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Sustainable Retailing – Influencing Consumer Behaviour on Food Waste

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ABSTRACT

The aim of this research was to examine the influence of a UK national retailer on its customers' food waste behaviour. Using six communication channels (in-store magazine, e-newsletter, Facebook site, product stickers and in-store demonstrations), Asda presented standard food waste reduction messages to its customers during two time limited periods in 2014 and 2015. Six national surveys over 21 months tracked customers' self-reported food waste. Our results showed that the combined communication channels and repeated messages over time had a significant effect on reducing food waste of customers. Surprisingly, customers who said they did not recall seeing the messages also reduced their food waste, showing the wider influence of interventions. Those who saw a food waste reduction message saved an estimated £81 annually from reducing food waste. The main conclusion of this paper is that retailers can influence the pro-environmental behaviour of customers using conventional communication channels; however, repeat messages are needed in order to have a long-term impact. © 2017 The Authors. Business Strategy and the Environment published by ERP Environment and John Wiley & Sons Ltd

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Introduction

FOOD WASTE IS A COMPLEX AND GLOBAL PROBLEM THROUGHOUT SUPPLY CHAINS AND IS CONTRIBUTED TO BY MANY DIFFERENT ACTORS, including farmers, food processors, retailers, food outlets and households. It is widely agreed that food waste needs to be reduced to avoid associated environmental, social and economic impacts (Tilman and Clark, 2014; Bajzelj *et al.*, 2014). Different actors can take responsibility to help reduce food waste, especially retailers, who have a significant influence up and down the supply chain (Mena *et al.*, 2011). One way retailers can do this is by influencing the food waste behaviours of their customers (Quested *et al.*, 2013). Cross-industry partnerships and voluntary agreements are starting to address this issue by facilitating the reduction of the environmental impact of the 'use' phase of their products and services (Spaargaren and Mol, 2008; Bocken and

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Allwood, 2012; Dauvergne and Lister, 2012; Hazen *et al.*, 2016). In terms of food waste, this area is under-researched, which is where this paper contributes to the literature.

This paper explores the effectiveness of a large retailer's communication channels, including an in-store magazine, product labelling and social media, to change the self-reported waste behaviour of their customers. Our approach was to conduct a quasi-experiment in a field setting using methods that have been demonstrated to be effective in laboratories to ascertain if these methods are successful in practice to change behaviour and thereby reduce environmental impacts (Young and Middlemiss, 2012). In doing so, we apply a co-production process (Clark and Dickson, 2003) (also called transdisciplinary research (Elliot, 2013)) between us as researchers and staff at the UK retailer Asda. We tested five communication channels in two intervention periods, one in 2014 and one in 2015, with cross-sector agreed standard food waste reduction messages. The effectiveness of the communication channels was monitored through six national surveys using an internet panel. By testing the effectiveness of the food waste communication campaigns in a supermarket environment, our messages were also competing with other products and services marketing campaigns. Our aim, therefore, was to test the effectiveness of Asda's communication channels using standard food reduction messaging in reducing reported food waste of customers.

Background

Companies and retailers have been focusing on the eco-efficiency of their operations and supply chains as part of their sustainability strategy (Sullivan and Gouldson, 2016; Dauvergne and Lister, 2012). Retailers are now extending their eco-efficiency strategies to incorporate their customers as well as their own operations and those of their suppliers (Morgan, 2015; Newson *et al.*, 2013). This may be in an effort to make the whole production and consumption system as efficient as possible and by avoiding the restriction of flow of products, which would in turn affect profit. Large food retailers in particular most often have a business model based on sales volume, whereby they make little profit per product (Mena *et al.*, 2011). As such, using their marketing and brand management skills to engage with the efficiency of consumption of their products is in line with retailers' current and dominant business model.

Food Waste

Waste recycling in general was a focus of increasing attention the 1990s and early 2000s, but food waste was ignored until the mid-2000s; this changed due to the increasing awareness of food waste levels and associated impacts (Metcalfe *et al.*, 2012). It is estimated that one-third of edible food produced for human consumption is lost or wasted globally each year (Goebel *et al.*, 2015; Graham-Rowe *et al.*, 2014). In the UK, food waste derived from households accounts for 7.3 million tonnes of total food and drink wasted each year (WRAP, 2017). UK households throw away approximately one-third of the food they purchase for consumption (Evans, 2011), with the average annual household waste containing 17% food waste (Defra, 2015). However, it is not solely the amount of food wasted that has increased interest in this waste stream but also the impact it has economically, socially and environmentally (Tilman and Clark, 2014; Bajzelj *et al.*, 2014).

According to Graham-Rowe *et al.* (2014), food waste exacerbates escalating food prices globally, which causes food to be less attainable to the world's poorest, increasing the number of malnourished people and demonstrating the direct social impact of food waste. The associated economic impact of buying food that is never eaten and thrown away (Graham-Rowe *et al.*, 2014) costs the average UK household £470 a year, growing to £700 for a family with children (WRAP, 2017).

