consumer food waste awareness campaigns in targeting consumer motivation, opportunity, and ability. The theoretical framework contrasts previous studies, which focused more on behavioral intentions or motivations (Schmidt, 2016; Septianto et al., 2020; Shaw et al., 2018; van der Werf et al., 2019; Young et al., 2016) and had less consideration for barriers related to opportunities and abilities.

Furthermore, these studies employed more quantitative methods of data collection (surveys, waste composition), which are less effective at capturing a deeper understanding of why consumers behave in the way that they do. By using the MOA framework to analyze an intervention based on feedback from focus groups, this study provides a more holistic analysis on the drivers that affect a consumer's decision to take action to reduce food waste at home or the barriers that prevent them from wasting food.

2. Material and methods

2.1. Research design

A 12-week household food waste campaign was designed based on themes and content from popular food waste campaigns including Love Food Hate Waste (Love Food Hate Waste Canada, n.d.) and Food: Too Good to Waste (United States Environmental Protection Agency, 2016). The goals of an awareness campaign are to provide information and resources that will raise consumer awareness and motivation and hopefully make individuals turn toward positive change.

Three types of interventions were tested in the food waste campaign. There were: information-only, community engagement + information, and gamification + information. The materials for the basic information intervention included a booklet with information highlighting the importance of reducing food waste (motivation). The booklet entitled "Save Food, Save Money, Save the Planet" (See Fig. 1) calls upon participants to reduce food waste with the motto "Together we can tackle food waste, eat well, save money, and save the planet" (Food Systems Lab, 2018) and included tips on reducing food waste at home (ability). In addition to the booklet, participants received a series of four newsletters, delivered via email or letter mail once every three weeks, which served as a food waste reminder and therefore a nudge (opportunity), and provided further tips (ability). Finally, they received a food storage fridge magnet that was meant to act as both a visual prompt or nudge (opportunity) and an instructional tool (ability) on the best way to store food in the fridge in order to reduce waste. The information campaign elements are mapped to the MOA framework in Fig. 2. These

Fig. 1. Save food, save money, save the planet booklet.

informational materials were given to participants in the Information group, as well as the Community Engagement and Gamification group. The Community Engagement group also received invitations to a series of four learning workshops (opportunity) that had presentations on how to reduce food waste at home, group discussions, activities, and prizes (motivation, ability). The workshops were one-hour long, and they were held in an accessible and transit friendly community center for the single-family households. For multi-residential households, meetings were held in the party/meeting room inside of the residents' apartment building. Children were welcomed, and childcare was provided for workshop participants. We hosted the workshop interchangeably on either Saturday or Sunday afternoon to accommodate work hours. The Gamification group was invited to play a weekly online trivia game (opportunity) with questions about the impacts of food waste (motivation) and how participants can reduce food waste through simple day-to-day actions (ability). Gamification group participants earned ten points for each week that they played the game of five trivia questions and were rewarded a $10 grocery gift card if they reached 60 points or a $20 grocery gift card if they reached 120 points (motivation). The newsletters, community workshop reminders, game reminders, and fridge magnet also acted as nudges as they provided prompts which reminded participants about food waste and therefore increased the opportunity to reduce food waste. The study also included a Control group with no intervention. Households in all four groups were asked to fill in a survey at the beginning of the study and at the end of the intervention period, three months later. All groups including the control group received a $10 gift card as an incentive for filling out a pre-intervention survey and another $10 gift card for completing a post-intervention survey. The community engagement group received food, prizes and draws for attending each workshop (worth $10 for each workshop). The surveys provided data on perceived changes in food waste, attitudes and behavior, use rates of the information materials, and reasons for participating (or not) in the community engagement and gamification interventions. The findings from the survey research are described in Soma et al. (2020).

2.2. Recruitment

Participants were recruited from single family homes and multi-family buildings in the City of Toronto. Details of the recruitment strategy can be found in Soma et al. (2020). The total number of participants recruited to this study was 501, of which 120 were in a Control group, 140 in an Information group, 119 in a Community Engagement group, and 122 in a Gamification group. Note that we will not be addressing participants in the Control group in this paper as they did not take part in the focus group.

2.3. Focus groups

The aim of the focus group was to explore how participants engaged with the campaign and obtain insights that could not be captured in the quantitative analysis of the surveys. We used the focus groups to better understand whether there were any changes in participant motivation, opportunities, and abilities from the campaign that resulted in behavioral changes around food waste reduction. Most importantly, we were interested to know if any of the interventions were still influencing participants three months after they finished.

