JOURNAL OF LITTER AND ENVIRONMENTAL QUALITY

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KEEP BRITAIN TIDY.

Keep Britain Tidy has been working to keep the country clean for more than 60 years and has expertise and access to a range of stakeholders in the area of litter and environmental quality. Within Keep Britain Tidy, the Centre for Social Innovation serves as an innovation hub to design and develop new approaches towards changes that benefit society.

The Journal of Litter and Environmental Quality has been created by the Centre for Social Innovation as an open-access, peer-reviewed journal that will share and discuss the latest research carried out by academics, practitioners and wider stakeholders into litter and environmental quality.

Litter refers to waste products that have been disposed of improperly, without consent, at an inappropriate location.

Environmental quality refers to the standard of the local area and includes all/any issues that might affect the appearance of the area and/or how people perceive the area.

The journal is available for download from the Keep Britain Tidy website www.keepbritaintidy.org

Keep Britain Tidy would like to thank the British Cleaning Council for its generous donation towards the publication of this journal.

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2019 REPORT TO READERS

I am delighted to be writing this introduction for the third edition of the Journal of Litter and Environmental Quality, the world's first open-access, peer-reviewed journal that shares and discusses research carried out by academics, practitioners and wider stakeholders into litter and environmental quality.

In this third edition, we have an exciting mix of articles by academics and practitioners, which add to the growing baseline of knowledge in this important area of study. Within these articles you will see the authors demonstrating the need to find solutions to tackle different forms of littering that add to the current degradation of the environmental quality of the places where we live.

The writing in the journal is adaptive, reactive and ambitious, and represents the ever-changing landscape that all leading agents working to combat littering behaviour operate in.

The first article, by Jackson and Tehan, provides robust evidence to demonstrate that a startling 76% of people surveyed said that if they were made aware of the environmental impacts of a product they thought was "flushable" they would no longer purchase it. Additionally, 85% said that they would also view the brand less favourably if this occurred – surely a wake-up call for producers.

The next article, by Harris, Hargreaves, Tehan, Hutton and Paris, provides an interesting overview of how trialling a "nudge" walking route intervention can increase the number of responsible dog owners playing their part in reducing dog fouling in public places.

The third article, by Moore, is an inspiring case study of an Eco-School that has been doing some fantastic work to improve its local environment. The article provides excellent examples and resources for other schools keen on embarking on a similar educational journey that will achieve a result for the environment.

The fourth article, by Gellard, Dickins and Coulson, offers a critique of nudge approaches that aim to tackle littering behaviour, but which often fail to consider the broader socioeconomic drivers of that behaviour. It highlights the importance of the cooperation of individuals in achieving a long-term positive environmental impact and hypothesises that tackling wider social inequality is central to understanding the main drivers of littering behaviour in areas of deprivation, and therefore in getting a result.

Finally, the fifth article by Yeow looks at the future of single-use plastic bags and suggests the use of nudging as a method to encourage long-term behavioural change towards their consumption.

I hope you will enjoy reading these studies as much as I have, and that you will join us in sharing these articles to encourage the widening of the scope for new work and possible collaboration. Our hope is that the journal will provide a rich evidence base for the environment sector and play its part in increasing the depth of knowledge about litter – awareness that will lead to effective strategies for tackling and changing behaviour.

I would like to thank the staff at Keep Britain Tidy, particularly out editor-in-chief Sabina Khan, who coordinated the editing and subsequent publication of this journal. I would also like to thank our peer reviewers and esteemed authors, without whom the Journal of Litter and Environmental Quality would not be possible. I would especially like to thank the British Cleaning Council for their support. Without their commitment to the search for knowledge into the causes of and innovative solutions to littering, we would not be making the strides we are today.

Finally, I hope that the arguments in this journal instigate discussions and debates about the latest emerging issues in litter and environmental quality.

Allison Ogden-Newton
Chief Executive, Keep Britain Tidy

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The Journal of Litter and Environmental Quality would not have been possible without the commitment and hard work of our peer reviewers. They provide not only the information needed for publication decisions but also valuable critiques for authors. We offer our sincerest thanks to the following reviewers who served as referees for the journal.

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UNDERSTANDING BEHAVIOURS CAUSING BLOCKAGES: RESEARCH WITH UNITED UTILITIES TO IDENTIFY FLUSHING HABITS IN THE NORTH WEST OF ENGLAND

Lorna Jackson works as a Senior Researcher in Keep Britain Tidy's Centre for Social Innovation and holds an MSc in Environmental Psychology from the University of Surrey and a BSc (Hons) in Psychology from the University of Liverpool. Her past research has involved looking at the role of values and empathy in increasing engagement with climate change communications.

Rose Tehan is a Research and Innovation Development Manager at Keep Britain Tidy. She specialises in the development and application of behavioural insights using collaborative and action-based research. In 2015 she helped to establish the charity's award-winning Centre for Social Innovation and has played an instrumental role in developing its approaches and frameworks.

1. INTRODUCTION

In 2017, Keep Britain Tidy partnered with North West England water and wastewater company, United Utilities, to understand behavioural insights around 'non-flushables' being incorrectly disposed of down household toilets. United Utilities commissioned Keep Britain Tidy's Centre for Social Innovation to carry out the research to further understand this behaviour, and develop recommendations for preventing it. The ultimate aim of the research was to identify the behavioural insights which should be addressed to prevent the 25,000+ blockages a year that occur in the region, and the environmental quality issues that these blockages cause. This paper presents the findings from that research.

1.1. Background

It is estimated that UK water companies deal with more than 366,000 sewer and drain blockages each year. Many of these can be attributed to bathroom products, such as wet wipes and sanitary items, being incorrectly disposed of down household toilets. These combine with fats disposed of via the kitchen sink, solidifying and causing blockages or larger "fatbergs" within the sewer system (Ratcliffe, 2015; Taylor, 2017). Across the UK, an estimated £90 million per year is spent on tackling blockages in drains and sewerage systems (Dyson, 2016).

Blockages not only create substantial costs for water companies, but can also cause untreated sewage to flood into homes, gardens and streets, and pollute rivers, beaches and other waterways, resulting in polluted waters and environments littered with incorrectly flushed household items. This is largely due to pressures caused by blockages on combined sewer systems, which make up approximately 70% of the total sewerage network within the UK (Environment Agency, 2011). These systems collect both sewage (i.e. bathroom and kitchen waste from homes and workplaces) as well as surface water (i.e. rainwater from roofs and roads), channelling the combined flow to wastewater treatment works for processing. However, when the amount of sewage and surface water flowing into a combined sewer system exceeds the capacity of the network of pipes, the excess will overflow. To prevent this excess volume overflowing (e.g. in the home from toilets, or in the road through manhole covers), "pressure release valves" known as combined sewer outflows (CSOs) allow the excess dilute sewage to bypass wastewater treatment centres and spill, untreated, into nearby watercourses and coastal waters (Department for Environment, Food and Rural Affairs, 2012).

This excess volume is most frequently caused by periods of heavy rain, producing a large amount of surface water. However, sewer blockages caused by the incorrect disposal of items being flushed down toilets also contribute to CSO spills taking untreated sewage directly into watercourses and coastal waters. In this way, household items such as wet wipes, sanitary items and cotton bud sticks turn into sewage-related debris, littering marine environments with raw sewage that severely affects water quality and surrounding ecosystems (Tibbetts, 2005).

Litter and pollution as a result of a CSO spillage can cause harm to UK marine life and their habitats (Gall and Thompson, 2015), as well as an overall reduction in environmental and water quality. Added to this, the European Environment Agency's 2017 overview of bathing water quality across the EU found that only 65% of the UK's bathing waters were of excellent quality, compared with an EU average of 85.5%.

With sewage overflow contributing significantly to these issues, preventing the huge number of sewer blockages has a major role to play in raising the standard of water quality of rivers and coastal waters in the UK and, vitally, protecting its marine life. As such, identifying ways to discourage the flushing of items that cause these blockages is vital in efforts to mitigate litter and other pollution in marine environments.

1.2. Non-flushables

In this article, the term "non-flushables" refers to items such as wet wipes, sanitary items and cotton bud sticks that should be disposed of in rubbish bins, but are often incorrectly flushed down toilets instead. Such non-flushable items, combining with solidifying fats, cause approximately 80% of the UK's blockages each year (Dyson, 2016). When flushed, non-flushables do not break down in the sewer as toilet paper is designed to, but can remain trapped and turn into "sewage-related debris" when CSO spills occur, releasing these items directly into marine environments. With many non-flushables containing synthetic plastic fibres, including wet wipes and many products labelled as "flushable", these break down and contribute to the millions of microplastic pieces in our oceans (Law and Thompson, 2014).

With the number of additional wet wipe products being made available to consumers in recent years, such as adult "flushable" toilet wipes, cleaning wipes, deodorising wipes, make-up removal wipes and hand wipes, the problems caused by these products appear to be worsening. The Marine Conservation Society's annual beach clean monitoring (2015) found the numbers of wet wipes on beaches to have increased by 50% between 2013 and 2014, and by a further 31% in 2015. The 2015 data also suggests that, on average, 28 wipes can be found on each mile of UK beach.

In addition to wet wipes, cotton bud sticks make up a large proportion of the problem. These are often too small to be filtered out through sewage treatment works, and therefore make up over 60% of all sewage-related beach litter (Marine Conservation Society, 2015). Although pushes have been made towards paper cotton bud sticks in the UK (Department for Environment, Food and Rural Affairs, 2018), these can spill out into the marine environment if flushed down toilets and therefore contribute to the critical and worsening issue of plastics in our oceans.

With these and many more non-flushable products contributing to the issue, it is important that research understands which products and attitudes are contributing most to the issue, as this will go some way in identifying potential target audiences for behaviour change solutions. Previous research (Berkley, 2007) has found that key behavioural drivers included a lack of knowledge of how the sewer system works, disregard for what happens to items once they are flushed and a lack of awareness of the detrimental effects these have on the environment. The four most common items that people admitted to flushing away were tampons (24%), facial cleansing wipes (17%), cigarette stubs (12%) and cotton wool (10%).

Additional qualitative research (Falp and Le Masurier, 2008) found that two key drivers to flushing behaviour are a misconception that certain products are "flushable" and a perception that it is more convenient to dispose of certain items down the toilet.

The items identified in this research as being most commonly flushed were kitchen roll, wet wipes, tampons, nappy liners and cigarette butts. However, being based on qualitative data, this study is not necessarily representative of flushing behaviours and attitudes across the UK.

With research from recent years (which also takes into account issues created by products labelled as "flushable") being limited, additional work is required to fully identify the behavioural drivers contributing to this issue. Such research could be utilised by the water industry, NGOs, policy-makers, manufacturers and other stakeholders to develop effective messaging and other solutions to reduce the number of items flushed down toilets in the UK.

1.3. Current research

Given the gaps in research surrounding the disposal of non-flushables and the drivers of this behaviour, the current research looked to explore this. The aim of the research was to understand the awareness, attitudes and other drivers that are contributing towards the incorrect disposal of non-flushable items. The objectives of the research were to identify:

- the products that are most frequently flushed in the North West
- attitudes, perceptions and awareness around the issue
- recommendations for policy-makers and other stakeholders in encouraging behaviour change.

2. METHODOLOGY

2.1. In-depth interviews

Twelve in-depth, semi-structured interviews were carried out with residents across the North West to understand disposal behaviours of different, frequently flushed household items, awareness and perceptions around the issue, and what residents felt should be done to change their and others' behaviours. The interview respondents were three males and nine females aged between 26 and 65.

The selection criteria for participation in the interviews were: a) respondents must live within one of the selected areas of the North West, as outlined in Section 2.3 below, and b) respondents must admit to flushing two or more items other than toilet paper down the toilet. Quotas were additionally set to include three parents or care-givers of children under three years old to gain insight into the disposal of baby wipes and nappies, and a larger number of female respondents to gain insight into the disposal of sanitary products and make-up wipes. Respondents were recruited through a partner fieldwork agency, and were each given £40 as a "thank you" for their time. Interviews were 30 minutes to one hour long, took place in respondents' homes, and were recorded, transcribed and analysed using thematic analysis.

2.2. Online surveys

The in-depth interviews were followed by an online survey carried out with a regionally representative sample of residents of the North West of England to further identify and quantify disposal behaviours, perceptions and awareness of consequences around the incorrect disposal of non-flushables. The survey was carried out by a market research agency using a questionnaire designed by Keep Britain Tidy. The survey achieved a sample of 1,140 respondents. Respondents were 45% male and 55% female, and age group samples were representative of the region. Quantitative data from the survey was analysed using Microsoft Excel and qualitative data was analysed using thematic analysis.

2.3. Site selection

For selecting the locations of the qualitative phase of the research, United Utilities provided a list of hotspots across the region where blockages frequently occur. These were six locations where there are significant problems caused by non-flushables. This data was primarily based on number of blockages/ call outs, and the recorded causes of these. From this list, three locations were selected wherein the interviews would be carried out: Stretford, Bollington and Disley.

3. WHO IS FLUSHING WHAT?

3.1. What items are people flushing?

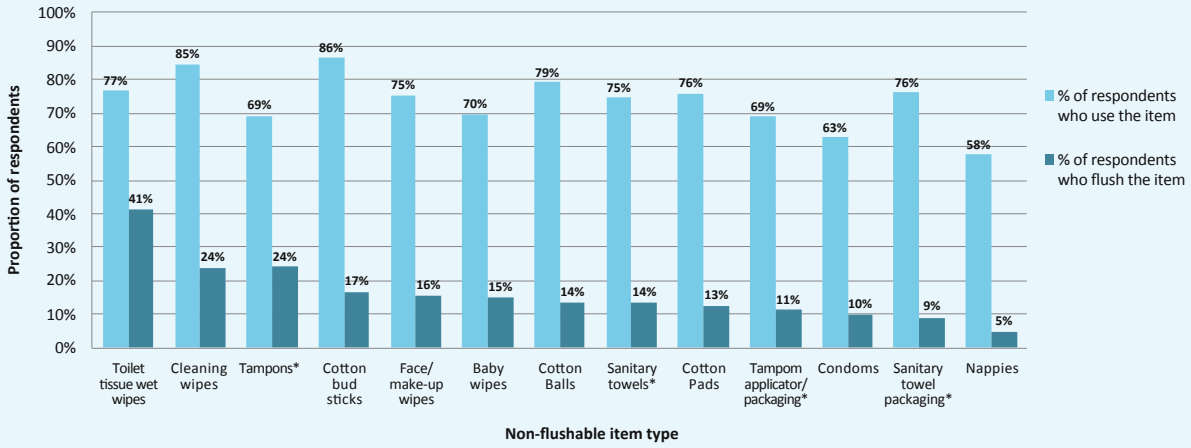
Of the 1,140 respondents, 56% (n=641) admitted to flushing one or more non-flushable item down the toilet.[1] The item flushed down toilets by the highest proportion of residents in the North West was "toilet tissue wet wipes". These are wet wipes specifically intended to be used in place of, or alongside, toilet paper, by adults as well as children, and are often marketed as "flushable". In all, 77% of respondents said that they used toilet tissue wet wipes, and 41% of all respondents said that they flushed them (see Figure 1 below).

Following toilet tissue wet wipes, tampons and cleaning/antibacterial wipes were the items most likely to be flushed.

Tampons were flushed down the toilet by almost one in four women (24%), and the same proportion of all respondents (24%) said that they flushed cleaning wipes down the toilet. It is interesting to note that this figure is higher than both face make-up wipes (flushed by 16% of respondents) and baby wipes (flushed by 15%). This may be influenced by certain cleaning/antibacterial wipe products being marketed as "flushable", particularly those intended for cleaning toilets.

These findings broadly reflect those from the in-depth interviews, in which nine of the ten interviewees said that they used and flushed toilet tissue wet wipes, six of the ten interviewees said that they flushed cleaning/antibacterial wipes, and four of the six female interviewees said that they flushed tampons.

Figure 1. Proportions of respondents who used and flushed non-flushable items

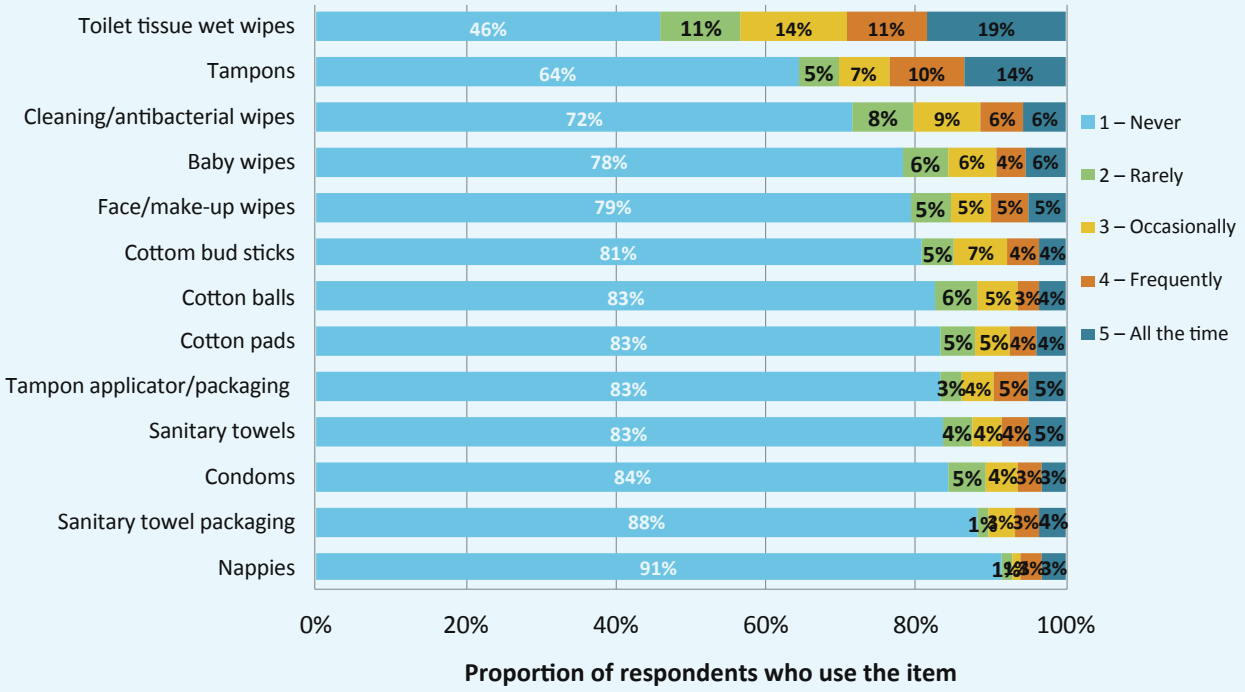


Base: All respondents = 1,140, except for items marked with an asterisk (*) which are female respondents only = 613.

