

## Research

# Clean vs green: the impact of reading short stories on sustainable and healthy cleaning behaviours

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## Abstract

Fact-based information campaigns aimed at encouraging more sustainable behaviour have typically resulted in minor effects that tend not to last. Scholars in the fields of entertainment education have proposed storytelling as an alternative strategy. Most existing studies have focused on health communication, but there is increasing interest in exploring storytelling to promote pro-environmental behaviours. Our focus in this study are behaviours which have both health and environmental implications: personal cleaning, household cleaning, and laundry. In a study using both quantitative and qualitative analyses (from a survey to which 77 individuals responded), we find that messages embedded into a short story significantly changed behavioural intentions in readers across all three domains. Readers reported gaining knowledge from the stories, in terms of the specific products and practices that one could undertake and with respect to the commonly held misconception that aggressive cleaning practices in the home (e.g., high temperatures, strong chemicals) are beneficial to human health. Results have implications for interventions aimed at promoting behaviours that have joint benefits for human and environmental health.

## Article highlights

- Our findings show that self-reported behaviour three weeks after reading the stories was more sustainable than behaviours reported before reading the stories.
- These results contribute positively to the literature on the use of fictional narrative, especially solution-focused stories, as a behaviour change intervention tool.
- These findings are useful to policymakers when designing behaviour-change interventions.

**Keywords** Persuasive narrative · Personal hygiene · Energy use · Cleaning behaviour · Sustainable behaviour

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## 1 Introduction

The urgent drive to motivate more sustainable behaviour has often relied on information campaigns. Typically, these are relatively affordable, publicly acceptable (in the immediate term), and simple to develop given they rely primarily on information that is already available, e.g., in explaining what a product or system is, does, or affects (e.g., [1]). This applies to energy and water-saving behaviour in the household, including showering, laundry, and the application of cleaning products. But fact-based interventions have often been ineffective in promoting sustainability [2]. They have also failed to counter the persistent narrative that germs must be completely eradicated, no matter the cost to the planet. A further issue is that, as people are increasingly able to curate their own media content, one tends to remain preaching to the converted. Scholars in the fields of entertainment-education, health communication, and climate fiction have increasingly documented the behavioural impact of storytelling as an alternative strategy. In this study we explore the effectiveness of including information about eco-friendly cleaning methods in stories as a way to reach a wider audience. The key research aim is to determine whether messages embedded into a fictional work can change attitudes and behavioural intentions. Our focus in this study are cleaning behaviours in three domains: personal cleaning, household cleaning, and laundry.

## 2 Literature review

For over 100 years, a strong anti-germ message has been used to sell products ranging from domestic cleaners to dental paste, and antibacterial paint. Such campaigns claimed to have scientific credibility, while simultaneously prolonging germ-based myths that suited commercial agendas [3]. The legacy of increasing consumer demands to eradicate germs has come with an environmental cost. Next to heating/cooling space, heating water is typically the most energy intensive activity in domestic households,<sup>1</sup> and the hotter the water and the longer it runs for, the greater the financial and environmental cost [4]. Similarly, cleaning products that claim to remove 99% of germs can themselves incur negative health and environmental costs if over-used. This can result in a perceived trade-off between cleanliness and the environment. Past research has highlighted the impact of environmentally focussed, persuasive interventions on domestic water usage (specifically, shower length; [5]); however, the impact of information challenging hygiene related assumptions has not, to our knowledge, been explored.

### 2.1 Household cleaning

The market for antimicrobial products has escalated since the COVID-19 pandemic. These products often contain mixes of chemical agents at varying concentrations, and there is strict regulation on their use of these agents as many (if not all) can be toxic to human health and the environment. For example, volatile organic compounds (VOC) increase with the use of many biocidal products. Increasing antimicrobial resistance is also a concern [6]. Moreover, it is estimated that less than one percent of all known microorganisms are human pathogens, i.e., capable of causing disease [7]. We are increasingly discovering that our own microbial communities are key factors in our health [8], and that alternatives to chemical biocidal surface cleaners can have sufficient antimicrobial efficacy and be less aggressive to us and the environment, for example white wine vinegar at appropriate concentrations [9].