Approximately three months after the end of the campaign, participants were invited to join a 90-minute focus group discussion. A total of 44 participants agreed to attend the focus group. We ran two focus group sessions to allow for more opportunities for the participants to attend. Space was confirmed on a first-come, first-serve basis until all spots were filled. The two sessions took place on the weekend during daytime hours. We made sure that there were a balanced number of participants representing the three types of awareness campaign (information, community engagement, and gamification). Participants received a $50

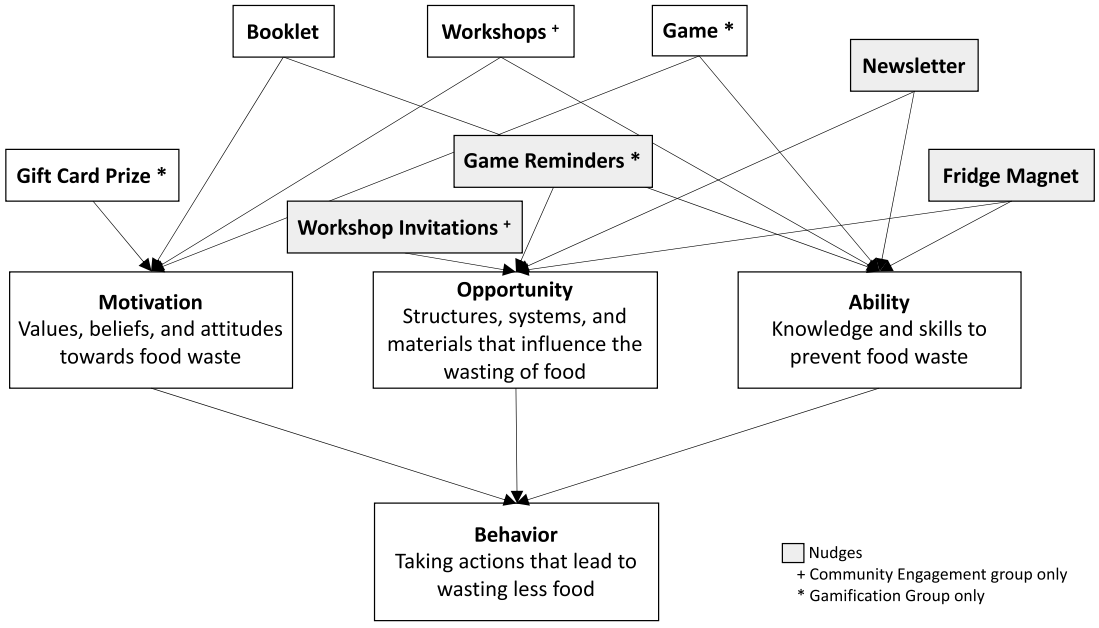

Fig. 2. Motivation opportunity ability model of food waste interventions.

grocery gift card for their attendance. When they arrived at the focus group, they were assigned to tables based on their campaign group, with a maximum of 5 participants at each table. According to Barbour (2008), while there are no set numbers for the ideal number of people in a focus group, in general a focus group can be done with a minimum of 3 people per group, to a maximum of 8, and in some fields such as marketing, larger numbers such as 10–12 participants are seen as ideal. Our tables of 5 participants are therefore within the expected range. We commenced the focus group with an introduction of the team, an overview of the study, and general questions for all the group. The general questions were then followed by more specific questions tailored to each campaign type. We applied a semi-structured approach to the questions to enable organic conversations and discussions to flow (see Table 1). The focus group was conducted in English. Unfortunately, none of the participants who belonged to the Community Engagement group and attended the focus group actually attended any of the community workshops we held. As such, we did not have examples of the impact of that intervention. However, we were able to document the reasons why participants did not attend the workshops. Participation in the workshops was not a requirement for members of the community engagement group to attend the focus group sessions due to the low participation rates in the workshops.

Table 1
Focus group questions.