Possibly the most damaging impact of vast levels of food waste is the corresponding environmental effect. For example, production of food that is consequently wasted magnifies the pressure on diminishing forests that are inevitably altered for agricultural land (Graham-Rowe *et al.*, 2014). Additionally, the disposal of food and drink to landfill adds to the avoidable release of gases such as methane (Graham-Rowe *et al.*, 2014), along with other greenhouse gas emissions that contribute to climate change (Goebel *et al.*, 2015). However, much of the environmental impact associated with household food waste stems from the production and supply of the food

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wasted rather than the disposal of food. 4.2 tonnes of CO_2 eq. is avoided by preventing waste compared with 0.5 tonnes of CO_2 eq. avoided by treating waste (Quested *et al.*, 2011). Ultimately, it is clear that minimizing food waste is crucial for obtaining a sustainable food system that does not have serious economic, social and environmental repercussions (Goebel *et al.*, 2015). Hence targeting the behaviours that create or exacerbate food waste is important.

In general, food waste behaviour is related to education level, sorting practices, convenience, attitudes and concern (Secondi *et al.*, 2015; Bernstad, 2014). Qi and Roe (2016) suggest that awareness of food waste in the USA, for example, is 50%, and that increasing awareness of the environmental impact of waste would be a good next step. According to Quested *et al.* (2011), household food waste transpires from the interaction of multiple behaviours called 'specific food behaviours'. These behaviours relate to planning, storing, preparing and consuming food (Quested *et al.*, 2011). However, other studies have found that it is more than just specific food waste behaviours that exacerbate household food waste. Goebel *et al.* (2015) argue that consumer expectations around availability, variety and freshness cause food waste along the supply chain and in households. Packaging is a contributor to household food waste due to too much product packaged together and packaging that is difficult to empty (Williams *et al.*, 2012). Evans (2011) and Metcalfe *et al.* (2012) argue that there is no evidence to suggest that consumers are careless or callous about the food they throw away; for example, parents tend to generate food waste due to showing affection to their family by having an abundance of food (Porpino *et al.*, 2016). However, influencing behaviour through multiple means is important in reducing an environmental harm, however unintentional (Young and Middlemiss, 2012).

Retailers on the other hand produce less than 3% of food waste in the UK (Defra, 2015); however, due to their pivotal place in the supply chain, retailers can produce significant reductions by working with their suppliers and influencing their customers. Quested *et al.* (2013) suggest that companies can help reduce customers' food waste at home by communicating key messages. Much retailer activity in the UK on food waste has been coordinated by the Waste and Resources Action Programme (WRAP) using the multi-stakeholder Courtauld Commitment (WRAP, 2015), with the most recent commitment extending to 2025. This is a voluntary industry agreement to help UK consumers cut down food waste in households using WRAP and retailer's campaigns. The campaigns have focused around shopping smarter (using shopping lists), storing products better, planning meals, using up food that could be thrown away and composting food waste where possible. However, recent figures by WRAP (2017) show that household food waste has stayed the same between 2012 and 2015 after dropping by 15% between 2007 and 2012, questioning the impact of recent efforts. Our case study retailer, Asda, is part of the Courtauld Commitment and in a customer survey found that its customers wanted more help from Asda in reducing food waste (Asda, 2013). Hence, Asda embarked on this research to identify if and how it could help.

Influencing Pro-environmental Behaviour on Food Waste

An information campaign to influence attitudes and behaviour of individuals is just one approach in the area of pro-environmental behaviour change (Abrahamse and Steg, 2013). Other approaches include the provision of infrastructure (e.g. household recycling bins), legal structures (e.g. vehicle emission related taxes) and incentives (e.g. renewable energy technology subsidies), but these are more the remit of national and local government (Auld *et al.*, 2014). Retailers could be in a good position to influence and promote pro-environmental behaviour because they have more frequent interaction with their customers than national or local government have with their citizens (Goworek *et al.*, 2012; Hampl and Loock, 2013). Retailers' corporate social responsibility (CSR) and sustainable business activities need to be intelligently communicated to their stakeholders (Maignan and Ferrell, 2004; Youn *et al.*, 2016) and are more likely to change consumption patterns than reduce consumption overall (Jones *et al.*, 2009; Lin and Hsu, 2015). These sustainable business activities are and should be seen as different from normal marketing activities, and about transparency or reducing the impacts rather than just promoting product or service sales (Young and Tilley, 2006; Wei *et al.*, 2017). Companies can also use their normal communication channels for sustainable business programmes, as they have been shown to be effective in influencing consumer behaviour in general (Danaher and Rossiter, 2011; Dad, 2012).

Figure 1 highlights the range of factors that can influence food waste, and we are especially interested in the influence of the 'retail supply chain' on 'individuals and households'. The retail supply chain is usually led by the