### 2.2 Laundry cleaning

A review by Abney and colleagues [10] noted the importance of temperature in laundry cleaning, with heating to 50–60 °C stated as being necessary to kill microorganisms unless a biocidal product is used. However, they also comment on the impact of the mechanical action of the wash, the effect of drying, and the impact of the cloth material, all of which affect microbial survival. The evidence for the need of high temperatures in domestic laundry processes is sparse and indeed. An early study by Blaser and colleagues [11] found no difference in microbial reduction between a wash of 71 °C and one of only 22 °C. A more recent study by Honisch et al. [12] found low temperatures to be as effective as high if either a longer wash cycle was used or activated oxygen bleach was added. It is therefore important to consider

<sup>1</sup> [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy\\_consumption\\_in\\_households#Energy\\_consumption\\_in\\_households\\_by\\_type\\_of\\_end-use](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_consumption_in_households#Energy_consumption_in_households_by_type_of_end-use)

the multifactorial aspects of the washing process, along with the immune status of the individual, in determining the actual risk. Indeed, when considering standards used for processing of health and social care linens (Health Technical Memorandum (HTM) 01–04 and BS EN 14065:2016 in the UK), a framework is used for local decision making in determining risk and critical control points. This is an acknowledgement that not all linens can be expected to pose equivalent risks to patients and staff.

Recent product development has focused on how to reduce temperatures while ensuring effective cleaning. The use of natural products as laundry agents has also been considered with acetic acid (found in vinegar) found to have disinfecting properties in a simulated laundry cycle [9], and studies are now being published looking at alternative environmentally friendly options, for example nanoprotease [13].

### 2.3 Personal hygiene—showering

There is no direct evidence to indicate the need for showering frequency or the use of a certain temperatures or product types. Our skin has its own microbiome which is a key defence against pathogenic species, and using higher temperatures for showering or hand washing can directly impact the skin microbiome and leave the skin more susceptible to infection [14]. Gupta and colleagues [15] thus advocate promoting healthy microbial diversity into the hygiene hypothesis rather than it being a conflicting factor.

### 2.4 Behavioural change interventions

Dietz et al. [16] estimated that the ‘reasonably achievable emissions reductions’ from household actions amount to 20%; however, the majority of campaigns to reduce the environmental impacts of household behaviours have failed to be fruitful [2]. Stern [17] suggested that looking at interventions in isolation can lead to an underestimation and more attention should be paid to the fact that many interventions work well in combination—a finding supported by later meta-analyses of interventions to reduce household energy demand [18]. Therefore, it is worth looking into alternative/additional mechanisms for encouraging pro-environmental behaviours.

The concept of ‘entertainment education’ emerged first in the health domain. Reviews of story-based interventions generally indicate ‘small but significant’ impacts on knowledge, opinions, intentions, and actions, with knowledge being the outcome with the largest effect [19]. Education entertainment often adopts similar tactics as traditional campaigns, such as providing information on the desired behaviour and highlighting benefits of targeted actions. The additional benefit is that the message is implicit rather than explicit, emerging naturally from the plot and characters’ story arcs. This can mitigate against psychological resistance to the message, a barrier that has been observed in previous studies [20].

Slater and Rouner [21] propose that immersion in narratives and empathy with key characters can reduce resistance by appealing to the peripheral, less conscious mode of processing. This is explained with reference to the extended elaboration likelihood model which proposes that immersion in a dramatic story makes viewers/readers less critical and less likely to challenge the underlying message [22]. Additionally, emotional identification with the aims of protagonist can lead readers to adopt the protagonist’s views as their own [23]. There is evidence also of an ‘absolute sleeper effect’ whereby the persuasive effects of the message embedded in the fictional narrative persist over time and become integrated into real-world knowledge [24]. Such effects may occur through the process of narrative transportation, whereby immersion in a story line amplifies story-consistent beliefs and values [25].

To date there has been limited research on the effectiveness of storytelling as an intervention to promote pro-environmental behaviours. From a survey of readers of climate fiction, Schneider-Mayerson [26] concluded that while it raised awareness it did not necessarily lead to effective actions to mitigate climate change. Many of the behaviours prompted by reading the sampled novels were insufficient to address climate injustice. For instance, *Flight Behavior* only motivated one reader to begin the use of recycled carrier bags—a necessary but insignificant reaction to the gravity of the climate crisis.