[1] In all, 39% (n=439) of respondents said that they "never" flushed any non-flushable items, while 5% (n=60) respondents did not use any non-flushable products.

Survey respondents were also asked how frequently they flushed the different non-flushable items they used. Results were largely similar, with toilet tissue wet wipes and tampons the items most regularly flushed by consumers (see Figure 2 below).

Figure 2. Respondents' frequency of flushing non-flushable items



Bases:
Toilet tissue wet wipes – 874;
Tampons – 411;
Cleaning/antibacterial wipes – 964;
Baby wipes – 796;
Face/make-up wipes – 859;
Cotton bud sticks – 984;
Sanitary towels – 443;
Cotton balls – 904;
Cotton pads – 865;
Tampon applicator/packaging – 409;
Condoms – 714;
Sanitary towel packaging – 452;
Nappies – 656.

3.2. Who is flushing items down the toilet?

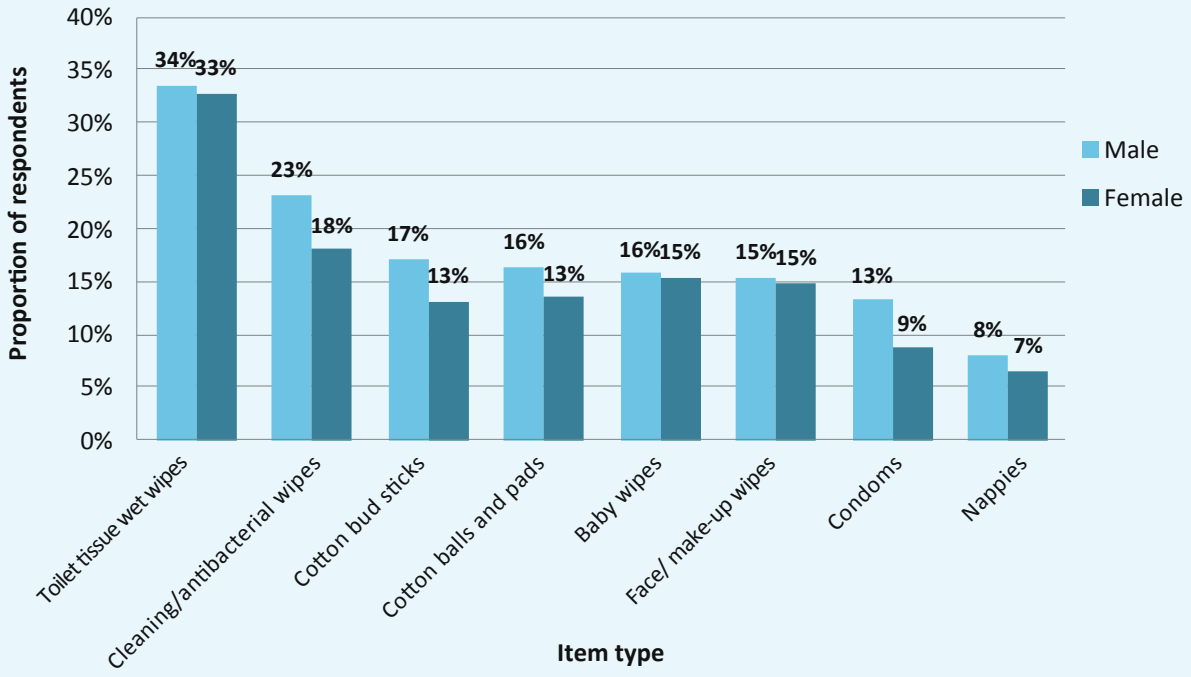
By gender

Disposal behaviour did not vary between males and females. Of those who used non-flushable products, 42% of females and 41% of males said that they always, frequently or occasionally flushed these down the toilet. These figures exclude sanitary towels, tampons and packaging used by 78% of the 613 female respondents, of which 31% flushed at least one of these items.

If these items are included, females were overall more likely than males to say that they always, frequently or occasionally flushed at least one type of non-flushable item down the toilet (51% of 602 respondents and 45% of 456 respondents, respectively).

Male respondents were slightly more likely to say that they regularly flushed cleaning/antibacterial wipes, cotton bud sticks, cotton balls/pads and condoms compared to female respondents (see Figure 3).

Figure 3. Respondents who "always", "frequently" or "occasionally" flushed non-flushable items (by gender)

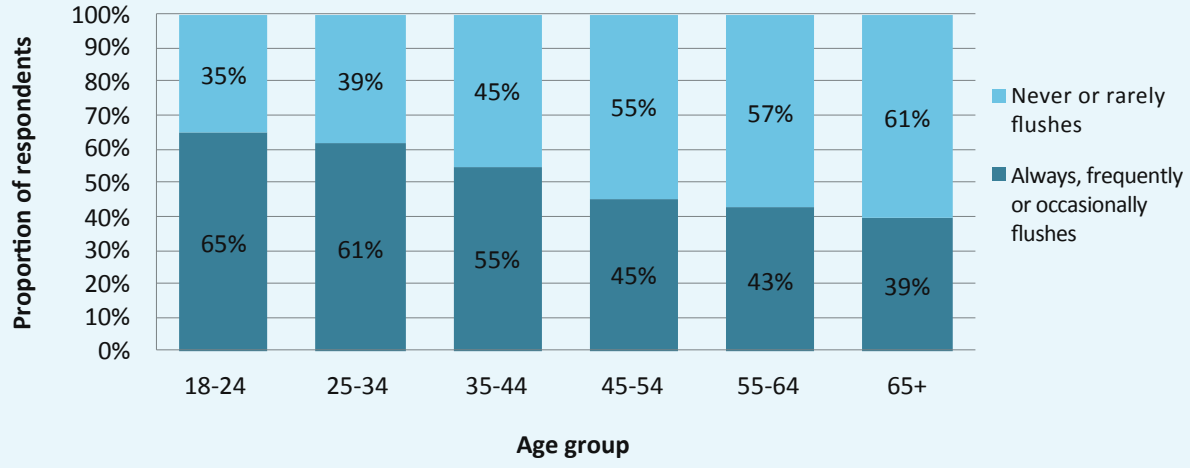


Bases:
Number of people who use the item type
Toilet tissue wet wipes - male = 504, female = 613;
Cleaning/ antibacterial wipes - male = 400, female = 544;
Cotton bud sticks - male = 408, female = 556;
Cotton balls and pads - male = 373, female = 563;
Baby wipes - male = 312, female = 467;
Face/ make-up wipes - male = 312, female = 530;
Condoms - male = 316, female = 381;
Nappies - male = 274, female = 367.

By age group

Younger age groups were overall more likely to flush non-flushable items (see Figure 4 below).

Figure 4. Proportions of respondents who flushed non-flushable items (by age)

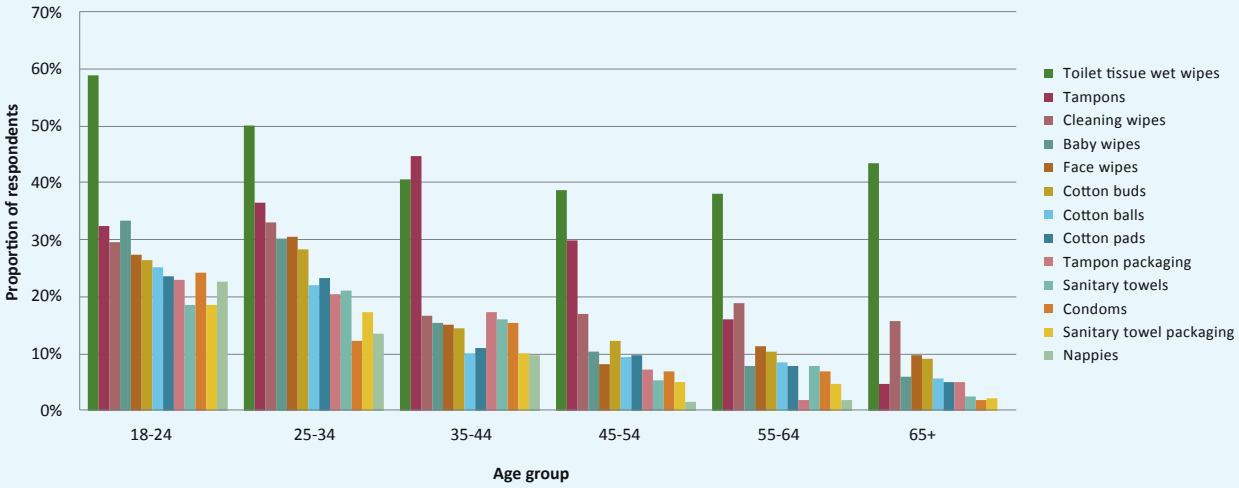


Bases:
18-24 = 110;
25-34 = 106;
35-44 = 172;
45-54 = 223;
55-64 = 242;
65+ = 206.

Those aged 18-24 and 25-34 were more likely than any other age groups to always, frequently or occasionally flush each type of non-flushable item, except for tampons, which were most likely to be flushed by 35-44 year olds (see Figure 5 below).

Respondents aged 65+ were least likely to flush all item types, except for toilet tissue wet wipes, which 44% of this age group flushed. Indeed, toilet tissue wet wipes were flushed by a relatively high proportion of respondents across all age groups.

Figure 5. Items flushed (always, frequently or occasionally) (by age group)



Base = number of people in each age group who use the products.

By location

Table 1 shows the proportion of respondents from each postcode area who admitted to flushing one or more item down the toilet on a regular basis.[2] Respondents who live in the Oldham and Stockport areas were the most likely to regularly flush non-flushable items, though the behaviour appears to be relatively common throughout the North West region, with more than 40% of respondents across all postcodes (except for Crewe and Lancaster) reporting doing this. These results should be treated with caution due to the small sample of respondents in some locations (noted as "base" numbers in).

Table 1. Frequency of flushing per North West postcode area

Postcode Area	Proportion of respondents who flush at least one "non-flushable" item down the toilet	Base: Total number of respondents from postcode area
Oldham	53%	55
Stockport	51%	92
Warrington	49%	191
Liverpool	48%	118
Manchester	48%	94
Blackburn	47%	74
The Fylde	46%	69
Wigan	45%	31
Carlisle	44%	43
Preston	42%	83
Bolton	42%	62
Chester	41%	88
Crewe	38%	48
Lancaster	33%	54
Other	67%	15

[2] Agreement scale rating: "Occasionally" + "Frequently" + "Always" (on a five point frequency scale: 1 = Never, 2 = Rarely, 3 = Occasionally, 4 = Frequently, 5 = All the time).

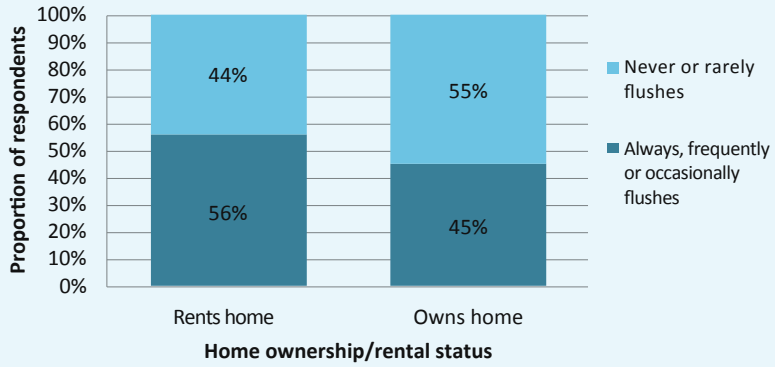
Interestingly, respondents who lived in postcode areas with a coastal boundary were slightly less likely to flush non-flushable items compared to those who lived in landlocked postcode areas (43% of 443 respondents and 47% of 659 respondents, respectively). In this research, respondents were asked for the first half of their postcode only to maintain their anonymity. These codes cover very large geographical areas, meaning that some respondents who live further inland might not consider themselves as living in a coastal area.

Therefore, further research is recommended to understand whether living near a coastal environment has an influence on flushing behaviours, and this should ideally capture respondents' locations in greater detail.

By home ownership/rental status

Respondents who rented their homes were more likely to say that they always, frequently or occasionally flushed non-flushable items compared to those who owned their home (see Figure 6 below).

Figure 6. Frequency of flushing non-flushable items (by home ownership/rental status)

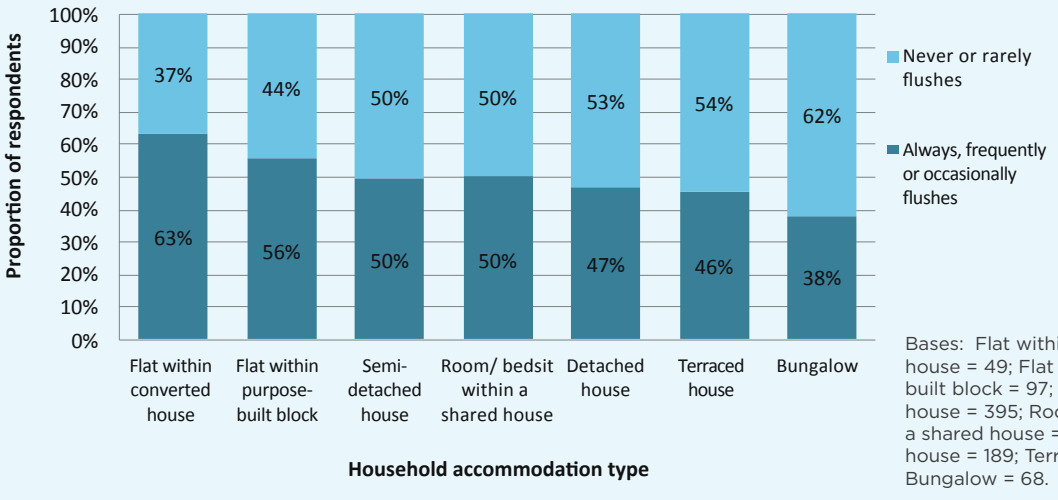


Bases: Rents home = 295; Owns home = 726.

By household accommodation type

Respondents who lived in a flat were more likely to say that they always, frequently or occasionally flushed non-flushable items compared to those who lived in other household accommodation types (see Figure 7 below), although the small sample of respondents who lived in a room within a shared house means that the results for this group should be treated with caution.

Figure 7. Frequency of flushing non-flushable items (by household accommodation type)



Bases: Flat within converted house = 49; Flat within purpose built block = 97; Semi-detached house = 395; Room/bedsit within a shared house = 8; Detached house = 189; Terraced house = 253; Bungalow = 68.

4. Behavioural drivers of flushing non-flushable items

4.1. Awareness of how non-flushable items should be disposed of

Sanitary items

One in five women (20%) said they had never been told how to dispose of sanitary items such as tampons and sanitary towels. This is an important finding, as this lack of awareness is likely leading to an increase in tampons and sanitary towels being incorrectly disposed of down the toilet.

Of those women who said that they had previously found out or been told how to dispose of sanitary items, 41% said they got this information from product packaging. Although this was shown to be the key source of disposal information, this figure is still relatively low, suggesting that six out of ten women do not look at product packaging to find out how an item should be disposed of. This suggests that more could be done on sanitary product packaging to make the correct disposal clear and obvious.

Other than packaging, women learn how to dispose of sanitary items through a friend or family member (28%) and personal experience (31%), for example through experiencing a blockage. Only 15% of women were told how to dispose of sanitary items at school.

This lack of awareness around how to dispose of sanitary items, particularly tampons, is supported by the qualitative findings. A number of quotes are shown below from women who believed, or used to believe, that they were doing the right thing by disposing of sanitary items down the toilet.

"I've never been told not to flush tampons. Other places you go tell you not to put sanitary towels down the toilet, but not tampons. I've always presumed that's the right thing to do, to put it in the toilet".

"Tampax, those I used to put down the toilet. I don't anymore, but I did all the time. I think it says you can dispose of them [down the toilet], on the box, but I don't really know what damage it does, I don't know if they do dissolve or not".

Wet wipes

Packaging for toilet tissue wet wipes specifies that used wipes can be flushed down the toilet. Of those who use toilet tissue wet wipes, one-third (35%) said that they found out how to dispose of them on the product packaging, and 23% said they found out through personal experience or a friend or family member. Interestingly, 37% of people who used these wipes suggested they had never been told how they should be correctly disposed of.