Group	Semi-Structured Questions
Information Campaign Group	1. How useful were the email tips, website and newsletter that was shared with you? 2. Did you implement any of the tips from the materials that we sent you? If so, which one? If not, why? 3. Has the program changed the amount of food wasted in your household and why? (please elaborate)
Community Engagement Group	1. Did you implement any of the tips from the materials that we sent you? If so, which one? If not, why? 2. Did you attend the community workshops that we organized? 3. Were there any barriers to attending our workshops? 4. What did you think about the activities we offered? 5. Did any of the things you learned surprise you? 6. Is there anything that we missed or should have talked about in the workshop but did not? 7. Has the program changed the amount of food wasted in your household and why? (please elaborate)
Gamification Group	1. Did you implement any of the tips from the materials that we sent you? If so, which one? If not, why? 2. Did you play all of the online games we sent? (Did you complete all 12 challenges?) 3. What did you think about the game? 4. Were the questions challenging or easy? 5. Did the game help you better understand the issue of food waste? 6. Did you find the game useful? 7. Did you implement any of the learnings from the game? 8. Is there anything that we missed or should have included in the game but did not? 9. Has the program changed the amount of food wasted in your household and why? (please elaborate)

2.5. Analysis

The focus group discussions were audio recorded and transcribed. Due to the relatively small number of participants, we decided on manual coding. The first author and a member of the research team started with the coding process individually. The codes were then compared in a preliminary coding analysis. This code as framed within the MOA framework was then shared with the second co-author. We applied Ryan and Bernard's (2003) approach to identifying thematic categories in qualitative research. This included identifying themes and subthemes, winnowing the themes, deciding which themes are important, and linking the themes back to the theoretical framework (Ryan and Bernard, 2003), which in this case is the MOA framework. We found numerous recurring topics mentioned by the participants, which helps explain the impact (or lack thereof) of the interventions, and the barriers or opportunities faced by the participants after participating in the awareness campaign. After numerous iterations of cutting and sorting, identifying repetitions, similarities and differences, we identified opposing themes such as positive and negative motivations, positive and negative abilities, and positive and negative opportunities. We also identified nudges that were particularly useful in addressing the opportunity category. Positive MOA codes are statements from the participants that reflect how the interventions have positively impacted a direction in the participants toward food waste reduction. Negative codes are statements from the participants that identify barriers,

challenges, or a lack of interest that would make it more difficult for the participants to achieve the overall aims of food waste reduction. The names of the participants in this study have been changed to pseudonyms.

3. Results and discussion

3.1. Motivation

When exploring the category of motivation under the MOA framework, we sought to identify whether or not the intervention from the awareness campaign made participants more motivated to reduce food waste. In addition to positive motivations, findings from the focus group also uncovered some of the reasons behind participants' lack of motivations and revealed motivations that were not originally expected in the study (e.g. altruistic versus self-interest motivations). As noted by van Geffen et al. (2020) awareness of the consequences of and attitudes towards food waste can impact motivation to act. However, there are also competing goals that may negatively impact motivations to reduce food waste (van Geffen et al., 2020)

3.1.1. Improved motivation from interventions

In general, most of the participants who attended the focus group said that they felt more motivated to reduce food waste after participating in the food waste awareness campaign. While many noted that they already had some awareness of food waste issues, participants felt that the campaign made them more motivated and in some cases resulted in them actually trying new approaches to reduce food waste. It is important to note that awareness interventions while potentially targeting motivation, also contributes to knowledge (ability). The quotes below explain how participation in the campaign impacted participants motivation to reduce food waste.

> It was making me more mindful of it. Participating in the study caused me to think of things like sharing with my neighbors. I was already doing brunches with them every week, so why not take them leftovers to share? So it was just a natural fit… (Information-Chris)

> I would say awareness definitely increased during the course of the study. We kind of went under, went on a bit of a transformation …I think it was good to have that awareness because now we were having to kind of reduce how much we bought and be really aware of what our needs are. (Gamification-Rhonda)

> I did reduce a little bit but I'm more aware of it after going through the study. If I get organics, I'll scrub my vegetables instead of peeling my potatoes or my carrots. Now I just eat it. (Community Engagement-Dianna)

3.1.2. Lack of motivation despite interventions

However, it is important to note that not all participants were motivated to change their behavior due to participation in the campaign. For some of the participants, they had established habits and did not feel the need to invest in the time or effort in making changes. In particular, some of the participants who did not make any changes felt unmotivated due to information fatigue from all of the materials in the study. This information fatigue was based on the perception that there were too many educational materials (booklet, newsletters, etc.) and it can become overwhelming.

> I answered that there was no change in my habits of waste or managing waste. There's a certain way we've been doing it and there's also a lot of educational material. Maybe it's also fatigue? There are a lot of information coming in and we think, it goes into the subconscious. This is the way we've been doing it, let's just keep doing it like this. (Community Engagement-Jabar)

Interestingly, while most participants said that they were interested in participating in the study due to more altruistic reasons such as concern for the environment or moral concerns, one participant from the Gamification group noted that they simply participated due to an interest in getting the grocery gift card that was supplied to participants.