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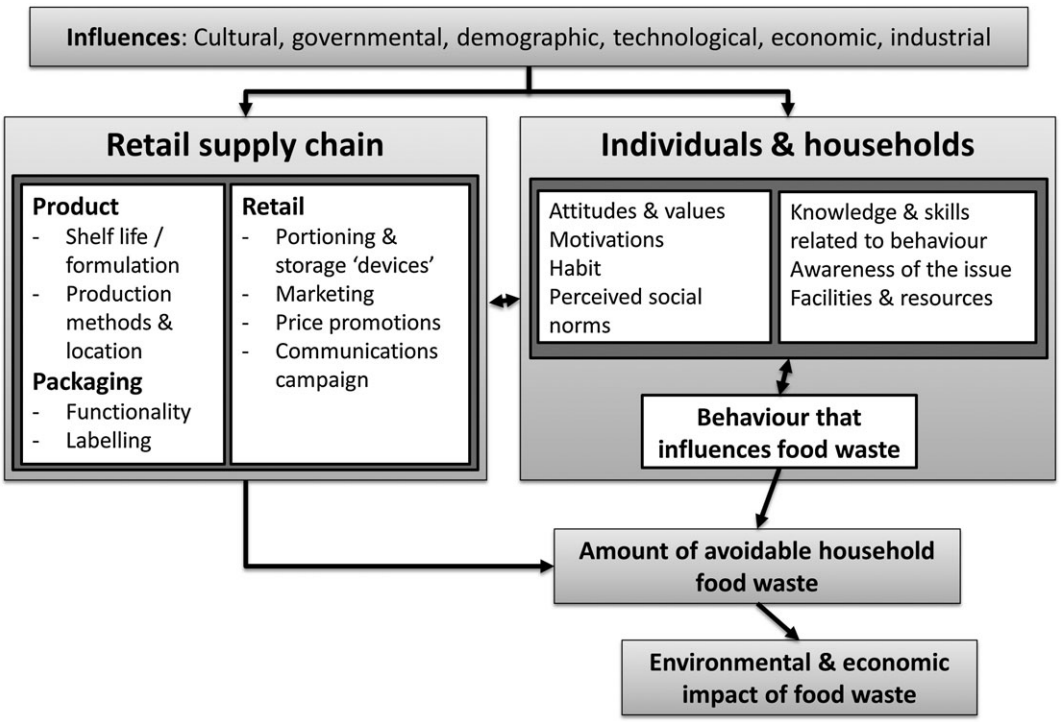

Figure 1. Influences on food waste (Quested *et al.*, 2013, p. 45)

retailer as controller of the food supply chain (Dauvergne and Lister, 2012; Hingley, 2005) and has an impact on individuals and households through information campaigns that influence 'attitudes and values', 'perceived social norms', 'knowledge and skills' and 'awareness'.

Previous pro-environmental behaviour research has been classified by Abrahamse and Steg (2013) in their meta-review, which in addition to 'information provision' has the following.

1. 'The use of social norms in information and feedback provision' (Abrahamse and Steg, 2013, p. 1774), for example a notice informing hotel guests that the majority of other guests use their towels more than once. The feedback may be a comparison of someone's energy bill against neighbours. Both play on the fact that people tend to compare themselves with others and may change if they see others do so.
2. 'Block leaders and social networks' (Abrahamse and Steg, 2013, p. 1774), for example recyclers encouraging their neighbours. This relies on the notion that people are more likely to take action if information is provided by someone in their social network. The stronger the ties in the network, the more likely the information will affect behaviour.
3. 'Public commitment making' (Abrahamse and Steg, 2013, p. 1774), for example signing a community pledge to conserve water. Publically binding someone to a behaviour has been linked to the need for consistency and social pressure to adhere to the commitment.
4. 'Modelling' (Abrahamse and Steg, 2013, p. 1774), for example a couple showing their neighbours how to compost. People are more likely to commit to something if they see other people undertaking the behaviour.
5. 'The use of social comparison in feedback provision' (Abrahamse and Steg, 2013, p. 1774), for example average energy use by households of the same size as your own. This is having your own behaviour compared against others, which is different from social norms, where there is no direct comparison of behaviours. This approach again uses the impulse of people to compare themselves against others.
6. 'Feedback provision about group performance' (Abrahamse and Steg, 2013, p. 1774), for example energy savings for a building with multiple apartments. This approach uses the collective effort of all residents as a means of identification and shared beliefs.

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Abrahamse and Steg (2013) found that those with the most effective approaches to behaviour change were block leaders with social networks, modelling and public commitments. The common factor in these approaches is 'face-to-face' interaction, which accentuates these influences (Abrahamse and Steg, 2013), and this element has also been a success in using mentoring of households to reduce their food waste (Sharp *et al.*, 2010; Staats *et al.*, 2004). In an attempt to replicate the effect of 'face-to-face' interaction with a large scale audience using social media, we found that the impact was no different from just 'information provision' (Young *et al.*, 2017). In addition, consumers with strong green values tend to respond to green messaging (Grankvist *et al.*, 2004), but others can be influenced by green messages without being aware of them (Nolan *et al.*, 2008; Thøgersen, 2006).

Attempting to influence millions of a retailer's mainstream customers using resource intensive mentoring of households is not financially viable. On the other hand, retailers have successfully used traditional sales campaigns for products and services using a range of communication channels such as mass media advertising, in-store magazines, emails, social media, in-store promotions and on-product labelling (Danaher and Rossiter, 2011; Dad, 2012). Research on food waste campaigns by government and non-governmental organizations with households has found that that multiple interventions can have a bigger impact than single ones (Sharp *et al.*, 2010; Staats *et al.*, 2004). Hence, to study this differing evidence from pro-environmental behaviour and mainstream marketing literatures on the effectiveness of information provision, we assess the impact of communication channels on Asda customers' food waste attitudes and behaviour. The information messages, communication channels and case organization are now explained in the next section.

Methods

In our study we aimed to test the effectiveness of Asda's communication channels using standard food reduction messaging in reducing reported food waste of customers. This study was the result of an on-going collaboration between university researchers and employees of Asda. The dual approach of developing impact on the behaviours of consumers while simultaneously contributing to scientific knowledge through collaboration between researchers and practitioners is known as co-production (Clark and Dickson, 2003). In conducting the research we, as researchers, deliberately influenced and changed decisions, actions and processes within the company. In turn, employees in Asda provided data, helped shape and implement the food waste reduction campaign, and facilitated data collection to fit the activities of the company for maximum effect.