Similar results were shown for baby or child wet wipes, with almost a third (32%) of respondents learning how to dispose of these on the packaging, but a larger proportion (45%) suggested they had never been told how to dispose of them. This same pattern was shown for cleaning wipes. These results show that, overall, large proportions of people are using items that they do not know how to correctly dispose of.

All items

Across all item categories, following product packaging, the second most frequently reported sources of information for finding out how to dispose of the items was through a friend or family member or personal experience. This suggests that how non-flushables should be disposed of is often discovered through word of mouth and not a concrete source, potentially contributing to misinformation and a lack of awareness around what should and should not be disposed of down the toilet.

When discussing items that can and cannot be flushed, interview respondents often related this to countries where people are asked to bin everything, including toilet paper. It was suggested that in these countries there is a clear-cut message of what should be done, which is easy to comply with. In contrast, in the UK there is a perception that different products have different methods of disposal, with the message being seen as less clear-cut. This indicates that communications around the fact that no items other than toilet paper should be flushed must be reinforced and made as simple as possible to understand.

"If I was in Greece or something where they say to put all the toilet paper into the plastic bin then I would probably do that, yeah".

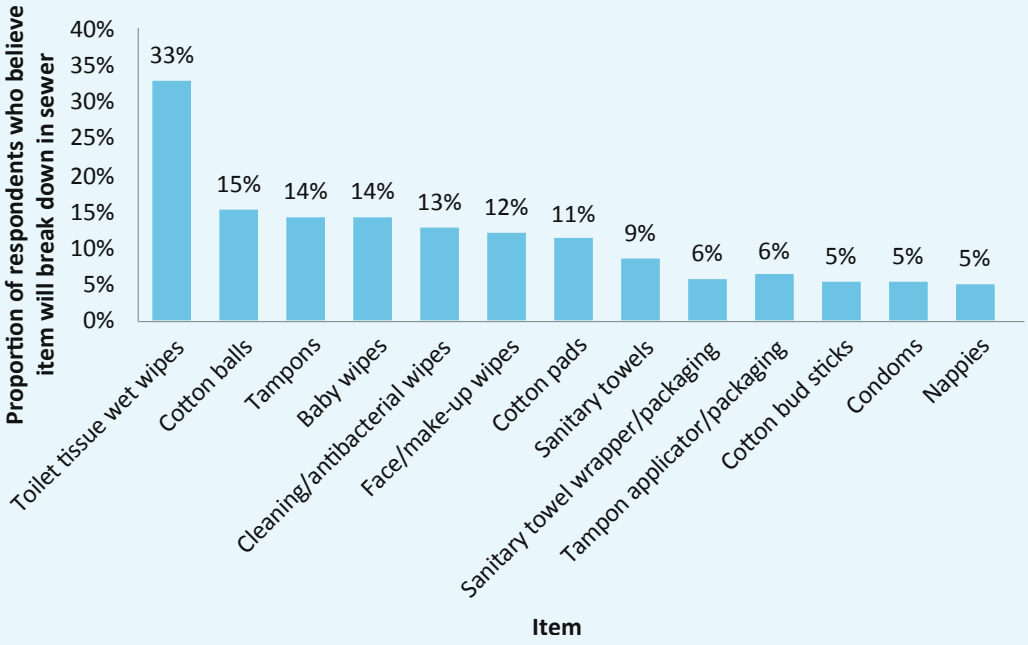
"You go on holiday like in Greece they have different standards for the waste and their sewage system and there were signs in there to put your toilet paper in the bin".

4.2. Awareness of the functions and capabilities of the sewerage system

Perception that non-flushable items will break down or biodegrade in the sewerage system

Awareness of the consequences of flushing items down the toilet was mixed. The products that people believed to be most likely to break down or biodegrade in the sewer if flushed down the toilet, aside from toilet paper, were toilet tissue wet wipes, with a third of people believing this. This was followed by tampons, cotton balls and baby wipes at around 15%. Interestingly, one in ten people believed that no items will break down or biodegrade in the sewer if they are flushed; however, 43% reported still flushing one or more item other than toilet paper down the toilet. These results are shown in Figure 8 below.

Figure 8. Items perceived as breaking down or biodegrading in the sewer



Perceptions that items will be filtered out of wastewater at treatment plants

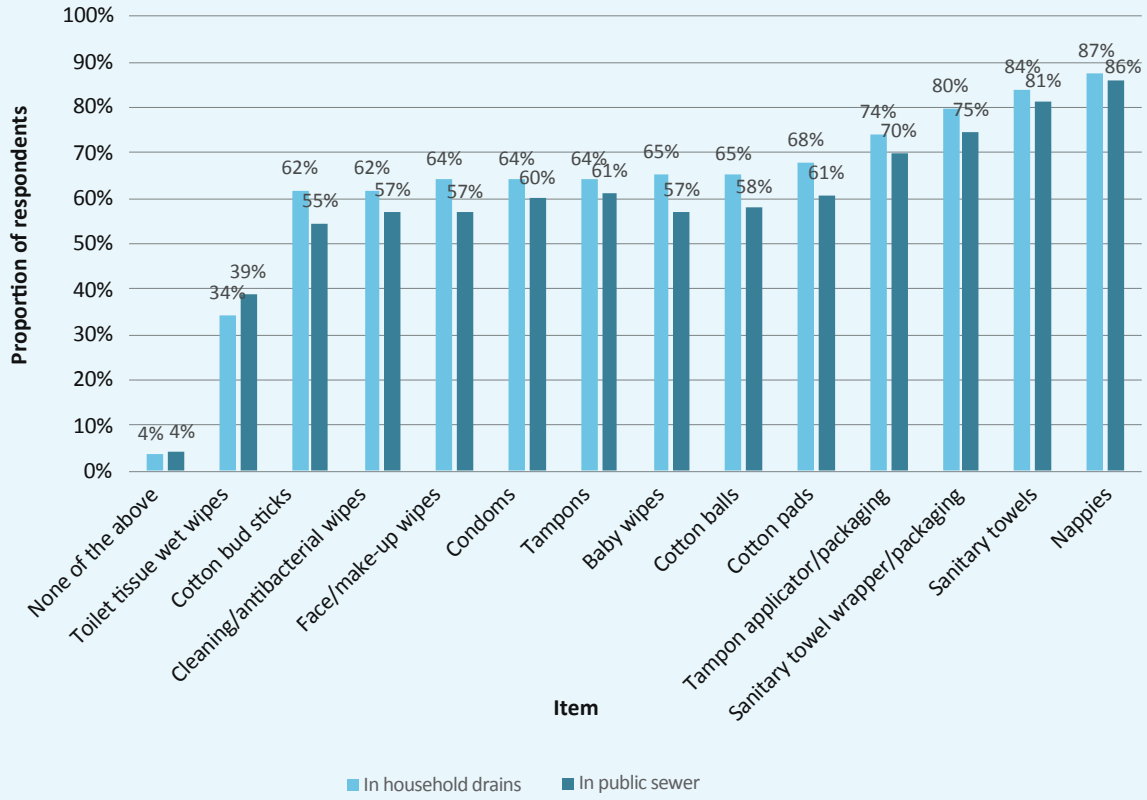
Two in five people believed that all items are filtered out at the water treatment plant if they are flushed down the toilet. This was around the same figure (38% to 40%) for larger items such as nappies and towels, as well as smaller items such as cotton bud sticks and wipes. This suggests that the overall perceived likelihood of these items ending up places they should not, such as rivers and seas, is low.

Of people who reported flushing at least one non-flushable item, 30% thought that no items are filtered out during wastewater treatment. This suggests that many people who dispose of these items incorrectly are not necessarily motivated by a belief that the items are filtered out.

Respondents were then asked to identify which items they believed would create a blockage both in a household drain and the public sewer if they were flushed down the toilet. Of the total sample, only 19% correctly identified that all the items, aside from toilet paper, would contribute to a blockage.

Figure 9 shows the perceived likelihood of a blockage occurring for all items. Responses did not differ hugely between drain (a personal impact) and sewer (a local impact) blockage scenarios, although household drain blockages were slightly higher for the majority of items.

Figure 9. Items perceived to cause blockages



The items perceived as most likely to cause a blockage were nappies and sanitary towels, with that perceived as least likely to do so being toilet tissue wet wipes. Interestingly, many of the items were seen as equally likely to create a blockage, at around 60%. These were baby wipes, face/make-up wipes, cleaning wipes, cotton balls and pads, cotton bud sticks, tampons and condoms. This shows that, on average, two out of five people (40%) did not think that if these items are flushed down the toilet they would create a blockage in their drain at home or in the public sewer. This is a substantial proportion of people, suggesting a lack of awareness contributing to the number of items being flushed down toilets each year in the North West region.

Personal experience of blockages

Of respondents who have previously experienced a drain blockage in their house, 75% said that this had made them more careful about what they put down the toilet.

This was the same amount for those who knew of someone close to them (e.g. a neighbour or a family member) who had experienced a blockage. These results are strongly supported by the qualitative findings, outlined below, which suggest that once someone has direct experience of a blockage, and therefore the impacts of flushing the wrong items, it is likely that they will change their behaviour and put more thought into how they dispose of non-flushable items.

"A water company will say actually you have personal responsibility, but until you've encountered a problem I think you assume that's your water rates and we don't have to cover that cost".

"Because my drains were blocked, I'm very conscious of not blocking them now. It has a negative effect on the environment and your toilet systems and drains".

"When my drains were blocked that made me think they don't dissolve and they get stuck".

"I never thought about the drains at all until my toilet became blocked. It's had a big impact, making me think not to flush anything, so I am more conscious about it now".

"I'm not sure whether the ones that I buy from Andrex are biodegradable or whatever. I don't think it's going to be a huge problem, I've not had any problems with my drains being blocked".

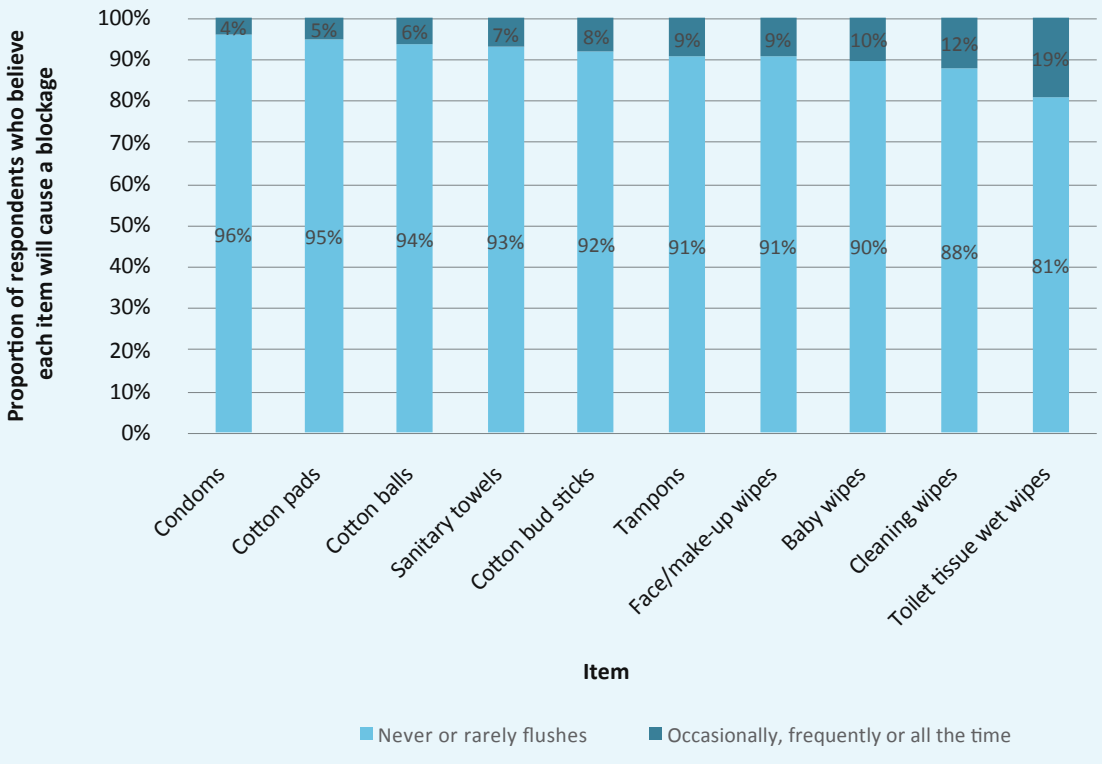
However, of the survey respondents who had previously experienced a blockage in their drain, 38% said that they still flushed at least one non-flushable item down the toilet. When asked if blockages made them more careful about what they put down the toilet, there were no notable differences between people who reported never, sometimes or always flushing non-flushable items. For instance, 73% of people who had both experienced a blockage and reported flushing cotton wool balls agreed that they were now more careful about what they put down the toilet. This was the same for people who reported never flushing cotton wool balls down the toilet. This pattern is replicated across the majority of items.

This suggests that the impact of personal experience of blockages may be limited. For instance, it could be the case that people change the way they dispose of the item that has caused the blockage (e.g. they stop flushing baby wipes if baby wipes are identified as causing the blockage), but may continue to flush other items (e.g. those they think should be flushed, or those labelled as flushable). This is something that was seen in the qualitative research phase, with one respondent associating their blockage with baby wipes and tampons, and therefore no longer flushing these items. However, this respondent reported continuing to flush cotton bud sticks and cotton balls, as these were not associated with the cause of the blockage.

Influence on flushing behaviours

As might be expected, people who believe that an item causes a blockage if flushed down the toilet are less likely to do this. For instance, of the women who believed tampons cause a blockage when flushed, only 9% flushed them down the toilet occasionally, frequently or all the time, compared to 91% who never or rarely flushed them (see Figure 10 below). These findings suggest that if someone believes an item will cause a blockage this will make them more likely to dispose of that item correctly.

Figure 10. The items that people believe will create a blockage if flushed (by flushing behaviour)



This same pattern was shown for perceptions around what items will biodegrade or break down in the sewer if flushed down the toilet, with those people who flush each item being more likely to believe this than those who do not.

Perceived responsibility

Respondents were asked to identify who they think is responsible for dealing with blockages in their local area. Table 2 below shows that the largest proportion of respondents said water and wastewater companies are responsible, while only 39% suggested residents are responsible. This indicates that 60% of respondents do not see themselves and other residents as being responsible for dealing with blockages. This could potentially be a contributing factor to the incorrect disposal of non-flushables.

In all, 30% of respondents suggested that local authorities are responsible for dealing with blockages. A fairly large proportion of respondents (more than one in ten) did not know who is responsible for dealing with blockages, again suggesting that there is a general lack of awareness around this issue.

Table 2. Groups perceived as being responsible for dealing with blockages

Groups responsible for dealing with blockages	% of respondents
Water and wastewater companies	57%
Residents	39%
The local authority	30%
Landlords	19%
Don't know	15%
The Environment Agency	13%
The manufacturers of products that cause blockages	3%
Environmental charities	2%

These results support the finding from the qualitative research, which suggests that people are, in general, unaware of the sewer system and who is responsible for maintaining it.

"There are people who I pay a lot of money to deal with it. I pay the water rates, who do I pay to do the sanitation? I don't know, is that the council or is that United Utilities?"

"I guess the residual has to go somewhere doesn't it? So where does it go? Does it go into a hole somewhere? I don't know the answer, but I've never thought about it that much".

Water and wastewater companies are seen as most responsible for making residents aware of what should and should not be disposed of down the toilet (see Table 3 below). Interestingly, more than 20% more respondents felt that water companies are more responsible than the manufacturers of the products. Again, the perceived responsibility of the local authority was fairly high. One reason for this could be that residents were used to receiving such awareness messages from their council, perhaps relating them with recycling messages, and therefore would be receptive to the local authority sending out a message regarding this issue in the future.

Table 3. Groups perceived as being responsible for making people aware of what should and should not be disposed of down the toilet

Groups responsible for making people aware of what should and should not go down the toilet	% of respondents
Water and wastewater companies	62%
The Environment Agency	43%
The manufacturers of products that cause blockages	41%
The local authority	40%
Landlords	21%
Residents	20%
Environmental charities	15%
Don't know	15%

Only one in five respondents felt that residents were themselves responsible for being aware of what should and should not be flushed. And again, more than one in ten respondents did not know who was responsible for making others aware of this.

4.3. Hygiene

Hygiene is an additional factor in the decision-making process of what and what not to flush. Overall, 68% of people who flushed no items other than toilet paper down the toilet found it unacceptable to do so when the item was seen as being unhygienic. This is compared to only 38% of people who flushed at least one non-flushable item down the toilet, demonstrating how flushing behaviour is very much linked to the perceived hygiene of the item.

When asked to select one factor that is most likely to encourage them to flush nothing but toilet paper down the toilet, almost a third of respondents (29%) said "being able to dispose of the item in a more hygienic way". This was the second most important factor behind being more aware of the environmental impacts of flushing the wrong things (38%). Hygiene was most important for 18-24 year olds, as well at those aged 65 and over, with a third of both age groups suggesting that improving hygiene would be the one thing to make them more likely to change their behaviour.

Hygiene as a barrier to correct disposal was also a prominent theme in the qualitative research. Respondents specifically discussed this being an issue when looking to dispose of sanitary items and those items used in place of toilet paper. Using a bin to dispose of these items was seen by many to be unhygienic, and flushing them down the toilet more so, as illustrated by the quotes below:

"I would have a concern about disposing of tampons in any other way. And just purely from being on holiday in places like Greece, where you have to do that [put them in a bin], it just really disgusts me".