As such, it is unclear whether participation that hinged simply on obtaining a reward without a need to be accountable to actual waste reduction would translate into actual reduction. While being motivated to participate in the study by gift card compensation may not seem altruistic or ideal at first glance, in their meta-analysis of financial incentive interventions to promote pro-environmental behaviors, Maki et al. (2016) found that financial incentives had small-to-medium effect on behavior while the intervention was taking place and after removal. As such, since the individual would not have participated without the financial incentive, this raises the question about the economic feasibility of scaling up campaigns with financial incentives and the importance of testing other motivations other than financial incentives. While financial incentives may be effective in certain contexts, it is important to consider whether financial incentives may in some cases undermine intrinsic motivation for pro-environmental behavior (Deci et al., 1999; Eisenberger and Cameron, 1996). The circumstances whereby a participant is more interested in getting the grocery card reflects an interesting point on motivation in food waste reduction, but it also highlights a new financial opportunity for participants that was created through the implementation of the campaign.

3.2. Opportunity

In implementing the food waste reduction awareness campaign, it became clear very quickly that it is easier to design interventions that address the motivation and ability categories of the MOA framework, than it is to design interventions that address the opportunity category. As noted previously, the opportunity category is usually tied to structural, systemic, and material changes which are quite difficult to address in an awareness campaign model due to budgetary, time, or regulatory constraints. However, beyond large scale transformation in opportunities, increasingly tools for behavioral nudges have been identified as a way to improve opportunities to reduce food waste through making small structural, systemic, and material changes such as reminders and visual prompts that reinforce positive behaviors (von Kameke and Fischer, 2018).

3.2.1. Improved opportunities due to interventions

Based on the focus group discussion, participants repeatedly identified nudges as being important in shaping their behavior. A participant from the Gamification group pointed out that:

> The other thing is that you get reminded about the behavior of reducing food every week [with the game] even if you don't remember the numbers necessarily and the handouts. Reminding you every week is helping you be aware that you start to keep track of what you are doing. (Gamification-Melissa)

While there may be barriers to playing online games due to technological issues or lack of tools (e.g., smartphone or computer), we also found that the fridge magnet offered something similar to the game in terms of nudging the participants to think about food waste reduction. The magnet may also be a more affordable tool for those groups or organizations interested in conducting an intervention.

> Yes, the magnet had really good information and remind me every time I look at it. Even my husband asked "Wow what is this? I'll do

that too." It was right there. I always was mindful in order to do more about our environmental footprint, but now it's more in my mind when I go shopping, how I prepare and plan. I'm more aware. (Community Engagement-Dianna)

Interestingly, despite what can be considered as information fatigue and the fact that one of the participants noted that they did not read the materials at all, simply getting the weekly game prompts helped to make them more mindful about food waste.

Maybe one of the challenges is that although getting weekly prompts were really nice because it kept me on track, I definitely did not read anything just because we are reading everything… Although maybe what this shows is that it isn't actually important whether or not people are reading it. It is just getting weekly prompts to think about it. Which seems odd that we don't have to take in the information. (Gamification-Ashley)

3.2.2. Lack of opportunities despite interventions

In identifying the opportunities that would positively impact food waste reduction, it is important to note that several studies have shown that shopping in smaller amounts and more frequently rather than stocking up can help to reduce food waste (Lee, 2018; Soma, 2019). This approach is also known as the "buy today eat today" model (Soma, 2018), to test interventions that would encourage smaller and more frequent food provisioning, it would be important that households have easy access and the ability to shop in smaller amounts. Unfortunately, the lack of food system planning consideration (Pothukuchi and Kaufman, 2000) has created car-oriented urban sprawl and neighborhood development that promotes stocking up due to the need to use cars to access grocery stores (Freund and Martin, 2008). When asked whether the awareness campaign changed the amount of food wasted in the household, and what has helped the participants reduce food waste the most, several participants noted that the changes they made had nothing to do with improved awareness or information. Rather, opportunities offered by a new space or the design of the built environment has helped provide the opportunity to buy less.

Now I moved to a city where I have grocery shopping nearby. I buy two or three times a week. It's been helpful and I'm not buying as much…it's more helpful to buy more times a week because you'll have more fresh things and it's easier if your meal plans changed. (Information-Jennifer)

Another participant stated that they already had the existing infrastructure, and materials to help them save more food.