With any co-production approach, it is important that researchers maintain a good standard of research ethics when receiving funding from and working with companies. The researchers and Asda employees complied with the University Research Ethics Policy and the work conducted was consistent with the British Psychological Society's Code of Human Research Ethics. While we acknowledge that the discussion of the ethics of co-funded research is important, a full discussion of the issues is outside the scope of this article (see Somerville (2002) for lessons from drugs research).

The Case Organization

The research for this study was conducted with Asda. Founded in the 1960s, Asda is one of Britain's leading retailers. It has over 180 000 employees serving customers from 600 stores, including 32 Supercentres, 409 Superstores, 27 Asda Living stores, 148 Supermarkets, three Home Shopping Centres and 14 Petrol Filling Stations. Asda serves over 18 million shoppers a week in its stores and its home shopping business became part of Walmart in 1999 (Asda, 2013).

Concerning sustainability, Asda takes the lead from its parent company, Walmart. The Walmart corporation has three goals for the group:

- to be supplied by 100% renewable energy;
- to create zero waste;
- to sell products that sustain people and the environment (Asda, 2013).

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To deliver these goals, Asda developed a set of environmental sustainability targets under its 'Sustainability 2.0' strategy, focusing on the following: products; corporate; property and energy; transport; and waste. Asda has also been working with suppliers through its 'Sustain and Save Exchange' programme to reduce food waste.

In 2011, Asda built the 'Everyday Expert' project. This is a panel of 20 000 consumers consisting of both Asda primary and secondary shoppers. With a response rate of between 4000 and 10 000 responses to each survey, the panellists regularly give their views on what Asda should be focusing on in terms of sustainability. This insight is now being used to shape product and strategy development (Asda, 2013). The project was started following surveys of Asda's customers revealing that they wanted Asda to reduce food waste in its supply chain but also to help them reduce waste at home (Asda, 2013). Hence, Asda's customers gave the supermarket the permission to influence behaviour in the home, but only on food related issues.

The Food Waste Reduction Campaign

The food waste reduction campaign aimed to test the effectiveness of the different communication channels at Asda and not the messaging. The messaging was taken from the standard 'Love Food Hate Waste' campaign promoted by WRAP that Asda and other companies have committed to use by being signatories to the Courtauld Commitment (WRAP, 2015). The standard messaging covers shopping smarter (using shopping lists), storing products better, planning meals and using up food that could be thrown away, all of which encourage consumers to reduce their food waste (WRAP, 2015).

Five communication channels were selected for the food waste reduction campaign. These were chosen as the ones that had a pragmatic mixture of potential influences using results from the meta-review by Abrahamse and Steg (2013), customer reach, feasibility for delivery and agreeability to Asda (see Table 1). Hence, five communication channels were used in two time limited periods (4–6 weeks each), one in 2014 and another in 2015. The exception was the Asda in-house magazine, which was used in both years. To avoid confusion, each food waste reduction intervention using a communication channel will be called an 'intervention'.

Six one-off interventions were carried out to impact and measure consumer behaviour around food waste to test the five different communication channels. They were designed and developed with internal Asda communication channel teams, and each of the interventions is now discussed in turn.

Intervention 1: Asda Magazine 2014

Asda Magazine is distributed to 3 million readers every month. It is made available to customers in Asda stores as well as online. This intervention consisted of publishing a featured article that provided expert tips to cut down household food waste.

The feature was published on page 47 of the October 2014 monthly issue of Asda Magazine (shown in Figure S1 in the electronic supplementary materials) and provided tips for reducing the waste of specific foods. Tips included storage advice, recipe inspiration and methods to use up leftovers. This feature specifically highlighted methods to make the most of the most commonly wasted foods based on data from WRAP (Pocock *et al.*, 2008) and the Everyday Expert Panel. Food covered in the article included (1) fruit and vegetables, (2) meat and fish, (3) bread and baked goods, (4) dairy items and (5) cooked rice and pasta.

Communication channel	Abrahamse and Steg (2013) intervention categorization	Timing of intervention
Asda Magazine	information	October 2014 & August 2015
e-newsletter	information	October 2014
Asda Facebook site	block leaders and social networks	October 2014
On-pack sticker	social norm information	August–September 2015
In-store event	block leaders and social networks	August–September 2015

Table 1. Communication channel and aim of intervention

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Intervention 2: Asda Magazine 2015

The second magazine intervention was in 2015, covering a larger space over a three-page feature, shown in Figure S2. This magazine, and feature, were available both online and in-store. The feature provided advice for reducing food waste at home and multiple recipes for using up leftovers. The feature was published on pages 62–64 of the August 2015 monthly issue of Asda Magazine. The article discussed tips around certain products, such as 'making the most of bread products', 'using up fruit', 'storing salad' and 'reviving veg past its best before date'. The feature also provided behavioural tips, including 'making a shopping list', 'checking cupboards before going shopping' and 'freezer guidance'.

Intervention 3: Asda e-newsletter

The Asda e-newsletter is circulated every two weeks and has a readership of 1.4 million customers. This intervention was circulated once in 2014 in conjunction with the social media campaign. The e-newsletter had two specific features addressing household food waste. The first feature, like the social media campaign, discussed using leftovers to reduce food waste and included a web link, connecting customers to the social media campaign encouraging them to share ideas for reducing food waste (see Figure S3). The second feature highlighted correct storage as a method of keeping food fresh and preventing waste, and provided a link for purchasing food storage items.