"I'd feel uncomfortable having them in the bathroom bin. I think the smell would be horrendous. I'm making myself feel sick thinking about it".

"A bin should have stuff that isn't going to create smell or hygiene issues".

4.4. Convenience

Flushing an item down the toilet is seen as a convenient method of disposing of certain non-flushables in certain situations. Flushing scenarios related to convenience, such as when there is no bin available, or when you don't want to leave it in a someone else's bin, received average scale ratings of around 2.4 on a five-point scale of acceptability. This suggests that they are around the middle of the scale, being seen as not very acceptable but not totally unacceptable. This may be because these flushing scenarios occur when people know how the item should be correctly disposed of (therefore making flushing that item unacceptable), but the convenience of flushing may override this.

The importance of convenience appears to be weighed up for each disposal decision depending on the situational factors. For baby wipes, focus group discussions suggested these are often put into nappy bags with nappies and therefore binned in general waste. For sanitary towels, these have their own wrapper, which helps to dispose of the item more cleanly, subtly and conveniently in the bin. Other times, disposal can depend on the proximity to a bin or a toilet, and which is the quickest and easiest way to dispose of the item at that time. The quotes below illustrate these points:

"The baby wipes go in with the nappy into a bag and they go directly into the dustbin".

"It's quicker to flush it. It's out of the bathroom, out of the house or the apartment."

"I would throw the cotton buds probably down the toilet, only if I'm upstairs in that area".

"It's a convenience decision as to what you do, whether you're closer to the toilet or closer to the bin".

4.5. Size and "flushability"

It could be assumed that people are more likely to flush smaller items down the toilet than larger ones. However, and interestingly, the size of an item appears to have little influence on flushing behaviour. There are large proportions of people who flush items, such as cotton buds, cotton pads and cotton balls, who actually think it is unacceptable to flush items because they are small—42% on average. This suggests that, for these people, the size of the item is not driving their behaviour.

Rather, the perceived "flushability" of the item appears to be more influential; more than a third (37%) of people who flush at least one non-flushable item regularly believe it is acceptable to do so if the item flushes down quickly and easily (e.g. without

floating or needing multiple flushes). This is compared to 17% who do not flush an item regularly. A number of quotes from interview respondents are shown below to support this suggestion:

"You know full well that if it takes a couple of flushes to go down, it shouldn't be going down there, whereas the toilet wipes flush first time round".

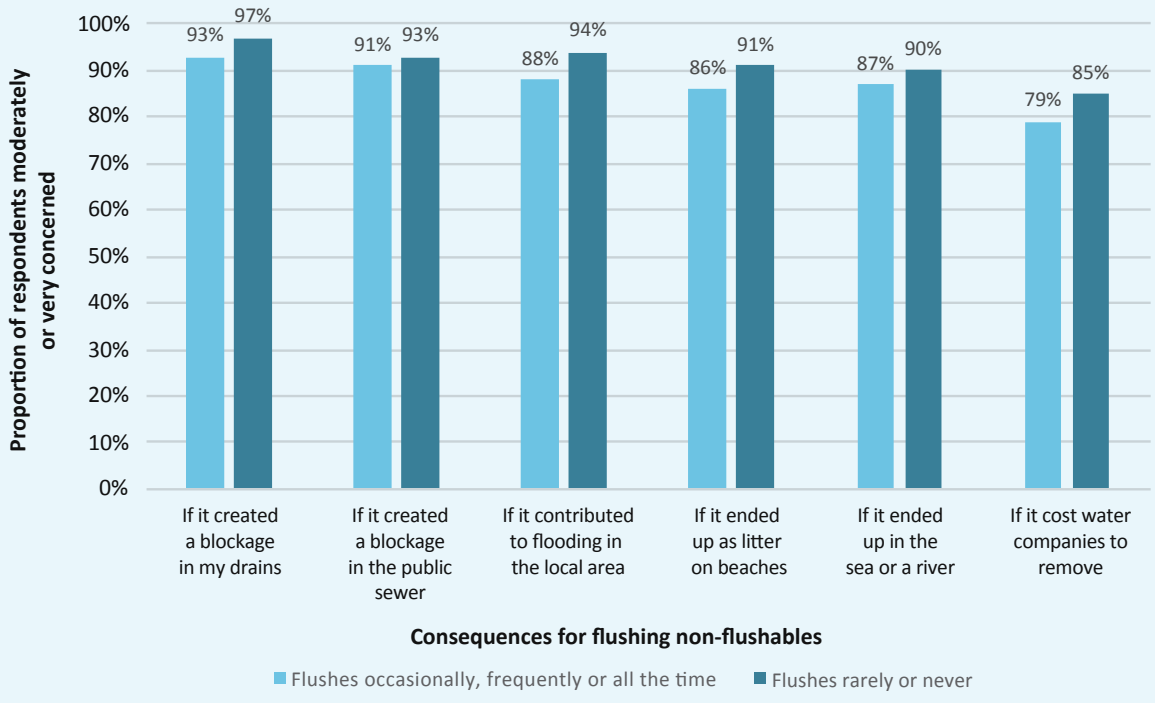
"The cotton wool balls I wouldn't think twice about putting down the toilet, 'cause I think they probably dissolve anyway and they're easily flushed away".

"The cotton bud sticks, sometimes when I used to put them down they didn't flush straight away they'd float, but I always throw toilet paper down to flush it away".

4.6. Concern for the consequences

There is a high level of concern among both those who do and do not flush items frequently, indicating a lack of awareness of the consequences (see Figure 11 below). Overall, respondents displayed the least concern towards the financial consequences for water companies, indicating that communications to influence behaviour should focus on the other consequences, such as blockages in drains and sewerage systems, and downstream environment impacts.

Figure 11. Levels of concern for the consequences of flushing the wrong items down the toilet



5. Changing behaviour

5.1. All products

In encouraging a change in the disposal behaviour of non-flushable items, the results suggest that there are two approaches that should be priorities in the first instance: increasing awareness of the environmental impacts and increasing how hygienic it is (or perceived to be) to dispose of the items in a bin. More than a third (38%) of people said the one thing that would encourage them to not flush the wrong items is if they were aware of the environmental impacts of doing so, and 28% said the most important factor for them is being able to dispose of the items in a bin, in a hygienic way (28%). This is consistent across all age groups.

These findings suggest that more should be done to increase awareness of the environmental issues related to non-flushables, and should look to tackle the perception that it is unhygienic to dispose of certain items in a household bin, as opposed to down the toilet.

However, consideration should also be given to other factors that smaller proportions of people suggested would be likely to encourage them to change their disposal behaviour. For instance, one in ten people said being more aware of the financial costs of the issue is the one thing that would encourage them to dispose of all items correctly. A further 8% said that receiving information on the number of blockages in their local area is most likely to encourage them to do this. Although these are lower proportions of people, these are the messages that are likely to be the most effective for some.

Behaviour change tackling this issue should therefore look to use a range of techniques and messages, therefore appealing to a range of audiences with different priorities and values.

5.2. Products labelled as flushable

There are a number of factors specifically surrounding items labelled by manufacturers as "flushable" which are likely to influence how frequently they are flushed.

In all, 88% of people said that if they were to flush an item down the toilet that was labelled "flushable", and that item went on to either block their drains or lead to environmental pollution, they would stop doing so in future. Furthermore, almost the same proportion (85%) said if either of these consequences occurred, they would view the brand less favourably, and three-quarters (76%) would stop purchasing the product entirely.

It is interesting to note that these results did not vary between those who flushed non-flushables down the toilet and those who did not.

Overall, these findings suggest that if people are provided with more information of the negative consequences caused specifically by products marketed as being flushable, this will have a great impact, changing not only flushing behaviour but also attitudes towards these brands and the likelihood of purchasing the items.

6. Conclusion

6.1. Summary

More than half (56%) of the adults surveyed in the North West of England disposed of at least one non-flushable product by flushing it down the toilet. When taking into account the population of the region (more than 7,052,000; see Office for National Statistics, 2016), the number of products this relates to and how frequently these tend to be used, the scale of this issue for drainage and sewerage systems, water and wastewater companies and, in turn, the environment is clear to see.

With 41% of adults disposing of toilet tissue wet wipes down the toilet, making it the most commonly flushed item in the North West, and 24% flushing cleaning wipes, there is a clear issue with products marketed as being "flushable". Consumers of these products, as would be expected, trust manufacturers, believing it to be acceptable to flush an item when it is labelled as "flushable".

The reality is that there remains no agreed criteria for flushability against which these disposable products are assessed (Water Research Centre, 2008), leading the international water industry and other partner organisations to release a statement suggesting that wipes labelled "flushable" should be labelled "do not flush" until such a standard is agreed by the water and wastewater industry (International Water Services Flushability Group, 2016). Consumers, however, are not aware of these disputes and the potential negative impacts of "flushable" products; if they were, the current research suggests this would not only prevent them from flushing the products, but would prevent large proportions (76%) from purchasing the products entirely. Furthermore, consumers would view these products less favourably if they were to learn that they went on to cause blockages and/or environmental pollution. This is an important finding, and something the manufacturers of these products should strongly consider.

Although efforts to tackle the issues caused by "flushable" products rely heavily on manufacturers and this change in labelling happening, behaviour change initiatives aimed at consumers should look to raise awareness of the potential negative impacts caused by these products, and the disputes surrounding what is "flushable".

Along with cleaning wipes, tampons are the second most commonly flushed item, with one in four women disposing of them down the toilet. With one in five women saying they have never been told or found out how they should be disposed of, and only 15% saying they found out how to dispose of them in school, there is an overall lack of awareness

contributing to the incorrect disposal of women's sanitary items. This could also reflect a lack of general discussion surrounding this topic, and a need for schools, manufacturers and others to do more to open this discussion and educate young women on how sanitary products should be disposed of.

Aside from issues surrounding products marketed as flushable and a lack of awareness of how items should be disposed of, there are a number of additional factors driving flushing behaviour. People overestimate the functions and capabilities of the sewerage system when it comes to what is flushed down the toilet, and underestimate the impacts of doing so. Overall, people who believe that an item causes a blockage if flushed down the toilet are less likely to do this. For instance, of the women who believe tampons will cause a blockage when flushed, only 9% flush them down the toilet occasionally, frequently or all the time, compared to 91% who never or rarely flush them. These findings suggest that if someone believes an item will cause a blockage if flushed down the toilet, this will make them more likely to dispose of it correctly.

In addition to this, items that are thought to degrade or break down are also more likely to be flushed, suggesting that these perceptions also need to be addressed. Behaviour change initiatives should look to increase awareness that non-flushables do not fully break down, highlighting that they either remain whole or degrade into smaller pieces or microplastics, and go on to cause issues such as blockages and marine litter. Respondents showed great concern for these issues, particularly environmental risks and blocked drains. The link between these issues and flushing behaviour therefore needs to be made more strongly.

People are also more likely to flush an item if they view it to be dirty or unhygienic. Although efforts could be made to help people dispose of products in a bin more hygienically, we suggest this issue is less associated with actual and more with perceived hygiene. Initiatives should look to tackle the perception that disposing of certain items in household bins is unhygienic, or, alternatively, demonstrate how flushing items into the drainage and sewerage system is far from "hygienic" when considering the potential consequence of blockages and environmental pollution.

The research suggests that there is also a general lack of responsibility for being personally aware of what should and should not be flushed; only one in five respondents felt that they themselves were responsible, as opposed to six in ten who felt that water companies were responsible. It is likely that this is linked to the lack of awareness around the functions and capability of wastewater and sewerage systems and the impacts of blockages caused by non-flushables. These findings suggest that manufacturers and the water industry should work together to develop consistent messaging approaches that educate consumers on the capabilities of sewerage systems and the impacts caused by blockages.

The research found that younger age groups, women and those who live in rented accommodation, compared to homeowners, are all more likely to flush non-flushable items down the toilet. However, these groups should not be exclusively targeted; rather, behaviour change initiatives should be targeted to specific items and those who use them.

Concern for the consequences of disposing non-flushables down the toilet is high among both those who do and do not flush items frequently, indicating a lack of awareness of the consequences. Overall, respondents displayed the least concern towards the financial consequences for water companies, indicating that communications to influence behaviour should focus on the other consequences, such as blockages in drains and sewerage systems, and downstream environment impacts.

Overall, the current research has yielded numerous insights relating to flushing behaviour and the drivers of this, which can be utilised in developing effective and targeted behaviour change interventions. Further research should explore how these can be used in practice and what is likely to be most effective in tackling this behaviour, for example via the piloting of interventions using randomised control trials. Furthermore, these findings have the potential to be utilised in influencing policy surrounding non-flushables, and tackling the issue directly at the source.

6.2. Recommendations

Based on the research insights, a number of recommendations can be made for water and wastewater companies, policy-makers and other stakeholders, as well as recommendations for further research. These are as follows:

- Consumers of products labelled as being flushable should be made aware of the potential impacts of these and their lack of agreed standards.
- Behaviour change interventions should look to address the perception that items will break down or biodegrade if they are flushed down the toilet, particularly around wet wipes, cotton items such as cotton balls and pads and tampons, and items that are labelled as flushable.
- Perceived issues around hygiene should be particularly addressed for the disposal of tampons and "flushable" toilet wet wipes.
- Schools should be supported to provide better education to girls, informing them on how they should dispose of sanitary items.
- Efforts to increase awareness of the impacts of issues relating to non-flushables should focus on a) how incorrect disposal impacts on people and their homes, and b) the environmental impacts of blockages.
- Residents expecting to receive information regarding the disposal of non-flushables in similar ways to how they get information on the disposal of other household waste (e.g. recycling communications) was a finding in the qualitative phase of the research. This message is largely expected to come from local authorities, water companies or the Environment Agency.
- Further research is recommended to understand whether living near a coastal environment has an influence on flushing behaviours, and this should ideally capture respondents' locations in greater detail.

6.3. Limitations

A number of limitations of this research can be noted and used for improving future research on the topic. The current research, firstly, focuses only on one half of the issue. Additional research is needed to understand disposal behaviours of fats, oils and greases in the kitchen, how these are contributing to the issue and how this behaviour can be changed. This is a research area that Keep Britain Tidy and United Utilities have also carried out work into, and will look to publish findings from. Understanding the full range of behaviours contributing to the issue will help to develop targeted behaviour change interventions to effectively address the issue.

While the current research identified the items being flushed most frequently in the North West, the survey did not identify how frequently each item is used. For instance, it may be that toilet tissue wet wipes are flushed at every use by some respondents, but are used very infrequently. In this case, these items would be contributing to the issue less than items used more frequently. This slight limitation suggests that the data in this research provides a good indication of the items that are most likely to be disposed of incorrectly, rather than an exact reflection of what is being flushed.

Finally, this research focuses only on the disposal of these items in the home. Although these are items that are predominantly used only in the home, and much of the findings are very much applicable to the use of these items in other situations, further research could look into the influence of situational factors outside the home. For instance, research could identify how the design of sanitary waste bins in women's public toilets influences the disposal behaviour of tampons and sanitary towels.

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THE BIG SCOOP: A NOVEL INTERVENTION TO ENCOURAGE HUMAN BEHAVIOUR CHANGE TO REDUCE DOG FOULING IN PUBLIC PLACES

Lauren Harris works as a Research Officer at Dogs Trust. She provides scientific support to the campaigns team, helping them to review evidence, analyse data, and measure impact and human behaviour change. She holds a PhD in Veterinary Sciences and Animal Behaviour from the University of Bristol.

Jane Hargreaves works as a Senior Researcher in Keep Britain Tidy's Centre for Social Innovation, and holds an MSc in Responsible Tourism Management from Leeds Beckett University. Her past research has involved testing messages to encourage more pro-environmental behaviour within protected areas in the UK, and to encourage more sustainable transport choices.

Rose Tehan is a Market Research Manager in Keep Britain Tidy's Centre for Social Innovation, which she helped to establish in 2013. Rose holds a BA in Social Science (Environment). She specialises in collaborative and action-based social research, and has extensive experience in designing and testing behavioural interventions in the field.

Jessica Hutton works as a Campaigns Assistant for Dogs Trust, and supports the creation and delivery of national campaigns designed to encourage responsible dog ownership across the UK. She is passionate about animal welfare and ensuring that all dog owners can access the knowledge of how to best care for their pets.

Lee Paris is Senior Campaigns Officer at Dogs Trust and is responsible for the development and delivery of the charity's responsible dog ownership campaigns. His aim is to positively impact the lives of dogs, their owners and the wider community through engaging and innovative behaviour change interventions.

BACKGROUND

Dog fouling is generally seen as one of the most unacceptable and harmful types of litter by the public (Campbell, 2007). This perception could be based on the fact that dog fouling presents a public health risk through the spread of zoonotic parasites (Katagiri and Oliveira-Sequeira, 2008; Mateus et al., 2014). Reducing faecal pollution from pet dogs can significantly reduce public exposure to zoonotic parasites such as Toxocara spp. (Morgan et al., 2013). The presence of dog faeces in an area can also reduce the psychological wellbeing of residents (Derges et al., 2012), and may discourage them from using outdoor spaces (Alves et al., 2008). If outdoor spaces are perceived as undesirable due to dog fouling, people will be less likely to use them, which could have a negative impact on physical activity levels (Toohey and Rock, 2011).