I already had a vacuum sealer to save food, we have a chest freezer. (Information-Patricia)

While it is helpful to have these food preservation tools available, to improve opportunities to reduce food waste, relying on households to have them in order to reduce food waste is not reasonable, nor is it practical.

We found that another common theme expressed by the participants in the focus group was that there are more opportunities to create food waste than there are to reduce or prevent food waste. The findings from this study confirm other findings on some of the drivers of food waste, namely the role of retailers and marketing practices in influencing the purchasing of food and the role of the retail environment in general (e.g. packaging, portion size, best before date) (Soma, 2019; Thyberg and Tonjes, 2016; Hebrok and Boks, 2017). These examples below highlight how the MOA identified a weakness in the campaign approach, namely its inability to address systemic issues.

Last week the pineapple was 1 dollar and I bought six of them. I know that my grandchildren would eat them but I didn't need to buy that much, but it was on sale, so I bought them. (Community Engagement-Tanya)

When you buy something, the market itself gives us the big portions with lower price. We are very tempted to buy because we are trying to live economically. I think that teaches us sometimes that it is not only about buying the things we need, but also has to do with the way they are selling. It is challenging because I have to calculate which way is better buying for my family life. (Gamification-Karen)

The quotes above reflect the economic challenges to reducing food waste, namely due to the push to overconsume and the rampant opportunities to waste food at the retail level. Participants repeatedly noted that they often have to reflect on the economic value of food, as buying more means that they are technically supposed to save money per unit of food. All of the participants who noted that they do impulse purchasing were aware that they do not really need to buy the amount of food that they buy from sales and discounts. However, as Karen from the Gamification group noted, the temptation is too hard to resist. Another interesting finding from our study is that opportunities to waste can come from what might seemingly be an environmentally sustainable and benign approach to waste management.

We bought this organic waste bin. I think it's made things worse [regarding throwing away food]. We've started throwing more things [in the bin] because the smell is not bad. (Community Engagement-Jabar)

One thing that the quote highlighted is the role of organic waste green bins as an opportunity for people to feel less guilty about wasting food because it goes to a composting process, which is considered to be a positive environmental action. In a related study, Qi and Roe (2017) found that subjects who were informed that food waste will be composted rather than landfilled were less concerned about reducing the amount of food wasted, and therefore wasted more. These findings therefore suggest a licensing or rebound effect. In the case of our study in the City of Toronto, the ease of and frequency of organic waste collection, improved green bin designs that can better contain odor, and the fact that participation in the green bin program is promoted as a more sustainable approach to managing organic (food) waste may make individuals less concerned about reducing their food waste even when they are exposed to a food waste awareness campaign.

3.3. Ability

One of the benefits of awareness campaigns as it relates to the ability category is that the educational and informational nature of the campaign naturally leads to more learning. The challenge is whether or not participants in a food waste reduction awareness campaign will translate the new information and skills into actions in their everyday food practices. In our study, information, recipes, tips, strategies were integrated through various delivery modes. Through the lens of the MOA framework, it was clear that the ability category was the strongest area of improvement achieved by the awareness campaign.

3.3.1. Improved abilities through the interventions

When asked whether or not they applied any of the tips, strategies or learning from the awareness campaign, most study participants came up with numerous examples of learning and practices. As mentioned in the methodology section, unfortunately, none of the participants who belonged to the Community Engagement group and attended the focus group actually attended any of the community workshops we held. As

such, we did not have examples of improved learning abilities due to the workshops. The delivery method of running an in-person community workshop created barriers for attendance due to scheduling. As such, most of the learnings for the Community Engagement participant who attended the focus group occurred via one of the online tools that was distributed to all of the campaign groups (online newsletters, games) as well as the fridge magnet.

> After the study, I start to freeze the leftovers and we eat them again. Before I used to throw it out. I think it was in your newsletter. If you put your leftover in a container inside a ziplock you can preserve the food and flavor better. (Information-Danika)

> Having an "eat me first" container and having all this information in my head really helped me to be more conscious. Having these numbers [statistics about food waste] while he prepares dinner helps him. I was reminded every week/every certain day about these consequences and I changed my behavior regarding food waste very quickly. (Gamification-Rhonda)

As noted from the quotes above, the 12-week awareness campaign covered different topics including better food storage, demystifying best before dates, tips on how to use leftover foods, better meal planning, and also better organization in the fridge so as not to forget food. In this study, we found that there were enough simple tips that participants can easily implement them regardless of their circumstances. In general, the participants noted that the campaign was quite helpful in improving their ability and we also heard that participants made changes in food practices based on what they learned.