Intervention 4: Asda Facebook Page

This intervention was designed to utilize the success of the 'face to face' interaction element from previous social influence interventions (Abrahamse and Steg, 2013). The aim was to facilitate discussion among customers on Asda's Facebook site, which has 1.4 million 'likes'. Utilizing Asda's social media group, this intervention consisted of posting a 'leftovers' campaign on Facebook (shown in Figure S4). The campaign asked Asda customers to submit their favourite recipes that involved using leftover food and directed users to a website providing 'Love Food, Hate Waste' tips from WRAP on reducing food waste at home (Love Food Hate Waste, 2015). The objective of this intervention was to encourage the use of leftover food to cut down waste within households and to promote discussion of this issue between Asda consumers.

Intervention 5: On-Pack Sticker Campaign

This intervention was designed to utilize the social norm information intervention (Abrahamse and Steg, 2013). This intervention consisted of on-pack stickers on four types of product that are highly wasted as reported by Asda customers. The products included: minced beef, potatoes, carrots and bagged rocket salad (example in Figure S5). These stickers provided tips for making the most of products, such as methods for storing the product and ideas for using up the whole product. These tips were combined with customer statistics on the percentage of customers who avoid wasting the product. For example '75% of shoppers avoid wasting their salad by keeping it in the fridge'. This was to test the effectiveness of using subjective norm messaging.

The stickers were on pack for 6 weeks, and over 4 million products containing these stickers were sold over this time period.

Intervention 6: In-Store Event

This intervention was designed to utilize the success of the 'face to face' interaction element from previous social influence interventions (Abrahamse and Steg, 2013). The in-store intervention was carried out using Asda's Community Champions over a 6 week period between August and September 2015 (see Figure S6). Asda's Community Champions carried out in-store food waste events across Asda's 600 stores. During this event, the Community Champions played games, shared top food waste tips and asked customers to make pledges to reduce their food waste at home. Leaflets were given out at this event containing quotes from Asda customers discussing the steps they take at home to cut back waste. Once again, this messaging was used to test the impact of subjective norm messaging.

Over 20 000 pledges were made by customers who took part in the nationwide events, and over 1 million views and 1500 comments were made on the complementary social media posts.

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Measures

An online questionnaire was used to measure changes in food waste behaviour as a result of the two sets of interventions. Questionnaires were carried out at Time 1 (May 2014), Time 2 (October 2014), Time 3 (March 2015), Time 4 (September 2015), Time 5 (December 2015) and Time 6 (February 2016). Surveys were carried out five months before the interventions (Time 1 and Time 3), two weeks after the interventions (Time 2 and Time 4), and a few months after the interventions were complete (Time 3, Time 5 and Time 6). Participants were recruited from Asda's existing customers who had signed up to complete market research (panel of 30 000 customers; see https://pulse.asda.com). Questions were designed by the research team to measure behaviours. Edits to the questions were suggested by Asda's customer insight team and final questions agreed as outlined below. Raw data collected by Asda were given to the research team to analyse.

At the start of each questionnaire, participants were asked about the food they waste at home. Participants were then asked if they remembered seeing any of the interventions as listed. If respondents indicated they had seen an intervention, their answers were coded based on which intervention set they had seen. All participants answered the same set of questions.

This paper particularly focuses on 'avoidable' household food waste, which Lebersorger and Schneider (2011) state has the greatest potential for reduction of food waste in the developed world with retailers, food services and, in particular, consumers. 'Avoidable' household food waste is defined as 'food and drink thrown away because it is no longer wanted or has been allowed to go past its best' (WRAP, 2013, p. 23).

Consumer behaviour around food waste was measured using a scale variable of food waste quantity. The quantity of foods wasted was measured by asking consumers 'Over the past week have you thrown out any of the following items? Please select all that apply'. Participants then selected which food items they had wasted from a list of nine product categories: fruit, vegetables, salad, bakery, dairy, meat and poultry, seafood, drinks and other. These were summed to provide an index of food quantity wasted.

Customer food waste savings during the study period, when they changed their behaviour due to the interventions and reduced waste, were estimated and monetized. The approach followed for estimating the monetary savings is as follows.

- A data set that contains those who took part in May 2014 (T1) and Feb 2016 (T6) surveys, reduced food waste between T1 and T6 and responded that they either recollected one or more of the interventions or did not recollect any of the interventions was prepared. The sample size for this analysis is 741.
- The dataset was filtered using a categorizing variable that splits customers into two main groups: primary shoppers and secondary shoppers. Primary Asda shoppers are those who do the majority of grocery shopping at Asda and visit the store several times a week. Secondary shoppers are those who have shopped at Asda in the past and use Asda as an occasional or top-up destination.
- Primary and secondary shoppers were also divided into two further sub-categories, including those who recalled seeing at least one of the interventions and those who did not recall seeing an intervention.
- Costs of food waste in May 2014 (T1) and Feb 2016 (T6) were calculated by coding each product type using WRAP's cost of food waste.
- The difference between T1 and T6 was then calculated to give food waste savings.
- The food waste savings for each sub-category was then calculated.