Typically, land owners seek to discourage dog fouling using enforcement strategies such as fines. However, enforcement strategies to prevent littering are often ineffective due to lack of awareness and the perpetrators' belief that they are unlikely to be caught (Keep Britain Tidy, 2011). Undesirable human behaviours are increasingly being discouraged using behavioural psychology techniques, in place of more traditional enforcement strategies. For example, in 2010 the UK government set up the Behavioural Insights Team (BIT), an organisation that uses behavioural psychology to increase public engagement with government policy and uptake of services. The BIT has undertaken projects including interventions to increase pro-environmental behaviour and charitable donations, and to decrease speeding on roadways (Behavioural Insights Team, 2017). Furthermore, a 2015 scoping review identified 82 different theories of behaviour

and behaviour change, 59 of which had been utilised in studies relating to public health interventions (e.g. reducing alcohol consumption or increasing physical activity) (Davis et al., 2015).

Behavioural psychology techniques have been used to reduce dog fouling prior to the current study; an intervention involving the installation of posters displaying images of "watching eyes" at hotspots successfully reduced the level of dog fouling in these areas by an average of 46% (Keep Britain Tidy, 2014). This intervention was based on previous work suggesting that cooperative and pro-social behaviour is positively influenced by the suggestion of being watched, and that even the presence of images of eyes can increase pro-social behaviour, such as clearing up litter (Ernest-Jones et al., 2011), and discourage antisocial behaviour, such as bike theft (Nettle et al., 2012).

A behaviour change technique often used by policy-makers is the "nudge" approach. A "nudge" is characterised as an intervention that "alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler and Sunstein, 2008). As an example: "Putting fruit at eye level counts as a nudge. Banning junk food does not" (Thaler and Sunstein, 2008). The efficacy of the nudge approach has been demonstrated in a meta-analysis of 37 studies aiming to encourage healthy eating, which found that nudge interventions caused, on average, a 15.3% increase in healthier consumption decisions (Arno and Thomas, 2016).

The aim of the current study was to pilot a novel intervention utilising the nudge approach to reduce dog fouling in public areas. Owners were encouraged to pick up and correctly dispose of their dog's waste by "nudging" them along specific walking routes where bins were provided. The effectiveness of the intervention was measured by conducting counts of dog faeces before and after the walking routes were installed.

METHODS

Set-up of dog walking routes

Signposted dog walking routes were installed at a convenience sample of six UK locations. To select the locations, a call was released for local authorities and land managers to partner with Keep Britain Tidy and Dogs Trust to execute the study. Partners were shortlisted according to their suitability for the intervention (Table 1 below displays the six selected partners).

The criteria for selecting the research sites were:

- The site had high levels of footfall from both visitors and dog walkers.
- The partner had received a number of complaints of both bagged and un-bagged instances of dog fouling/the partner had a significant dog fouling problem.
- The site had established walking routes/ trails with a number of bins.
- The partner had the capacity to commit to eight weeks of dog fouling baseline and intervention monitoring.

Table 1. Participating local authorities/land managers

Local authority/ Land manager	Location	Land type	Number of dog walking routes
Ashfield District Council	Brierley Forest Park	Park	2
Bassetlaw District Council	Langold Country Park	Country park	3
Bridgend County Borough Council	Rest Bay	Coastal walk/bay	1
Middlesbrough Council	Hemlington Lake	Park	1
Newark and Sherwood District Council	Vicar Water Country Park	Country park	1
Rochdale Borough Council	Queens Park	Park	1

Each partner selected a park in their area that suffered from high levels of dog fouling. Dogs Trust and Keep Britain Tidy worked in partnership with the local authorities to establish dog-walking routes using signage, maps and colour-coded route-markers for each park. A map placed at the park entrance displayed the walking routes and suggested different route options: small (2km), medium (4km) or large (6km). Brightly coloured stickers were applied to bins to turn them into route-markers and increase the salience of the bins by making them more eye-catching (see Figure 1 below). The message on the stickers read: "Any bin will do, for litter and dog poo too!" in order to remind owners that dog waste could be disposed of in any bin. Additional route-markers were distributed in between bins to ensure people kept on the route. These additional markers were attached to wooden stakes (provided by Keep Britain Tidy and Dogs Trust) or existing park infrastructure such as fences or lampposts (see Figure 2 below). Dogs Trust match-funded the cost of the materials, so councils payed a maximum of £200 (all three walking routes) or a minimum of £53 (smaller walking route only).

In order to raise awareness of the walking routes to the public without identifying the pilot as a dog fouling intervention, partners used social media to promote the dog walking routes, focussing on their health and wellbeing benefits.

Figure 1. Bins with stickers

Figure 2. Route marker on fence

Monitoring dog fouling incidence

During the four weeks preceding installation, partners were asked to record all instances of dog fouling within a defined area of the park, as selected by the partner. Prior to the four week pre-installation period, partners were asked to conduct a full cleanse of the park so that there were no dog fouling incidences remaining from before the pre-installation period. Dog fouling incidences were recorded at least twice a week, on the same days each week. Partners were asked to space the counting days evenly throughout the week so that there were three or four days in between counts (e.g. counts were conducted on Tuesday and Friday each week). Dog waste that had been bagged but not put in a bin was counted as well as un-bagged dog waste. Partners were encouraged to record the dog fouling incidences as part of their normal park cleaning routine; no extra staff had to be recruited to carry out the counts. Counting incidences of dog fouling as they were being cleared helped to ensure that the same incidence was not counted twice, and reduced the level of disruption to the partner's routine.

Post-installation, incidences of dog fouling were counted in the same way for a further four weeks. Again, partners were asked to conduct a full cleanse of the area prior to the commencement of the four week post-installation period, so that there were no dog fouling incidences remaining from the pre-installation period. Dog fouling incidences were counted cumulatively, so that there was a total count for both the pre-installation and post-installation periods for each site. The pre-installation and post-installation incidences of dog fouling were compared.

The statistical software SPSS (IBM, version 24) was used to determine whether there was a significant difference between the total counts of dog fouling incidents before and after the installation of the walking routes. The data were collected from the same locations at two different time points and were not normally distributed, therefore a non-parametric, repeated measures test was chosen (Wilcoxon Signed Ranks Test).

Surveying the public

Face-to-face surveys were carried out at the six sites during the post-installation period. The surveys were conducted by an independent market research agency, in accordance with the Market Research Society's Code of Conduct.

Interviews with partners

Telephone interviews with partners, lasting approximately 30 minutes, were conducted to identify what worked well during the initiative, and what could be improved for any future roll out.

RESULTS

Dog fouling incidence

The dog fouling incidence after the dog walking routes were installed was lower than the counts made pre-installation at all six sites (see Table 2 below). On average, dog fouling incidence decreased by approximately 38%.

Table 2. Dog fouling incidences before and after installation of the dog walking routes

Location	Monitoring phase	Total bagged count	Total un-bagged count	Total overall count	Overall reduction (%)
Ashfield	Pre-installation	19	688	707	-22%
	Post-installation	16	537	553	
Bassetlaw	Pre-installation	4	122	126	-33%
	Post-installation	0	85	85	
Bridgend	Pre-installation	14	49	63	-41%
	Post-installation	10	27	37	
Middlesbrough	Pre-installation	19	173	192	-15%
	Post-installation	0	164	164	
Neward and Sherwood	Pre-installation	7	224	231	-28%
	Post-installation	2	164	166	
Rochdale	Pre-installation	2	44	46	-89%
	Post-installation	1	4	5	

Only a small proportion of the dog fouling incidences observed were bagged compared to un-bagged, so it was difficult to robustly measure decreases in the incidence of bagged dog waste. It was therefore decided that the bagged and un-bagged incidences should be combined and analysed together. The Wilcoxon Signed Ranks Test revealed there were significantly fewer incidences of dog fouling observed post-installation than during the pre-installation monitoring ($z = -2.207$, $p = 0.027$, $r = -0.637$). This finding suggests that the intervention led to a significant decrease in dog fouling across the six locations tested.

Public surveys

A total of 643 members of the public were surveyed across the six sites. Survey data indicated that many park users, dog walkers and non-dog walkers alike, were unsure of how to dispose of dog waste: 50% of dog walkers and 53% of non-dog walkers surveyed thought that dog waste should be disposed of in "dog poo specific bins only", while 47% of dog walkers and 43% of non-dog walkers thought that dog waste should be disposed of "in any litter bin" (including dog poo specific bins).

Park users responding to the survey tended to have a positive impression of the impact of the dog walking routes: 63% agreed that the park was a "more fun and enjoyable place to be", and 56% agreed that more people were using the park since the installation of the routes. However, only 36% agreed that "the amount of dog fouling in the park has reduced". It was hypothesised that the percentage of people who had noticed a reduction in dog fouling was influenced by the actual reduction in dog fouling in that location (as measured by the counts of dog fouling incidence). In order to investigate further, the percentage of people who said they thought the amount of dog fouling had reduced was calculated for each of the six locations. Contrary to the hypothesis, there was actually a negative correlation between the percentage of people agreeing that dog fouling had been reduced and the actual reduction. In fact, the area with the lowest reduction in dog fouling incidence (Middlesbrough, -15%) had the highest proportion of people saying that they agreed that it had reduced (44%). However, conclusions from this correlation should be drawn with caution. Due to the small sample size (n=6), this correlation had low statistical power, and was not statistically significant (r_s = -0.543, p = 0.266).

When asked to rate how unacceptable they found various types of litter, respondents found all types highly unacceptable. On a scale of 0-10 (with zero being "not at all acceptable", five "neutral" and ten "extremely acceptable"), the majority of respondents rated dog faeces, bagged dog faeces, chewing gum, cigarette butts and picnic litter as zero (83%, 82%, 79%, 76%, and 83%, respectively).

Partner interviews

The feedback from partners was largely positive, with partners reporting that they were happy with the quality, design and salience of materials provided by Dogs Trusts. Partners felt that the ordering and delivery process worked well.

Partners reported that they saw a noticeable reduction in instances of dog fouling when the intervention and materials were in place. Partners also received positive feedback from park users, some of whom stated that they had noticed a difference in the levels of dog fouling at the site.

Overall, partners felt that the intervention was cost effective and well received by the public, particularly on social media. Some partners reported that the intervention exceeded their expectations and that they intended to roll the dog walking routes out across their borough.

Discussion

The current study demonstrated that the installation of the dog walking routes was successful in reducing the incidence of dog fouling in public areas. The success of this intervention suggests that using a "nudge" approach to direct people towards bins and increasing bin salience constitute a viable method of encouraging people to pick up after their dogs.

As well as reducing dog fouling, the survey data suggested that the installation of the walking routes may have encouraged park use, potentially having secondary effects on public wellbeing and physical activity levels.

A previous behaviour change intervention, which involved installing posters featuring "watching eyes" in dog fouling hotspots, achieved an average reduction in dog fouling of 46% (Keep Britain Tidy, 2014). It is not clear why the "watching eyes" approach induced a greater reduction in dog fouling compared to the walking routes intervention. It is difficult to compare the two interventions as they were carried out at different sites and with different populations. One potential benefit of the walking routes over the "watching eyes" posters is that it was a more positive intervention, which had the secondary benefit of making the parks more appealing, and therefore encouraging the use of outdoor space.

Despite messages on bins reminding dog owners that dog waste could be disposed of in any bin, survey data suggested that the misconception that dog waste must be disposed of in dog waste specific bins remained. Perhaps people were not reading the messages on the bins or assumed the bins had become "dog poo specific" with the addition of the stickers. Future campaigns could benefit from clearer communication of the message that "any bin will do".

Previous studies suggest that dog fouling is the type of litter that people find least acceptable (Campbell, 2007). However, in the current study, the majority of survey respondents found all types of litter completely unacceptable, which created a floor effect and made it difficult to detect differences between different types of litter. This difference may be because, in previous studies, opinions were gathered in focus groups where people may have had more time to think about and discuss which types of litter they found more or less acceptable.

The success of this pilot led to plans to expand the walking route intervention to other locations in the UK. Partners reported that they were pleased with how the intervention was executed, so the methodology for the expansion remained largely the same as the pilot study. However, there were certain limitations in the pilot study, which should be addressed in future studies assessing the impact of this intervention.

Future studies could benefit from measuring footfall in parks before and after the intervention. The level of dog fouling may increase if there are more people in the park (assuming that more people means more dogs), or decrease if people are more likely to clear their dog's waste if they think someone is watching. Therefore, it should be underlined that there was no difference in footfall before and after installation of the walking routes. There was no record of how many bins were present in the park before the intervention, and how many were added as a result of the intervention. It could be argued that reductions in dog fouling were influenced by increased bin provision, rather than the "nudge" approach and increasing bin salience. Another factor that may affect dog fouling levels is the proportion of dogs on lead compared to off lead; as far as the authors are aware, there is no empirical evidence to suggest this, but it seems reasonable to assume that off lead dogs are more likely to foul without their owners noticing.

When monitoring dog fouling levels, cumulative counts were made throughout the four-week baseline and four-week intervention period. This was justified because dog waste was counted regularly and was cleared as it was counted. Furthermore, dog waste generally remains in place unless it is intentionally cleared (following the personal experience of the Keep Britain Tidy researchers involved). However, in some cases, counts were conducted more sporadically than planned, and there were up to seven days between counts. It may be that some incidences of dog fouling disappeared between counts due to factors such as heavy rain, grass cutting or removal by a responsible citizen (Keep Britain Tidy, 2014). Future studies should be careful to emphasise the importance of regular counts.

Partners were required to completely cleanse the site immediately before the pre-intervention period and immediately before the post-intervention period. Dog fouling was also cleared while it was being counted, during the partners' normal park maintenance routine. There is evidence that people are more likely to litter in an area that already contains litter (Campbell, 2007), so more regular clearing of dog fouling may have encouraged people to pick up their dog's waste. It could be argued, therefore, that the counts may not have reflected the usual levels of dog fouling in that area. However, the same cleansing routine was used both in the pre and post-intervention phases, so any effects are likely to have had the same impact on both phases.

In conclusion, this pilot suggests that the walking routes intervention is a successful method of reducing dog fouling in public areas. This pilot not only demonstrated that this methodology could reduce the amount of dog fouling, but also lead to an increase in park user satisfaction. At the time of writing, an expansion of this methodology is currently underway. The success of the pilot study was shared with councils across the UK, and there was a great deal of interest in taking part in the expansion. The walking routes have been installed at 16 different sites across England, Scotland and Wales. Counts of dog fouling are being made following the same methodology as the current study in order to ascertain whether our findings are repeatable on a larger scale.

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ECO-SCHOOL CASE STUDY: DAMERS FIRST SCHOOL

Edd Moore is a year three teacher and Eco-Coordinator at Damers First School, Dorchester, Dorset.

BACKGROUND

Damers First School is based in Poundbury, Dorchester, Dorset. The school has 450 children aged from five to nine. The school has held the Eco-Schools Green Flag award since April 2016, and the last Eco-Schools Report in April 2018 said, "The school has clearly demonstrated commitment to the Eco-Schools programme. It was great to see this really was largely led by the pupils (Edd Moore and all teachers clearly giving them the inspiration) but the pupils were really heading it up with a strong ability to speak for themselves, debate and question difficult subjects, well done to everyone" (Damers First School, "Eco-Schools").

The whole school took part in the National Recycling Week in September 2017, with a focus on plastic in our oceans. The children found that nearly 300 million tons of plastic are thrown away every year, half of which is single-use. More than eight million tons of plastic are dumped into our oceans every year. Statistics like these inspired the Damers Eco Crew (which has a class representative from every year group, taking their peers' as well as their own views forward) to take this further by wanting to "be the change" and make an impact across the school as well as the local community in reducing the use of single-use plastic.

The Damers Eco Crew (see Figure 1) worked with Litter Free Coast and Sea on their Dorset Refill Scheme. This is where customers can go into a business displaying a refill sticker and have their reusable water bottle filled up with tap water for free. The children launched Refill Poundbury to businesses and guests by writing a persuasive letter to businesses, asking them to sign up to the scheme. They visited interested businesses where they spoke to the managers about the scheme and why it is important. So far 23 businesses have signed up, and were invited to an official launch that took place at the school. This is a huge amount, especially considering that Bournemouth has 25 refill stations. The children wrote and performed a Dorset refill rap, which was then used by Eco-Schools England and Eco-Schools International as their Christmas message (Damers First School, "Damers eco crew do the refill rap").

Figure 1. Damers Eco-Crew

Figure 2. The children being interviewed by Martin Dougan

CBBC Newsround found out about the children's inspirational work and filmed them speaking about their refill campaign and their views on plastic pollution. Figure 2 shows a picture of the children being interviewed by Martin Dougan (a television presenter) (BBC Newsround, 2018).

The children have started to mentor other schools to help them sign up refill stations in their locality. The children's Refill work has been celebrated as a case study by City to Sea on their website (City to Sea, 2019). City to Sea was founded by Natalie Fee, who also founded Refill, which was launched in Bristol in 2015.

The children have been active in getting local businesses, including Waitrose, to collect printer and toner cartridges for recycling. They also persuaded Waitrose, Buttermarket Post Office, and Parkers Estate Agents to become collecting stations for the school so the community can easily drop off their cartridges for recycling, doing their bit for the environment while also raising some money for the school (see Figure 3).

Figure 3. Children with Poundbury Store manager Jeremy Board

The children also got everyone connected with school to recycle pens, biscuit wrappers, baby food pouches, beauty packaging and air fresheners. They have a Delphis "eco turtle" where they are selling different ecological cleaning products in the UK's first post-consumer plastic packaging (see Figure 4) (Delphis Eco, 2019). So far, the school has raised £500 through these recycling and enterprise projects, which has gone towards the purchase of a bird hide for the school grounds.