3.3.2. Lack of abilities despite interventions

Unfortunately, there are barriers to implementing the learnings from the campaign such as better food portioning and better understanding of best before dates. This is where other factors such as habits and fear, as well as the fact that every household will have very different circumstances can hinder participant learning:

> One the challenges is that it is hard to differentiate the expiry dates. I learned somethings about expiry dates, but I am still scared. I would end up throwing it out. (Gamification-Melissa)

> For me, it's deciding the amount to make. For us, it is especially rice and pasta. We always make enough for a family of four but we are just two people. When I try to save the rice in a container, it just dries out and it's gross, so we just throw it away. I just find it would be helpful if I had another magnet telling me two people would eat this much rice. Then I would follow that to a T. I know I can just easily go online and look this up, but I haven't. (Gamification-Ashley)

It is important to note that general learning tools and tips commonly offered in food waste awareness campaigns may not necessarily be appropriate for all cultures, incomes and circumstances. When designing a food waste awareness campaign, it is important to note that a household is not necessarily a unified or homogenous unit (Metcalfe et al., 2012). There is not one unified approach to waste, and individuals may perform different practices, which in some case may help reduce food waste, while in others it may create more waste. Some households especially in some traditional cultures consists of multiple intergenerational family members living together (Soma, 2017). The household complexity and differences in abilities and motivations is particularly evident with more than one person in the household does the shopping.

> My partner is more impulsive with buying things at the grocery store. And so for me, when I go, I just get exactly what we know that we need and I won't overbuy, but my partner may see a really fancy cheese or something that would just end up sitting in the fridge and maybe we will have to throw it out. So the easiest thing is to shop alone. The hardest thing [referring to reducing food waste] is to control my partner. (Information-Trey)

4. Conclusion

Our study found that the MOA framework was effective in identifying both strengths and weaknesses of interventions that were part of a food waste awareness campaign. The interventions seem to target motivation and abilities quite easily, particularly by increasing awareness through environmental, economic or moral reasonings, as well as providing information that can improve knowledge on how to better manage food. However, it is very challenging to design interventions that would improve opportunities for participants not to waste. This is due to the fact that the "opportunity" category typically arises from structural, material, and potentially systemic changes occurring further upstream from the household level. An example of this may include changing access to retail infrastructure or a complete change in marketing practices by food companies. Interventions such as awareness campaigns do not necessarily address these long-term and systemic opportunities to reduce food waste. While it may seem difficult to explore food waste reduction interventions that can tackle all three aspects of motivation, opportunity, and ability in a comprehensive manner, our study found promising results in "nudging tools" which can fill the gap in the opportunity piece (von Kameke and Fischer, 2018). In particular, fridge magnets that act as a reminder about food storage can be easily integrated in a campaign-type intervention. However, it is also clear that participants find that there are more "opportunities" to waste than there are to reduce waste.

Competing goals and barriers to reduce food waste found in this study are similar to those identified by other studies (van Geffen et al., 2020), namely issues around promotions in stores, confusion around best before dates, time scarcity, and differences in abilities among members of the same households. The contribution of this study is that it places those competing goals and barriers within the broader context of the MOA framework. Future research should test the framework with other types of interventions. As Reynolds et al. (2019) have noted, lack of theory has hindered the development of effective food waste interventions to date; the MOA framework may help to address that problem. Future studies could also test the efficacy of weekly online games as nudging tools when there are no economic inducements to participate in the game. To conclude, while the findings in this study demonstrate that awareness campaigns can indeed move the pendulum of awareness and ability towards positive environmental behavior, it is only one tool out of the many tools required to support changes in food-related practices and to address the issue of food waste in the long term.

Credit author statement

Conceptualization, Tammara Soma, Belinda Li and Virginia Maclaren; **Methodology**, Tammara Soma and Belinda Li; formal analysis, Tammara Soma, Belinda Li and Virginia Maclaren; **Writing**—original draft, Tammara Soma and Belinda Li; **Writing—review and editing**, Tammara Soma, Belinda Li, and Virginia Maclaren; **Project administration**, Tammara Soma; **Funding acquisition**, Tammara Soma, Virginia Maclaren, and Belinda Li. All authors have read and agreed to the published version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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