Results

Participants

The six surveys were sent to 20 000 customers through Asda's Everyday Experts panel. Response rates varied from 40% to 14% (Table 2). After removal of cases with missing responses from one or more surveys, the final sample included 631 matching responses across all six surveys. These responses have been broken down by intervention

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Questionnaire	Responses (*N*)
May 2014 (T1)	7900
October 2014 (T2)	5383
March 2015 (T3)	4398
September 2015 (T4)	3464
December 2015 (T5)	3267
February 2016 (T6)	2789

Table 2. Response rates for all six questionnaires

Shopper type	Intervention recall	Sample size (*N*)
Primary shoppers	Did not recall any intervention	76
	Recalled at least one 2014 intervention	164
	Recalled at least one 2015 intervention	26
	Recalled at least one 2014 and one 2015 intervention	126
Secondary shoppers	Did not recall any intervention	64
	Recalled at least one 2014 intervention	115
	Recalled at least one 2015 intervention	18
	Recalled at least one 2014 and one 2015 intervention	42

Table 3. Sample size of each intervention group

recall and split by the type of Asda shopper (primary or secondary). These figures are shown in Table 3. All analyses reported in relation to the survey and demographics refer to respondents who took part in all six surveys.

Food Waste Behaviour

A repeated measures analysis of variance was conducted to assess the impact of the sets of interventions (2014 and 2015) on participants' scores of food waste quantity, across six time periods (before each intervention, shortly after each intervention, and 5-month follow-up). There was no significant interaction between the interventions and time for primary shoppers, Wilks lambda =0.993, $F(5, 386) = 0.580$, $p = 0.715$, partial eta squared =0.007. There was also no significant interaction between the interventions and time for secondary shoppers, Wilks lambda =0.989, $F(5, 233) = 0.530$, $p = 0.753$, partial eta squared =0.011. Hence no individual intervention influenced reported waste.

There was however a significant main effect for time for primary shoppers, Wilks lambda =0.951, $F(5, 386) = 3.955$, $p = 0.002$, partial eta squared =0.049, with primary shoppers showing a reduction in mean quantity of food waste across the six time periods (see Table 4, Figures 2 and 3). On the other hand, there was no significant effect for time among secondary shoppers. The main effect comparing the intervention group against the 'none' group was not significant for primary shoppers, $F(1, 390) = 1.493$, $p = 0.223$, partial eta squared =0.004. The main effect was not significant for 'none' group secondary shoppers either, $F(1, 237) = 2.122$, $p = 0.147$, partial eta squared =0.009.

Customer savings: Table 5 shows the monetized savings as a result of reduction in the food waste between phases T1 and T6.

Among primary shoppers, the average savings per customer per week are greater for those who remembered seeing at least one intervention. The data shows that the maximum savings are made by the customers who recalled seeing at least one of the interventions. Irrespective of whether customers recalled or did not recall seeing an intervention, customer behaviour seemed to have been influenced by the interventions and resulted in reduction of food waste. Considering the sample that 'recalled at least one intervention', the average savings per customer per week are about £1.56 (£81 per year).

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Shopper type	Intervention recall	T1		T2		T3		T4		T5		T6	
		Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Primary shopper	None	1.18	1.41	1.04	1.24	0.83	1.09	1.03	1.47	0.83	1.19	0.91	1.20
	Recalled at least one 2014 and/or one 2015 intervention	1.24	1.30	1.20	1.31	1.12	1.27	1.18	1.34	1.00	1.21	1.05	1.29
	Total	1.23	1.32	1.17	1.30	1.07	1.24	1.15	1.37	0.97	1.20	1.03	1.03
Secondary shopper	None	1.03	1.32	0.84	1.18	0.80	1.06	0.80	1.26	0.80	1.22	0.86	1.13
	Recalled at least one 2014 and/or one 2015 intervention	1.12	1.37	1.13	1.34	0.99	1.14	1.09	1.31	0.95	1.17	1.14	1.35
	Total	1.10	1.35	1.05	1.30	0.94	1.12	1.01	1.30	0.91	1.18	1.07	1.30

Table 4. Means, standard deviation of behavior from Time 1 through to Time 6

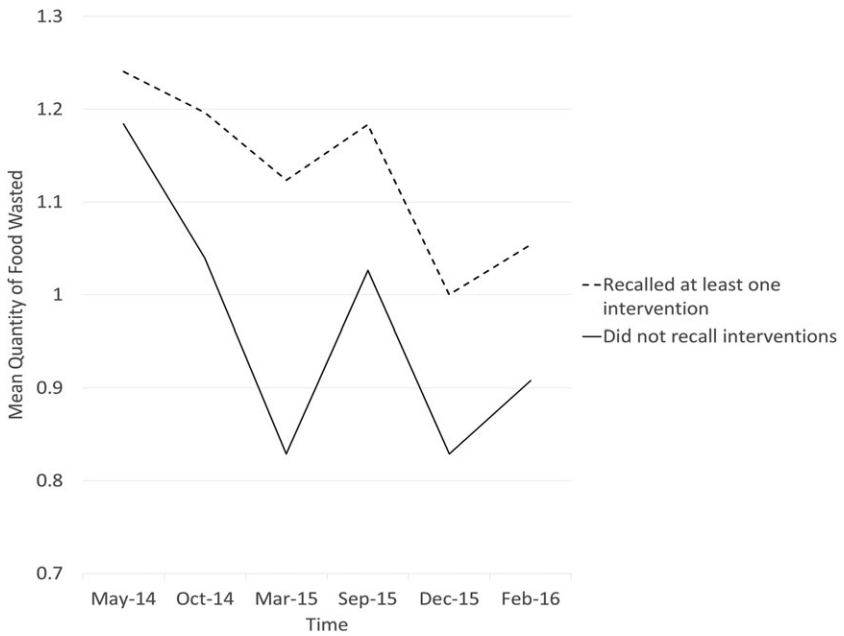

Figure 2. Quantity of food waste over time for primary shoppers

Further Analysis

A paired samples *t*-test was conducted to evaluate the points in time at which the change in mean quantity of food waste was significant. The dataset was split by shopper type (primary shoppers and secondary shoppers) and intervention recall.