Figure 4. Children selling ecological cleaning products

The children decided to plan for making the school plastic free (starting with single-use plastic), organised meetings with the PTA and local MP Oliver Letwin (see Figure 5), and took assemblies to encourage their friends to buy reusable water bottles.

Figure 5. Children talking about their Waxtastic No Plastic product

Children came up with ideas about what could be used instead of plastic, such as stainless steel or paper straws and reusable stainless steel bottles and lunch boxes. The children wrote letters to the school fruit and milk suppliers (see Figure 6 below), asking for paper straws, fruit without packaging and milk in bottles. The power of the children's voices worked, with the milk company offering to deliver milk in glass bottles and giving the school reusable cups. The fruit provider was less helpful with negotiations still ongoing between the children and the company about what they can provide to reduce plastic but make sure the fruit is kept fresh when being transported. They wrote to the Duchy of Cornwall, the Poundbury landlord, asking for water fountains to be placed around Poundbury so water is easily accessible for the whole community. The children received a positive response from Ben Murphy, Deputy Estate Director for the Duchy of Cornwall, who is looking into this and will get back to the children when there is more information.

Figure 6. Letter written by the children to the Dutchy of Cornwall


Damers
FIRST SCHOOL

Dear Mr Murphy,
We are writing to ask you to put water fountains up around Poundbury because too many plastic bottles are bought and carelessly thrown away. They end up scattered over our land and are left floating in our oceans. 1 million plastic bottles are bought around the world every minute. But we could encourage Poundbury to buy reuseable water bottles and then they could keep on filling them up while they're out and about. Whilst they are walking and cycling around Poundbury.
We could become plastic-free Poundbury!
We look forward to hearing from you,
From The Damers Eco Crew.

DASP

Brave, unique, caring and kind

The PTA put on their first plastic-free event with a disco in May, which had luminous paint, jugs of water and cups, and cans of drink. All the PTA events will be plastic free from now on. Damers First School was awarded Plastic Free School status by Surfers Against Sewage, and was highly praised for involving the community.

In September 2018, year three children teamed up with year nine and ten students from the Thomas Hardye School in neighbouring Dorchester to take part in a Campaign to Protect Rural England (CPRE) and Litter Free Dorset Green Clean (see Figure 7 below). CPRE brought their "reverse vending machine" with them, as can be seen in Figure 7.

Figure 7. Children from Damers and students from the Thomas Hardye School

They challenged the children and students to find as many plastic bottles and cans as they could in one hour. For each one they found they raised 10p for the school's campaign to help Dorchester achieve Plastic Community status. This is a campaign run by Surfers Against Sewage to help towns and cities across the UK to reduce their single-use plastic, getting businesses, schools, town councils and local community organisations involved. The children picked litter on the route between Damers School and the Thomas Hardye School, and the children and students found 156 plastic bottles and cans, raising £15.60. These figures, along with the rest from September, will be going into a report that CPRE will present to the government.

Each class has its own raised bed where the children plant vegetables to grow, harvest, prepare and make meals. These meals are related to a chosen country, a best vegetable competition at a village show or a traditional

British dish. Sometimes, the vegetables have been sold to the parents for a donation to raise more funds for the garden. The school was awarded the RHS Five Star Gardening School award in September 2017. An allotment area has been created with funding from the Dorset Gardens Trust so the school can grow more vegetables to contribute to the food served at lunchtimes.

The school have a group of volunteers who work with the children, sharing their knowledge and passion for gardening in the afternoons so everyone across the school can get out into the garden to learn where their food comes from. The school also have fantastic support from the Poundbury Garden Centre with donations of seeds, vegetable plants and trees, as well as their expertise to support the children in the garden. The children also harvest what they have grown and use it to cook with in our technology room to make soup or crumbles, for example. Prince Charles was impressed when he came to open the school on 27 November 2017 (Figure 8).

Figure 8. Prince Charles visits the school

In September 2018 the school came second in the National Cultivation Street School Gardening Competition. The judges, including celebrity gardener David Domoney and Lady Salisbury, said, "It is nothing short of incredible. We loved that the children get out gardening in all weathers and get benefits year round. The school composts all its food waste so the garden is eco-friendly". The PTA helped to raise money for a Ridan food waste composter (see the right hand picture in Figure 9). Since June 2018, all the food waste from school lunches and children's snacks at playtime, as well as any other food, goes into the composter, which makes compost for our school gardens.

Figure 9. Teacher Edd Moore with children from year one in the school gardens

The Eco Reps & Entrepreneurs entered the Santander Young Enterprise Fiver Challenge and won best group, most profitable product, best logo and best advertisement in the five to eight age group. This year's product is Waxtastic No Plastic (see Figure 10).

Waxtastic is a piece of 100% cotton dipped in beeswax. It is an alternative to clingfilm for all foods except meat. It lasts for up to a year and is 100% eco-friendly.

Figure 10. Children endorsing Waxtastic

The children have sold this product at the school summer fete, outside Poundbury Waitrose, at the Poundbury farmers' market, the Dorset Food and Arts Festival, the West Dorset District Council Plastic Free Lunch Box Event and the Dorset County Show. To date, the children have raised £3,384, with the money going towards a nature area with a pond for the school grounds.

Each term, every class makes a Jane Goodall's Roots and Shoots pledge to help people, animals or the environment. The photograph on the top of Figure 11 shows the Roots and Shoots board that displays all the class pledges in the hall. One class, Grayling 1 (see the photograph on the bottom of Figure 11), inspired by the work the Eco Crew were doing within the school, wanted to pledge to make Dorchester and Poundbury plastic free. They designed posters showing how to do this.

Figure 11. Roots and Shoots Board and children with posters

They talked to businesses and asked them to put up their posters. The children invited the manager of Waitrose, Jeremy Board (see Figure 12), to school to ask him what the store is doing to reduce plastic use. His answer was that their egg boxes are 50% grass and 50% cardboard, and they plan to get rid of all black plastic by 2019. Grayling 1 are going to write to Waitrose head office to put pressure on them to reduce plastic packaging for fruit and vegetables.

Figure 12. Waitrose store manager Jeremy Board with the Grayling 1 class

The children have an idea to reduce takeaway coffee cups by introducing a deposit scheme called Recup and Cup Club. Customers pay a £1 deposit for a cup. They can drop the cup off at a shop or designated bin, receiving their £1 deposit. The cups are then collected, washed and returned to the shops. The children put together a questionnaire, with 108 members of the community and eight businesses in Poundbury taking part. Here are the results:

- 84% said it was extremely important not to use plastic-lined coffee cups
- 60% were interested in having a Recup or Cup Club scheme
- 55% of people bought their coffee from Waitrose, 43% from Costa and 27% from independent shops
- 83% of businesses used paper straws
- 66% used cans to reduce their plastic waste
- 67% said it was extremely important not to use plastic-lined takeaway cups
- 50% of businesses were interested in a Recup/Cup Club scheme (Poundbury, 2019).

The amount of takeaway cups being sold per week is less than the 10,000 cups that are needed to make the schemes work. The children have suggested to the businesses that they have a loyalty scheme instead where customers receive money off their takeaway hot drink if they use a reusable cup, or where they get six stamps and then receive a free cup of coffee or a reusable cup. Four independent cafes have already put a loyalty scheme in place after the feedback from the children's questionnaire. Children appeared on BBC Radio Solent to speak about plastic and their idea for a deposit scheme for takeaway hot drinks.

Edd Moore, the Eco-Coordinator, presented the work the children had achieved since September 2017 in reducing plastic at school and in the local community, as well as the findings of the Recup and Cup Club questionnaire, to the town council, who were very impressed. An action plan is being put together to present to the council in November to support the children in working towards Plastic Free Community status for Dorchester. The action plan will include having at least 12 businesses giving up three single-use plastics and finding alternatives, a third of schools gaining plastic-free status, involving other organisations like the Scouts, Girl Guides, Rotary, Dorchester Chamber for Business and Litter Free Dorset, organising two community cleans and putting together a steering group. A target date for achieving Plastic Free Community status has been set for 29 June 2019.

You need someone to be a driving force for Eco-Schools who is passionate and has the enthusiasm to engage staff and pupils to work together. Getting members of the local community and local businesses involved in your eco work is a great way to support the children, and they have a wealth of knowledge they can share alongside donating their time through giving talks or offering support in the garden.

Plans for the future include an area in the orchard for chickens which the children will take care of and a nature area with a pond, and the children will lead the campaign for Plastic Free Community status for Dorchester. There is plenty for them to do.

If you would like to become an Eco-School, the following websites and organisations might be a helpful start:

And Keep
https://andkeep.com/

Campaign to Protect Rural England
https://www.cpre.org.uk/

City to Sea
https://www.citytosea.org.uk/

Cultivation Street
https://cultivationstreet.com/

Delphis Eco, 100% ecological plant based cleaning products
https://delphiseco.com/

Eco-Schools
https://www.eco-schools.org.uk/

Empties Please, recycling cartridges and toners
https://www.emptiesplease.com/

Greenpeace UK
https://www.greenpeace.org.uk/

Jane Goodall Roots and Shoots Foundation UK
https://www.rootsnshoots.org.uk/

John Muir Trust
https://www.johnmuirtrust.org/

Kids Against Plastic
http://www.kidsagainstplastic.co.uk/

Learning through Landscapes
https://www.ltl.org.uk/

Marine Conservation Society
https://www.mcsuk.org/

Modeshift Stars
https://www.modeshiftstars.org/

National School Partnership
https://nationalschoolspartnership.com/

Plastic Oceans
https://plasticoceans.org/

Refill – https://refill.org.uk/

RHS Campaign for School Gardening
https://schoolgardening.rhs.org.uk/home

Ridan Food Waste Composter
https://www.ridan.co.uk/

RSPB – https://www.rspb.org.uk/

Surfers Against Sewage
https://www.sas.org.uk/

Sustainable Learning
https://www.sustainablelearning.com/

Sustrans
https://www.sustrans.org.uk/

Terracycle
https://www.terracycle.co.uk/en-GB/

The Global Goals for Sustainable Development
https://www.globalgoals.org/

The Pod – https://jointhepod.org/

Wildlife Trust
https://www.wildlifetrusts.org/

Woodland Trust
https://www.woodlandtrust.org.uk/

Young Enterprise Fiver Challenge
https://www.fiverchallenge.org.uk/

Tenner Challenge
https://www.tenner.org.uk/

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THE ECOLOGY OF COOPERATION: CONSIDERATIONS FOR LITTER RESEARCH

Claire Gellard is a PhD student at Middlesex University, London. Her research focuses on cooperative social behaviour, investigating the role of social norms and future orientation to further understand littering behaviours. Claire is involved in the Sustainable Development Research Cluster at Middlesex University.

Thomas E. Dickins is Professor of Behavioural Science at Middlesex University, London. He uses behavioural ecological and psychological models and methods to study behaviour. Recent work includes the ecological determinants of human fertility scheduling in western populations, breeding success in Kittiwakes and foraging in urban gulls. He is a member of the Sustainable Development Research Cluster at Middlesex University.

Mark Coulson is Associate Professor in Psychology at Middlesex University, London. His research interests include the psychology of happiness (positive psychology), the expression of emotion through body posture and movement, theoretical and simulation models of emotion, the effects of video games, the efficacy of psychological therapies (especially in older adults) and mindfulness.

1. INTRODUCTION

There is often a disconnect between desired environmental change and the short-term costs required to deliver it. Environmental ambitions are set at many levels (local, national or international), while the behaviours that will lead to change are reliant on individual execution. For example, reducing the amount of single-use plastics one uses will not result in an immediate, observable reduction of plastic waste in the Pacific gyre. Nonetheless, a population of individuals delivering on this behaviour will have an impact in the long run. Environmental outcomes require the concerted action of individuals who are able to forecast change and place value on the future benefits.

Kolodko and Read (2018) discussed this tension within the context of littering interventions, noting that short-term goals may outcompete any distal future considerations, and that this behavioural situation is not to be seen as necessarily irrational at the individual level, especially when understood as a commons dilemma (Hardin, 1968). They went on to discuss a variety of nudge techniques that might be used to direct behaviour towards litter reduction. In this paper, we will extend the argument of Kolodko and Read in order to focus upon the nature and cause of individual differences in cooperative behaviours within commons and other settings. We will approach this task as behavioural biologists, rather than social scientists, and argue that various forms of cooperation rely on the ability to forecast future social benefits. There are clear individual differences in this ability, and some of those differences are developmental outcomes, broadly understood as a consequence of ecological exposures throughout a lifespan. We will present one framework for capturing these outcomes that has the distinct advantage of predicting variance in a wide variety of behavioural and somatic phenotypic expression. This framework suggests that patterning in littering behaviour is a function of what social scientists refer to as socioeconomic status. Our argument is that socioeconomic status is a marker of ecological realities, and is therefore a useful and relatively easily assessed proxy for ultimate causes.

For the purposes of this paper, we are defining littering, in broad terms, as the placement of an unwanted item in an area not designated for waste disposal or collection. This can be actively or passively achieved (Sibley and Liu, 2003) and can include anything from discarding food packaging and unwanted food, through to illegal dumping of waste (i.e. fly-tipping).

The paper is structured as follows: First, we provide an introduction to behavioural biology and life history theory to explore the role of fitness-maximisation in explaining behavioural adaptations (Section 2). We then highlight how cooperation can emerge and evolve within related and non-related populations (Section 3). In Section 4 we discuss how inter-temporal choice and relative inequality affect discount rates, which is crucial in stabilising cooperative behaviour. We then discuss a number of potential interventions (Section 5) based on varied ecologies, before offering some concluding remarks (Section 6).

2. BEHAVIOURAL BIOLOGY

Behavioural biology is primarily focused on evolutionary accounts of behaviour. Much of the development of evolutionary biology was achieved through developments in behavioural science, with a focus on social behaviours. This is because social behaviours present specific questions for evolutionary theory, and we will discuss cooperation below. To begin, however, we must outline the core theoretical commitments of behavioural biology (BB).

As an evolutionary discipline, BB is focused on adaptations, where an adaptation is any trait that operates in such a way as to increase the relative frequency of its underlying genes within the population genepool. The concept of fitness captures the idea that organisms are vehicles that act to further the replication of the genes that built them (Dawkins, 1989). Fitness is not a property of individuals, but a modelling concept that enables the examination of evolutionary effects. Thus, individual fitness is increased directly by reproduction, such that genes are replicated and represented across generations, and fitness is increased indirectly by the reproduction of genetic relatives, or kin. Traits that increase successful direct and indirect reproduction are adaptations. The sum total of fitness maximising effort is referred to as inclusive fitness. Inclusive fitness theory assumes that organisms act to maximise their average lifetime inclusive fitness, and behaviours that do this are adaptations that have been selected through evolutionary time (West and Gardner, 2013). Testing this baseline hypothesis is the business of BB.

Behavioural adaptations introduce flexibility, or plasticity, enabling organisms to deal with change. This is a key point. Behaviour is a method of calibrating organisms to complex environments in a way that will enable their survival and reproduction (Godfrey-Smith, 1996; 2002). Behaviours calibrate on a moment to moment basis, through learning and core developmental processes.

A key framework for BB is life history theory, originally cast in terms of r/K selection (Pianka, 1970). Both r and K are parameters in ecological equations, where r denotes the reproductive growth rate of a population and K is the carrying capacity. The basic idea was that carrying capacity could check reproductive growth rate, but also that different option spaces existed for organisms within this dynamic. Thus, in species that were heavily r-selected, more effort would be put into reproduction, and one would expect to see rapid development from birth to sexual maturity, high levels of reproduction, and little specialisation. In contrast, heavily K-selected populations would consist of organisms that were slow to develop, had relatively low rates of reproduction, and became niche specialists as they dispersed and moved into particular ecologies due to local carrying capacity constraints. These two parameters are not, in fact, equivalent to one another, and life history theory repackaged these ideas in terms of fast versus slow life history strategies (Stearns, 1977; 1980; 1992), where slow life histories enabled the development of specialisations. Species can be ranked in terms of the relative speed of their average life histories, but within species there is also variance, indicating a variety of strategic options as a function of circumstances.

The notion that life histories are strategic is important. Developing organisms are regarded as collecting information about their environmental circumstances and using this to establish rational fitness maximising strategies. This is an optimality assumption that incorporates the notion of trade-offs. The key trade-offs in life history theory are those between current versus future reproduction and the quantity versus quality of offspring produced. These trade-offs are a response to current and predicted resources, where resources are broadly construed to include such things as access to calories and nutrients through to social benefits. At some point in development, trade-off strategies may become fixed, but it is important to be clear about what this means. Recent life history theory research into age at first pregnancy in humans demonstrated that maternal birthweight, breast feeding regime,

and socioeconomic status are all predictors. Specifically, early first pregnancies were predicted by low birthweight, reduced breast feeding and the low socioeconomic status of the mother (Coall et al., 2011; Nettle et al., 2011). Moreover, these young mothers reached sexual maturity and other developmental milestones sooner than their matched controls (Nettle et al., 2013). Socioeconomic status should be seen as capturing real, ecological facts under this model (Marmot, 2010). To put it metaphorically, all of these predictors tell the developing mothers, in this case, about the relatively harsh environment they are living in, and investment in earlier pregnancy makes good evolutionary sense when future extrinsic resource is unlikely to improve, and ageing effects will put offspring at risk if reproduction is delayed. Thus current reproduction is favoured over future reproduction. Here, natural selection is seen as the rational actor, having selected for plastic developmental response that is sensitive to key parameters. But the actions of the individuals are also rational under these contexts, as there is much evidence to suggest that attendant psychological processes around desire for and planning families match these parameters (Arai, 2009). In this way, learning and development are closely coupled and deliver an outcome that is fixed once delivered: in effect, the bet is taken.