For primary shoppers who recalled at least one 2014 and/or one 2015 intervention, there was a significant decrease in mean quantity of food waste following the 2015 interventions. Quantity of self-reported food waste for primary shoppers who recalled the interventions decreased between Time 4 (M = 1.18, SD = 1.34) and Time 5 (M = 1.00, SD = 1.21), $t(315) = 2.81$, $p = 0.005$ (two tailed). Quantity of self-reported food waste also decreased overall among primary shoppers who recalled the interventions between Time 1 (M = 1.24, SD = 1.30) and Time 6 (M = 1.05, SD = 1.29), $t(315) = 2.60$, $p = 0.010$ (two tailed).

For secondary shoppers who recalled at least one 2014 and/or one 2015 intervention, there was a significant increase in mean quantity of food waste between Time 5 (M = 0.95, SD = 1.17) and Time 6 (M = 1.14, SD = 1.35), $t(174) = -2.25$, $p = 0.026$ (two tailed).

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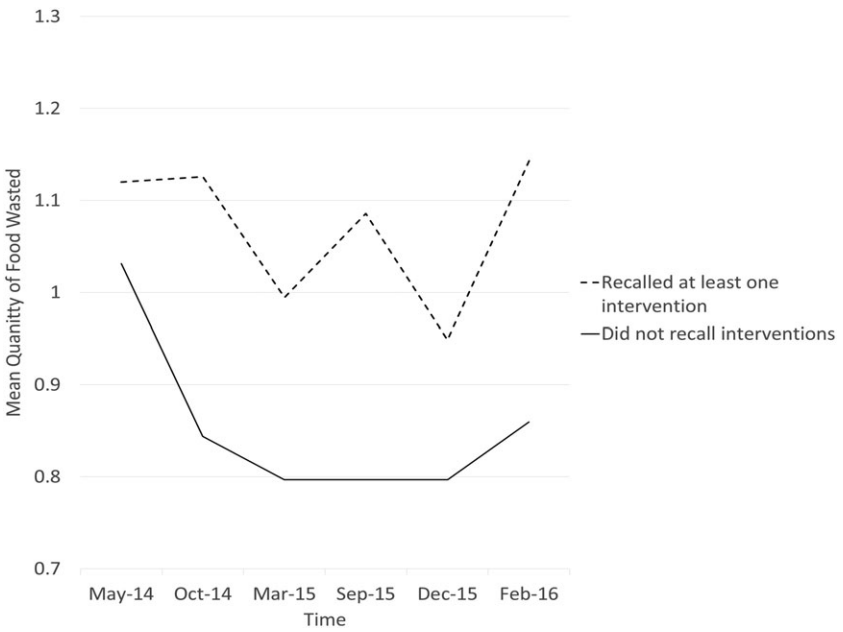

Figure 3. Quantity of food waste over time for secondary shoppers

			Saving per customer per week (£)			
Shopper type	Intervention recall	Sample size (*N*)	Mean	Std Dev.	Min.	Max.
Primary shopper	Recalled at least one intervention	440	1.53	1.008	0.56	9.69
	Did not recall any intervention	51	1.49	0.782	0.56	3.88
Secondary shopper	Recalled at least one intervention	217	1.58	0.973	0.56	6.70
	Did not recall any intervention	33	1.67	0.925	0.56	3.92

Table 5. Savings per customer per week by shopper type

Among primary shoppers who did not recall any intervention, there was a significant decrease in mean quantity of food waste between Time 2 (M = 1.04, SD = 1.24) and Time 3 (M = 0.829, SD = 1.09), $t(75) = 2.01$, $p = 0.048$ (two tailed). However, there was no significant decrease in food wasted among these customers at any other time point or across all six time points.

For secondary shoppers who did not recall any intervention, there was no significant decrease or increase in mean quantity of food waste at any time point. For socio-economic characteristics of the participants, no factor was significant.

Discussion and Conclusions

Our study's aim was to test the effectiveness of the different communication channels known to be effective for marketing products and services (Danaher and Rossiter, 2011; Dad, 2012) but unknown in their influence on consumers' food waste reduction behaviour. We know from previous research that the messaging strategies we used do have an impact (Quested *et al.*, 2013) and that the communication channels themselves have an effect for promotions (Danaher and Rossiter, 2011; Dad, 2012). Our results show that the communication

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channels combined and repeated over time using standard messaging had a significant effect on levels of reported food waste of shoppers who say they saw a message. This supports evidence in the wider food waste literature (Sharp *et al.*, 2010) and wider pro-environmental behaviour literature (Staats *et al.*, 2004) that a suite of measures should be used to affect behaviour and to penetrate the everyday noise of the myriad of information that consumers are presented with. This finding also challenges the finding of the meta-analysis by Abrahamse and Steg (2013) that only a few types of intervention can have an effect on individuals' behaviour. In addition, our work supports the wider pro-environmental behaviour literature that behaviour change campaigns need to be repeated over time to continue to effect behaviour change (Frederiks *et al.*, 2015; Osbaldiston and Schott, 2012). What is particularly important in our results is that we found a significant effect in a field study of a national supermarket where the food waste reduction communications were presented alongside the normal product marketing by Asda. It is perhaps not surprising that food waste levels rose a few months after each intervention, and this could be attributed to attention being drawn away from food waste and taken over by other promotions, as well as the removal of feedback or social pressure associated with the communication strategies. This finding is also important for practitioners and policy-makers, in that it suggests that mainstream consumers need constant reminders and that one-off awareness campaigns may not be effective over the long term.