3. COOPERATIVE BEHAVIOUR

Cooperation is a generic term that captures a number of behaviours. Specifically, a cooperative behaviour will provide a benefit to another individual, and will have been selected for as a consequence of that benefit (Davies et al., 2012). Within evolutionary biology, this possibility initially presents as a problem – how could selection operate in order to benefit the genes (or fitness) of another individual? Surely all selected behaviour must directly benefit the behaving organism?

It is important to be clear about what this question means. In our discussion of BB and life history theory we dealt with adaptations for plasticity. The assumption was that those adaptations were underpinned by genes that had been selected over evolutionary time. For new traits to emerge, new genetic variants must be introduced, and most often those are mutations of an existing gene, leading to new forms of that gene. The various forms of a gene are referred to as alleles. In most evolutionary models that try to understand how a new trait might emerge, the question becomes one of how a new mutation, or allele, might go to fixation in a population, remembering that the mutation will arise in one individual only. That individual has to receive some relative reproductive advantage as a result of the new variant in order for that variant to thrive in the population.

Hamilton (1964) addressed the issues of cooperation first by classifying social behaviour in terms of actors and recipients, costs and benefits (see Table 1 below).

Table 1: Hamilton's classification of social behaviour (adapted from Davies et al., 2012, p. 308)

Effect on actor	Effect on recipient	
	Positive	Negative
Positive	Mutually beneficial	Selfish
Negative	Altruistic	Spiteful

Mutualism makes sense as both parties benefit (though see West et al. (2011) for clarity on the complexities here). One obvious way in which altruism might emerge is if actors and recipients are related, thus sharing the same genetic variants (or alleles) and enabling direct selection. This idea is referred to as kin selection and enables the stabilisation of cooperation across close and more distant relatives just so long as the costs to the individual do not outweigh the benefits, weighted by genetic relatedness. Hamilton captured this in a mathematical expression, referred to as Hamilton's Rule (see Dickins, 2011). Under this rule, spite will emerge when the recipient is less related to the actor than the average individual in a population. Specifically, it will make sense to harm a non-relative in this way if doing so frees up resource for relatives in the population, thereby benefitting individuals carrying the same spiteful genes.

It is not always the case that cooperating individuals are related. To address this issue, game theory was introduced. Game theory focuses upon competitive interactions between individuals and seeks equilibrium solutions to those interactions.

These are behavioural strategies that cannot be outcompeted by any other strategy that might be adopted within the confines of a game. The Prisoner's Dilemma is one of the best-known games used in evolutionary theory. Multiple forms of this game now exist, but originally it comprised two prisoners planning an escape. The prison guards become suspicious and interrogate both prisoners individually. There is no direct evidence of an escape plot, so the guards put a deal to each prisoner. Here is how Gardiner (2001, p. 391) expresses the deal:

Each faces the following proposition. He can either confess or not confess. If both confess then each gets five years. If neither confesses, then each gets one year on a lesser charge. But if one confesses and the other does not, then the confessor goes free, and the non-confessor gets ten years. Neither knows for sure what the other will do; but each knows that the other faces the same choice situation.

The original version is a one-shot game where each player has only one strategic move that they can make: to cooperate or to defect. Most people understand the best option for any prisoner in this situation is to defect and confess the plot. If the other prisoner confesses too, any punishment will be relatively light compared to the worse case punishment of an extra ten years, if a prisoner stays quiet while the other confesses. Thus, on average, the best decision is to defect on your prior arrangement with the fellow prisoner. This is an issue of individual rationality. If the prisoners could confer then something else would emerge.

In evolutionary terms, the assumption is that the strategy of defection in these circumstances will thwart any mutation that tends to cooperation. If we think of the costs in the dilemma as fitness costs, then the relative benefits of defection will stop cooperation genes going to fixation in a population. Thus, BB uses evolutionary game theory to model genetic strategies, which are expressed in behavioural terms. Equilibrium solutions are referred to as Evolutionarily Stable Strategies (Maynard-Smith, 1982).

The finding that defection is a stable strategy in one-shot Prisoner's Dilemma games is consistent under multiple cost-benefit trade-offs (Axelrod and Hamilton, 1981). Defection is also a stable strategy in multiple-shot games if the number of interactions is known in advance. Once the last move is reached, a player should defect as the last move is effectively a one-shot game, and this means defection will also be best on the penultimate move and so on, all the way back to the first iteration.

If the series of encounters goes on with no end in sight, or there is a possibility, however small, that the individuals will encounter one another again at a later date, then more complex encounters and strategies can emerge. This was famously tested with a computer contest in which scientists played their strategies against one another, against themselves (in ignorance), and against random defector or co-operator strategies (Axelrod, 1990). There was a high probability of future encounters in this contest. The strategy that won, or was stable, was tit-for-tat. Tit-for-tat cooperates on the first move, and thereafter copies its opponent's previous move. Thus, tit-for-tat becomes a strategy of cooperation based on reciprocity. It succeeds because it is initially cooperative but then retaliatory, discouraging defection, and it forgives after one retaliation, restoring cooperation.

Tit-for-tat is a method for facultatively enforcing reciprocity (West et al., 2011). Reciprocity has been a key solution to cooperation between non-kin – you scratch my back now and at some future point I will scratch yours (Trivers, 1971). However, this solution is open to free riding, such that individuals could take the benefit but never deliver a future return. This would clearly destabilize cooperation, and the tit-for-tat strategy introduced retaliatory punishment to enforce continued cooperation. In that case, the punishment was simply to copy any move, and thus defection would be "rewarded" with defection, and over time the average benefits to all players would be driven down. Cooperation thus becomes rational again.

Tit-for-tat, as it has been described so far, is a behavioural strategy initially implemented on computers. For reciprocity to work in natural populations, individuals need to be able to keep track of others, thereby understanding that there are probabilities attached to future interaction, and they need to be able to model a future payoff. Population structure is key to reciprocity, as cooperation is between non-kin, but so too are memory and the ability to forecast. Where these capacities are challenged or limited then cooperation will not stabilise (Stephens et al., 2002; Stevens and Hauser, 2004).

This idea is potentially captured in the tragedy of the commons in that individual benefits outweigh population benefits, at least in part because the population effect is more distal; the implication is that a littering individual is unable to appropriately model the future costs of accumulated litter. The time periods between choice and outcome are therefore of great interest and are captured in the literature on inter-temporal choice.

The tragedy of the commons problem is regarded as a multiplayer Prisoner's Dilemma game (Gardiner, 2001). Kolodko and Read (2018) give an example of this, noting that at the individual level the benefits of littering can outweigh the costs of responsible disposal, while at the population level the costs of littering can outweigh the benefits. In effect, a decision to litter is a decision to defect on the public good of responsible disposal because of the perceived cost-benefit imbalance. Kolodko and Read go on to discuss a series of nudge interventions that might alter these perceptions. We shall return to this in Section 5.

4. INTER-TEMPORAL CHOICE AND INEQUALITY

Imagine searching for a pen to write a birthday card. Rifling through the kitchen drawer yields a cheaply produced Biro, which will enable the task to be completed, but a longer search in one's study might yield an expensive pen that improves one's hand and thus the quality of the overall card. Search time is a cost that must be balanced against the benefits of a well-crafted card. As the card is an investment in a social relationship, the amount of time searching for a pen is revealing of how much value the actor attaches to that relationship. The situation can be packaged as this choice: a poor pen now, or a much better pen after x minutes of searching.

Financial behaviour often provides examples and models of choices across time intervals – or inter-temporal choice. Imagine being given the choice between £10 in two days' time or £50 in two months. Clearly, the latter is financially more rewarding, but the wait is much greater. Those who choose the former option might be said to be discounting their future more heavily than those choosing the latter. Indeed, a discount utility function could be mathematically derived from such choice behaviours to descriptively capture at least this instance of choice (Frederick et al., 2002).

Intertemporal choice has previously been explored using the discounted utility model which suggests that discount rates remain constant and stable over time; that is, the discount rate decreases exponentially as time progresses (Streich and Levy, 2007). For example, if you prefer £10 today rather than £20 tomorrow, you will also prefer £100 in one year rather than £200 in one year and a day from now. This model predicts that outcome valuation is predictable over time; however, hyperbolic discounting has been found to be much more accurate in predicting and describing intertemporal choice (Frederick et al., 2002). Hyperbolic models suggest that people discount more heavily in the near present (e.g. today versus tomorrow), but then the discount rate is less rapid as time progresses (e.g. next month versus the month after next).

Discounting has been studied widely in behaviours such as smoking (Reynolds et al., 2004), substance abuse (Petry, 2001) and gambling (Dixon et al, 2003), where there is a preference for short-term payoffs (i.e. the immediate benefits of nicotine, the release of endorphins from a glass of wine, or the occasional immediate pay out from a slot machine). This is indicative of impulsivity and seen as symptomatic of a fast life strategy (Walther et al., 2012; Griskevicius et al., 2013). Smoking, substance abuse and gambling are also asymmetric in their socioeconomic distribution. Lower socioeconomic status populations are more prone to these behaviours (Barnes et al., 1999; Wilkinson and Pickett, 2009). Those living in situations where long term futures are uncertain are more likely to heavily discount that future in favour of immediate gratification. What this means is that future orientation is a highly valuable and relevant mechanism to consider when it comes to environmental behaviours, of which payoffs often require a delay of gratification.

Differences in discount rates can be predicted by life history theory whereby preferences for delayed versus immediate rewards are influenced by mortality rates and resource shortage (Griskevicius et al., 2011). Griskevicius found that individuals who grew up relatively poor chose smaller but immediate payoffs, and those who grew up relatively wealthy preferred to wait for the larger future payoff, when primed with mortality cues. Following our preceding argument, if one's environment is unpredictable, the wisest option would

be to take what you can today as tomorrow is uncertain, whereas if you expect to live for many years it may be worth your while investing now for a larger payoff in the future.

As indicated above, discount rate is also crucial for stabilising cooperation and will therefore impact on structured populations facing commons dilemmas. Even in minimally structured interactions there should be an effect. For example, Curry et al. (2008) found that people who were more patient, as measured with a standard discount rate task, were more cooperative even within a one-shot public goods game. The implication here is that a cooperative disposition is integrally related to an ability to forecast, value and invest in potentially uncertain distal payoffs. Indeed, socioeconomic status has also been related directly to levels of altruism, with poorer neighbourhoods demonstrating less altruistic behaviour (Holland et al., 2012; Nettle et al., 2011; Wilson et al., 2009).

The implication here is clear. At least in the developed world, with high levels of relative inequality (Wilkinson and Pickett, 2009), low socioeconomic status, which captures exposure to health risks, shorter life spans and reduced resourcing going forward (Marmot, 2010), is associated with steeper discounting and lower levels of cooperation. Unsurprisingly, littering behaviour and attitudes towards it are also socioeconomically distributed such that lower socioeconomic circumstances predict more littering and less concern about it (Arafat et al., 2007; Eastman et al., 2013; Santos et al., 2005). Pampel (2014) found that, cross culturally, higher income populations in more affluent countries show greater environmental concern than their low income counterparts. In addition, slow life history strategists, who place more value on later rewards, may be more concerned with their reputation as they are more likely to attract direct and indirect benefits from future parties within their social groups (Wu et al, 2017; Sylwester and Roberts, 2010). These findings lend themselves to the notion that littering behaviour, for example, is not an issue of immediate concern for those living under lower socioeconomic conditions as they are focused on more immediate fitness maximising endeavours.

5. COOPERATIVE LANDSCAPES AND INTERVENTIONS

Cooperation depends upon the structure of the population but also the ability of individuals to forecast and remember. Individual differences in these abilities are, to a large extent, a consequence of exposures to risk and resource differentials across the lifespan, such that low socioeconomic conditions within developed countries create neighbourhoods of individuals with steep discount rates and lower levels of cooperation. Low socioeconomic status is also associated with lower levels of pro-environmental beliefs and behaviours, and this is relevant to the commons problem of littering. These effects can be seen to pulse with changes in macroeconomic fortunes, such that periods of recession lead to greater impoverishment of neighbourhood environments (Allen, 2013). Given this, we might understand the overall problem of littering as one that is happening across a diverse and dynamic landscape and is caused by a variance of ecological pressures on populations. These pressures demand very different priorities, and therefore very different cost-benefit trade-offs. This makes it unlikely that generic policies aimed at reducing littering will work uniformly well.

The association between litter, and other environmental degradation, and poor life outcomes and quality has long been noted and discussed. There are two leading causal theories. The first is the “broken window theory”, which suggests that disordered environments signal that defection is an acceptable behaviour (i.e. it is the social norm), and therefore individuals adjust their behaviour accordingly. Additionally, visible signs of disorder indicate risk and unpredictability, which further emphasises the need to prioritise immediate fitness returns. The second argues that these things might best be seen as a symptom of a lack of social cohesion. O’Brien and Kauffman (2013) found that social relationships, and a greater sense of social efficacy, led to more prosocial behaviours irrespective of physical deterioration at the neighbourhood level. We do not believe this is a coherent contrast.

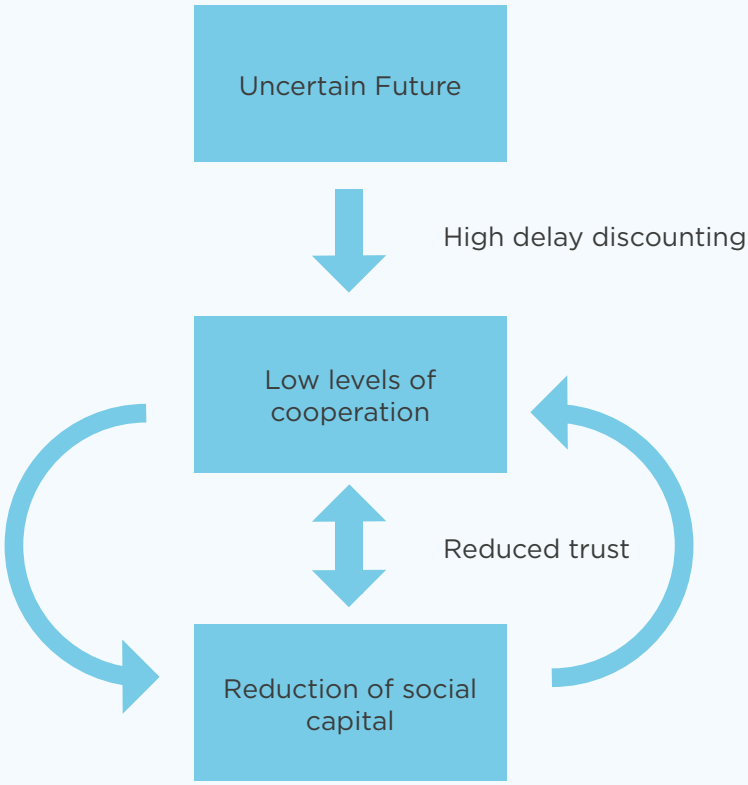
Not only does forecasting enable individuals to imagine future reciprocity with an individual presenting in the here and now, but it enables the modelling of new social relationships. This idea is captured by the concept of social capital, considered broadly as the “features of social organisation such as networks, norms,

and social trust that facilitate coordination and cooperation for mutual benefit" (Putnam, 1995, p. 67). Social capital has the ability to reduce the transactional costs of collective behaviour (Pretty and Ward, 2001) and facilitates interpersonal feedback opportunities by the communication of values and behaviours. In this way culture is developed, which can act as a collective memory as well as a collective prescription about how to act. Neighbours can provide advice to others, which can act to challenge previous habits and provide a frame of reference, whereby the behavioural norm can be assessed and adjusted to better reflect the expected behaviour (Macias and Williams, 2016; Thoyre, 2011). Interestingly, people are more altruistic towards better connected individuals in a social network, indicating a clear understanding of social capital, or future social resource (Curry and Dunbar, 2011).

Social capital has been linked to more engagement in pro-environmental behaviours as it fosters values of collective over individualistic interests (Thoyre, 2011). Differences in social capital have been found between contrasting socioeconomic populations, with more deprived populations reporting less social capital. Conversely, more affluent populations reported more trust in others and that they believed that their neighbours were more likely to look out for one another (Nettle, 2015). In other words, the more connected one feels to a community, the greater likelihood social cohesion can prevail and lead to cooperative behaviours. Research indicates that people give more in economic games when they are provided with information about the potential recipient, such as seeing them or being told their name and hobbies (Eckel and Grossman, 1996; Bohnet and Frey, 1999a; 1999b; Charness and Gneezy, 2008).

Instead of making the contrast, our claim is that risky or uncertain futures make cooperation difficult to stabilise, which, in turn, reduces the social capital of a population and makes long term future pay-offs less likely still. In other words, this becomes a vicious circle of downward degradation (as depicted in Figure 1 below).

Figure 1. Representation of the challenges in formulating cooperation within low socioeconomic populations.



Acting at this point, with social interventions designed to facilitate reciprocity, has been found to be consistently effective (Kraft-Todd et al., 2015). Kolodko and Read (2018) note that there are social and situational contexts to littering. They claim that social contexts are best dealt with through efforts to promote cooperation, including communication strategies, shared social values and territorialisation (such that individuals are associated with small patches that they have some ownership over). Situational contexts require the development of what they refer to as "new paths of least resistance" to the appropriate behavioural outcome. This can amount to innovations in bin design and placement, or financial incentives and disincentives (or punishment), both of which we consider below.