One surprising result was that primary shoppers who said they had not seen the interventions reported food waste reductions, unlike secondary shoppers. This is an important finding in that it suggests that interventions will be having an effect on a wider group of people than previously thought, thus providing support to some of the wider pro-environmental behaviour evidence (Nolan *et al.*, 2008; Thøgersen, 2006). Nolan *et al.* (2008), for example, found that normative messaging, similar to our product stickers, had the biggest effect on reduction of energy meter readings even though respondents to interviews had not registered the effect of the normative messaging. A lesson from this study therefore is that researchers should measure behaviour change rather than just awareness of campaigns in order to obtain a more accurate indication of the effectiveness of an intervention. For practitioners and policy-makers, this finding also suggests the need to measure efficacy more widely than just those who were aware of a campaign or event.

From our study, retailers such as Asda can use their communication channels, expertise and enormous reach to affect the food waste behaviour of millions of consumers. Dauvergne and Lister (2012) have concerns about big brands leading the sustainability agenda, but in food waste we feel it has been left to consumer companies participating in cross-sector voluntary agreements to fill the void left by the lack of action by government. To facilitate this, a strong sustainable business strategy by retailers and cross-sector agreements such as the Courtauld Commitment (WRAP, 2015) are essential in making sure companies focus on the most significant environmental issues in a consistent way. However, government should still have a role in encouraging the larger companies to engage in reducing food waste and reduce the environmental costs to society.

The business model of food retailers continues to rely on selling more products, and no matter how many interventions are put in place this continues to be an issue for some serious environmental impacts (Mena *et al.*, 2011). For food waste, if consumers reduce their purchases of food they waste most frequently, they may switch their purchasing to other food or non-food items at the same retailer. In this case, the retailer does not lose out financially and tackling food waste is a reputational and brand loyalty issue. From the business strategy point of view, influencing customers' use of products can be seen as an extension of the company's eco-efficiency oriented strategy from just the retailer's operations and supply chains. This approach of influencing the full supply chain helps companies to control environmental impacts within the sphere of their influence without having to fundamentally change their volume based business model. Our case study strengthens the emerging literature showing this extension of eco-efficient business strategy to customers (Morgan, 2015; Newson *et al.*, 2013; Dauvergne and Lister, 2012). In the end, it is the role of government to change the economic incentives that retailers respond to if mass consumption and related environmental impacts are to be addressed.

Conducting research in the field is always exciting, but doing it with a large and fast-paced supermarket was both rewarding and challenging. We would encourage future researchers to continue to develop the co-production method, and we hope that our study will help to inform its future development (Clark and Dickson, 2003). The advantages of this method have been to be able to conduct a quasi-experiment in the environment of a supermarket where our interventions were competing for consumers' attention alongside all the other promotions as well as the busy day to day life of consumers. Commitment by the retailer was essential and strong leadership from the

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sustainable business team was key to this ongoing commitment and support of the research. In addition, our research team included having a researcher embedded within the Asda offices, which helped enormously in developing strong relationships with key decision-makers and especially with Asda's communication channel teams.

Despite the benefits of the co-production approach, it was not without its limitations. Our study was limited by the reliance on self-reported behaviour and quantitative data only. Because of the pragmatic considerations of time and financial constraints we were not able to monitor or observe consumers' bin contents and therefore cannot say how accurate the self-reported measures were. Past research has shown that self-reported behaviours have been used successfully used in other household waste studies (Graham-Rowe *et al.*, 2014; Liu *et al.*, 2015; Fielding *et al.*, 2016). The disadvantage of this approach was not being able to isolate the factors detailed in Figure 1. Furthermore, our study was limited by a reliance on quantitative survey data only. We urge future researchers to further knowledge in this area through mixed methods that combine both quantitative measures and qualitative measures, including observations and in-depth interviews. These may take the form of measures of actual outputs of behaviour (e.g. bin contents) and recall of seeing interventions through in-depth interviews or focus groups to explore these factors more closely.

Another area for future research is translating reductions of food waste into reductions in associated environmental impacts. We assumed that consumers reducing food waste will reduce environmental impacts (Metcalfe *et al.*, 2012). It could be, for example, that consumers reduce food waste and use the money saved to purchase goods that have a higher carbon intensity. Further research that investigates this effect would be beneficial, especially with a focus on greenhouse gas emissions (Chitnis *et al.*, 2013). The main contribution of this paper is that we have shown that communication channels in retailers can be used to influence pro-environmental behaviour of customers, even for those who say they do not recall the interventions. This is an important piece of evidence for organizations and policy-makers who want to reduce reported food waste.

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Supporting information

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