5.1 BIN DESIGN

The design and placement of bins is effectively an attempt at stimulus control (Geller et al., 1979; O'Neill et al., 1980). Early research in littering focused on preventative measures based on behaviour analytic techniques, with the basic idea being to make bins more salient discriminative (or controlling) stimuli that would then become attached to the appropriate behavioural response. In early experiments, such as those of O'Neill et al. and Geller et al., information was also posted on or near to bins in order to direct the appropriate behavioural response. The hope was that the response would generalise across bins more generally, and that the litter disposal would become entrained rather than discarding. However, in order to do this effectively experimental procedures that presented related bin stimuli would be required, along with some kind of variable interval of presentation tied to a reward structure in order to avoid extinction of the desired response (Staddon, 2016). This makes it likely that any bin redesign project will have to rely upon schedules of reward and punishment.

5.2 REWARD AND PUNISHMENT

Rewards and punishments are used in behaviour change processes more generally. Fines can be effective punishments if tied tightly to the undesired behavioural response, but can also be damaging in that they can exacerbate the problems facing low socioeconomic status individuals. Fines, as punishments, can therefore be overgeneralised as they impact on many aspects of life. As such, they lose their controlling function. Indeed, Gneezy and Rustichini (2000) found that penalties for late child pick-ups from day care rendered an increase in the undesired behaviour, possibly because the penalty payment essentially bought them the right to do so. Rewards are a commonly used method to improve performance or facilitate behaviour change and can take different forms, such as monetary or social. Again, they must be appropriately tied to the behaviour in focus.

For social scientists, rewards are designed to appeal to two primary motivations: intrinsic and extrinsic. Intrinsic motivation relates to the performance of a behaviour as a reward in its own right (e.g. enjoyment of the task), whereas extrinsic motivation is when the behaviour is performed in order to attain a reward or avoid punishment. Research has indicated that extrinsic rewards can have a negative effect on intrinsic motivation because extrinsic rewards can "crowd out" any existing intrinsic motivation. Self-determination theory (Ryan and Deci, 2000) suggests that there are three essential elements to consider when exploring motivation: autonomy (a need for choice and self-regulation over behaviour), relatedness (a need for relationships with others) and competence (a need to interact effectively with the environment). Indeed, studies have shown that when monetary rewards are offered as incentives, performance often decreases, whereas positive verbal feedback can increase performance (Deci, 1971). The concept of intrinsic motivation might best be linked to the concept of wanting something, as opposed to liking. Want implies some form of need or requirement, whereas liking is some kind of positive response. It is possible to like what one wants, but these responses are under distinct neurological control (Berridge et al., 2009). Deci suggests that money, as a reward, may "buy off" one's intrinsic motivation, whereas verbal reinforcement may be interpreted as less controlling and foster feelings of competency (Deci, 1971, p. 114). This might be reinterpreted as money being something that is required in a second order manner – it can buy many things – and as such it will operate as a general solution to a general problem. Targeted verbal reward is more directly tied to a behavioural response, by definition, and if verbal reward is something that is liked then

this will act as a discriminative stimulus far more effectively. Financial and related reward structures are also problematic because they are costly, and the reinforcement schedules required to establish a successful generalised response are not always practical (O'Neill et al., 1980). This suggests the possibility that a low contingency intermittent reward schedule (e.g. rewarding behaviour only on occasion) may render the behaviour resistant to extinction.

5.3 NETWORKS AND SOCIAL CAPITAL

Those who cooperate are more likely to benefit from future acts of reciprocity, and so making cooperative behaviours observable to others is one way in which cooperation can be sustained. Yoeli et al. (2013) applied this theory to a large-scale field experiment where they found that people were significantly more likely to sign up to an energy conservation initiative when they could be identified (as opposed to signing up with a generic ID code or receiving a monetary incentive). These findings indicate that social rewards, such as positive feedback and public recognition, may constitute an effective and less costly alternative to promote pro-environmental behaviours, and in addition foster positive feelings.

Kolodko and Read (2018), in line with the majority of scholars in this field, recommend interventions aimed at small groups. An expressed hope is that the successful targeting of small groups will lead to a tipping point for the spread of pro-environmental, anti-littering social values, presumably mediated by social network structures and key nodes between groups, perhaps through some kind of contagion model (Burt, 2000). This hope relies on notions of social capital and its categorisation into bonding, bridging and linking capital (Dahal and Adhikari, 2008). Bonding capital applies to others that one shares common traits with, such as family and close friends. This is related to kin selection (see Section 2 above). Social groups formed around these kinds of bonds are very strong, and it is of interest that organisations seeking to instil high levels of costly cooperation often invoke fictive kin mechanisms that include uniforms for similarity of appearance and the adoption of kin terms such as brother and sister (Qirko, 2009). Bridging capital refers to the ability to form ties with those who are unlike you, and this must rely on an ability to buffer free riding costs as well as model ongoing long term interactions with non-kin. Where bonding capital can help you by "getting along" in life, bridging capital can help you by "getting ahead" through providing a gateway to accessing more resources (de Souza Briggs, 1997, cited in Putnam, 2000, p. 23) but it is intrinsically risky for all the reasons discussed in Section 2 above. Research suggests that members of lower socioeconomic status have less social capital overall, but bonding capital, specifically, can act to buffer against negative health effects (Uphoff et al., 2013). Linking capital refers to ties with organisations or individuals where there is a power hierarchy, and this captures links with formal institutions. Institutions make a great effort to bind people to trust relations via legal procedures including contracts, and individuals can protect themselves with insurance. This is costly, and therefore excludes many, but in some ways this makes linking capital a less risky prospect than bridging capital. Clearly, the number of individuals with different kinds of capital in any one social grouping will impact on the nature of that local network, but also its connection to and influence over wider social networks. More specifically, social capital is a property of social network structures and can directly impact upon fitness in humans and other primates (Hawkins and Maurer, 2010; Silk et al., 2009).

As we have discussed, there are limitations on the formation of social networks due to memory and the ability to forecast. Thus far, we have discussed this in terms of the ability to stabilise cooperation, but it is also entirely possible that memory also limits the size of possible social networks, and that this has put an evolutionary limit on the size of our networks (Dunbar and Shultz, 2007; Hill and Dunbar, 2003). However, a key issue that has yet to be considered by scholars in this field is how the nature of social networks changes across urban, suburban and rural communities, in line with our discussion of the socioeconomic effects above. There is also good reason to ask how the nature of local facilities affects the number of strangers coming into an area and the opportunity to develop and maintain stable cooperative networks (Hristova et al., 2016). According to Hristova et al., some places act to enable bonding and others bridging, with large cities presenting high social entropy (or diversity), such that bridging forms of social brokerage are necessarily higher. Entropy here is a measure of social instability such

that there is a high throughput of different and new individuals. This makes repeated future interactions difficult, and, following the discussion in Section 2 above, suggests that cooperation will be hard to establish. This suggests an interaction between social and situational contexts such that aspects of physical geography yield social affordances, enabling the accumulation (or not) of social capital or particular types. We would predict patterns of littering and also differences in the uptake of litter interventions as a consequence of these distributed social capital effects.

6. OVERVIEW

While we have been critical in our evaluations of the kinds of intervention summarised by Kolodko and Read (2018), we do not dispute the efficacy of the studies they cite. Effects have clearly been won. What we are suggesting is that those effects deserve further scrutiny using the theoretical tools we have outlined above. Idiosyncrasies of local social networks, oddities of reinforcement around reward interventions, etc. will all be of value if exposed. The problem with the nudge approach is that it represents a pragmatic borrowing from multiple literatures without any effort to understand how or why interventions work. We believe this is necessarily limiting in two ways: First, it prevents thorough understanding of the problem of littering; second, we question the longevity of any effects, something that is simply never assayed. Pragmatism is laudable, but time-limited pragmatism perhaps less so.

This second point is the most salient. Our framework leads us to believe that littering behaviours are tied to a much broader fabric of social concerns, and that the best way to address the issue of littering is to bite the political bullet and see this as a key issue of inequality and a public health concern. Clearly, there are public health consequences to the build-up of unwanted items, including food and food packaging, as well as other pollutants. But where you see evidence of such future discounting you also find stressed ecologies that have definitive morbidity and mortality consequences for their inhabitants. The much publicised concerns about increases in mental health problems and loneliness are, we believe, linked to the issues of cooperation that we have discussed. Interventions designed to build sustainable social capital in complex spaces like cities, but also in dispersed rural communities, will pay dividends on many fronts, including an increased sense of custodianship of our natural environment.

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THE FUTURE OF SINGLE-USE PLASTIC BAGS: IS THE END IN SIGHT?

Pamela Yeow leads the joint MBA between Central Saint Martins and Birkbeck, London. This course takes a transformational and design-led approach to business, and launched in September 2017 with a cohort of 22 inspiring students. Pam's research interests include the role of trust and communication in managing change effectively, the attitude-behavioural gap, and how communities of practice work in reality. Recently published papers include a case study analysis of how ethical consumerism can be embedded. Pam has received various faculty and departmental grants. She has successfully supervised eight PhD candidates, and is currently supervising two.

INTRODUCTION

A lot of attention has been placed on the use of plastic bags recently. According to the Department of Environment, Food and Rural Affairs, in the UK (2007, cited in Haddock-Fraser, 2010), "62% of adults claim to have become more environmentally active in recent years". In October 2015, the UK government introduced the single-use plastic bag charge of 5p in England (Department of Environment, Food and Rural Affairs, 2018a), and the government's data shows that "the 7 main retailers issued around 83% fewer bags (over 6 billion bags fewer) in 2016 to 2017 compared to the calendar year 2014 (for which WRAP reported data). This would be equivalent to each person in the population using around 25 bags during 2016 to 2017, compared to around 140 bags a year before the charge" (Department of Environment, Food and Rural Affairs, 2018a). When the 5p single-use plastic bag charge was first introduced in Wales in 2011, this resulted in a 71% drop in usage (Warmington et al., 2016). Similar significant drops were found when a 5p charge was implemented in Northern Ireland in 2013 (Northern Ireland Direct Government Services, 2015) and Scotland in 2014 (BBC News, 2015).

The drive to charge a small amount of money for single-use plastic bags has picked up significant momentum across the world. Many other countries have had similar successes in passing legislation limiting and eliminating single-use plastic bags.

For example, the European Union has passed a directive declaring an 80% drop in plastic bag use by 2019 (Official Journal of the European Union, 2015), with countries like Germany imposing fees on excessive packaging through its Green Dot programme, which also includes plastic bags (All About Recycling in Germany, 2018). Other continents have taken on board the need to reduce plastic pollution, including Africa, Asia and Australia. For example, Malaysia recently declared that it would eliminate single-use plastic bag usage and introduce a plastic bag charge (ChannelNewsAsia, 2018). There is clear evidence that imposing a charge has led to significant drops in single-use plastic bag consumption, some even claiming an 86% reduction rate (Khan, 2018). Significantly, this drop has been almost immediate, with impacts measured as early as three months after implementation.

Activists and campaigners in this area have declared success in the reduction of single-use plastic bag usage, and many have moved on to calling for charges on plastic bottles and disposable coffee cups in the hope of producing a similar effect. While it appears that there has been a significant reduction in single-use plastic bags through the imposition of small charges by respective governments, there is scope to consider further reductions through means other than the bag charge. This article will look at what has worked and what other means can be put in place to encourage greater reduction.

WHAT WORKED?

It would be useful to understand how UK consumers were encouraged to switch their behaviours in the first place.

Terlau and Hirsch (2015) wrote about the powerful role of the attitude-behaviour gap phenomenon in understanding sustainable consumption. A complex combination of behavioural and economic psychology, it is influenced by individual, social and situational factors. Yeow et al. (2014) led an extensive discussion on how the attitude-behaviour gap can be used to explain apparent discrepancies in people's intentions to consume ethically and their subsequent behaviours. Moser and Dilling (2007) found that when people were provided with more information about the impact of climate change it did not necessarily lead to more action. Wood and Neal (2009) found that consumers sometimes act like creatures of habit, automatically repeating past behaviour with little regard for current goals and valued outcomes, and estimate that 45% of our daily actions are habitual. This means that, even if people's attitudes were altered, it does not necessarily follow that behaviour will change accordingly.

Yeow et al. (2014) wrote that a combination of both individuals and institutions play a significant role in sustaining behavioural change towards ethical consumerism. This includes having a clear message that is clearly supported by relevant institutions. In the case of single-use plastic bags, this would include the UK government introducing the 5p charge and the "big four" supermarkets using "nudge" reminders through text messages, offering loyalty points and messages in advertising dotted around the shop and aisles, combined with peer pressure (friends and family who keep up the nudge messaging and encouragement to adopt reusable bags) (Osborne, 2007).

What other methods can we utilise to decrease the use of single-use plastic bags? Can we encourage users to switch?

Nudging is a concept which proposes positive reinforcement (positive messaging and indirect suggestions) to influence and change the behaviour of groups and individuals. Thaler and Sunstein (2008) define nudging as any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives. To qualify as a nudge, the intervention must be easy and cheap to avoid. Nudges are not mandates. To encourage shoppers to buy water as opposed to fizzy drinks, putting water bottles at eye level would count as a nudge, while banning fizzy drinks would not.

Halpern and Sanders (2016) wrote an extensive review about the role of nudge units within governments to encourage people to behave in certain ways. Spanjaard and Garlin (2017) write that behavioural nudges can help to make people stop and think about what would otherwise be unconscious behaviour. In the case of the reduction of single-use plastic bags, nudging could be used to encourage more UK consumers to switch to reusable bags or consume fewer bags. Shoppers could be encouraged to purchase reusable bags by attractive reusable alternatives (Osborne, 2007). Other large supermarkets encourage shoppers to buy reusable strong bags which can be exchanged for new ones once the original has worn out. Indeed, in 2017 Tesco, one of the main supermarkets in the UK, chose to replace all 5p single-use bags with 10p reusable bags (Tesco, 2017).

Supermarkets and shops can also display the reusable options at eye level or prominently by the tills so that shoppers are reminded that the single-use options are not as readily available. Back in 2009, Marks & Spencer was the first retailer in the UK to launch a 5p charge for food bags (Osborne, 2009). While some retailers chose to charge for bags, others opted to use the carrot approach, including offering loyalty points for every bag reused. More recently, Don (2018) reports that Morrisons is the latest major supermarket to commit to removing single-use plastic bags by the end of 2018.

Nudging can help to change the perception of what "normal" is. When till operators at shops ask shoppers "Do you need a bag?" this prompts shoppers to be more conscious of the decision they are making. This can also act as a reminder of the consequences if people buy a single-use plastic bag when they see posters reminding them of the scale and impact of plastic pollution.

The use of the "celebrity" endorsement as a positive nudge is a tried and tested method. Recently, David Attenborough, the celebrated environmentalist who has produced numerous award-winning documentaries for over fifty years, created Blue Planet II in

2017 to highlight the huge negative impact of plastic on marine life. This created a zeitgeist and a platform for people to engage or re-engage with the debates and efforts around the use and reduction of plastic, in particular the single-use plastic bag. The Collins Dictionary named "single-use" as its word of the year in 2018, which reflects the increasing global awareness of environmental issues (Petter, 2018). A spokesperson from Collins said that "single-use" has seen a fourfold increase since 2013.

Finally, negative messaging on single-use plastic bags could make them "uncool", which could help nudge shoppers to either choose the reusable alternative, or even not take a bag. Plastic cups currently have messages like "useful for 10 minutes, around for decades" to discourage consumers from using them. Waitrose removed single-use disposable takeaway cups from all their stores in the autumn of 2018. It is estimated that making this change will prevent 52 million takeaway cups a year going to landfill (Waitrose, 2018). As part of their free hot beverage offer, instead of takeaway cups they offer free drinks when customers bring in their own reusable cup.

Based on recent data showing that the usage of single-use plastic bags has dropped by 86%, we know that consumers are signalling that they are willing to use alternatives or reduce their usage. Leaders in businesses can now advocate strongly for the use of alternatives, and be assured that their consumers will support them in these ethical actions.

There are critiques of the actual benefits of nudging and behavioural economics. Finighan (2015) suggests that the benefits, if any, are minute. Using the example of the nudge "success" story of the Save More Tomorrow scheme, it was found that the nudges used to encourage greater savings rates over time resulted in an insignificant increase of the national US savings rate by 0.33%. Regardless, both nudges and traditional tools can be used in tandem to help encourage prosocial change, particularly in large populations. In the case of the consumption of single-use plastic bags, we can see that the small charges of 5p in the UK have resulted in a significant drop. However, this has plateaued. With large supermarkets starting to remove 5p single-use bags and replace them with 10p recyclable bags (Tesco, 2017), one might posit that customers will eventually get used to paying for the 10p bags and usage will plateau at a similar level, as with the single-use plastic bags.

CONCLUSION

It is impressive that the UK population reduced its consumption of single-use plastic bags by significant levels within a short period after the introduction of the 5p plastic bag charge. The UK government is now considering the possibility of increasing this charge to 10p and including smaller shops and supermarkets (Department of Environment, Food and Rural Affairs, 2018b). However, there is resistance from HM Treasury about the increase to 10p for various complex reasons (Watts, 2018). Therefore, there may be merit in looking to greater efforts to promote the use of nudge methods to encourage the remaining minority of the UK population to reduce their use of single-use plastic bags.

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