Another finding was that such stories can also lead to negative emotions which could be counterproductive [26]. Indeed, evidence within social marketing suggests that narratives based on fear and guilt tend to cause self-protection more than pro-social behaviour [27], while environmental information focussing on problems (rather than solutions) are ineffective at activating values related to pro-environmental consumption behaviours [28]. In contrast, narratives that feature positive solutions may have greater potential to motivate readers. This hypothesis was tested by Baden [29] in a study which asked readers to comment on four short stories. The eco-fiction stories containing positive solutions were found to lead to greater pro-environmental intentions than stories of catastrophe. A similar finding was reported

by Parant and colleagues [30] who noted that persuasive environmental interventions were more effective when they include information about solutions.

A follow up study [31] reported how climate fiction stories cause a modest yet significant impact on multiple opinions and beliefs. However, positive impacts dwindled to 'statistical non-significance' after one month. A factor that may explain such findings is that studies that target those who choose to read climate fiction may be preaching to the converted. Berger and colleagues [32] explore tipping points in pro-environmental norm diffusion and suggest that targeting those who are already favourable limits the potential for impact. Baden [33] therefore proposes that smuggling desired behaviours and attitudes within stories aimed at a mainstream audience has greater potential for impact. A study into readers' responses to the rom-com *Habitat Man*, found that 98% adopted at least one green alternative as a result of reading the book [33].

## 2.5 Summary

To summarise, attitudes towards cleaning and misconceptions about the need for hot water and biocidal cleaning products can have harmful environmental and health impacts. Our key goal, therefore, was to address misconceptions that all bacteria are harmful and that domestic environments require the same level of sterility and cleaning as hospitals. Many interventions aiming to encourage pro-environmental household behaviours report modest effects which tend not to last. Common barriers reported are targeting populations that are already relatively 'green' which limits the gains that can be made, or resistance and reactance against persuasion techniques. Numerous scholars in the field suggest that a varied package of interventions can result in greater gains. In this research, we explore the use of storytelling as a means to address some of these barriers. Our hypothesis, based on the literature, is that incorporating information into short stories that address misconceptions about bacteria and encourage more eco-friendly cleaning methods will result in changes in attitudes relating to cleaning and bacteria. We investigate whether such covert messaging in stories can lead to changes in behavioural intentions relating to amount/type of products used in cleaning, frequency of cleaning and temperature of water across household cleaning, personal cleaning, and laundry.

## 3 Method

### 3.1 Sourcing of stories

A practical issue is how to source stories that are both educational and entertaining. The proposed mechanisms by which stories can influence behaviour depend upon the extent of immersion and 'narrative transportation' felt by readers. Writing stories that can engage readers to such an extent is a rare skill that we cannot expect most sustainability experts to possess. Therefore, a secondary objective of this research was to test out various means to source such stories. We adopted two distinct approaches. The first was to source writers from ghost-writing sites and offer them £500 to write a story of between 1000 and 3000 words. We sourced three writers through such means and offered them a choice of story plots with suggestions how to incorporate the desired information.<sup>2</sup> The benefit of this approach is that we are using experienced writers. The risk is that we may end up paying for a story that is not what we had hoped for. We found that two out of the three stories were of good enough quality and fit the specifications sufficiently to use, so there was some wastage from this method.

Another mechanism was using the Green Stories website<sup>3</sup> which has run 19 competitions since it was set up in 2018 with the explicit aim of encouraging writers to embed green solutions in fiction. A prize of £500 was offered for the winner. The benefits are that we can source a larger number of stories to choose from. The risks are that they may mostly be poor quality. The short story competition attracted 177 entries. The usual judges for the Green Stories competition rated the stories initially to weed out those that were poorly written and did not meet the criteria. A second judging round, which included two judges from the current authors, served to identify the best four stories generated by the competition. Each was rated by four to five judges. Three that were not the winner were paid runner up prizes of £100

<sup>2</sup> <https://www.greenstories.org.uk/upcoming-competitions/short-story-clean-vs-green/#story-ideas>

<sup>3</sup> <https://www.greenstories.org.uk/>

each. We therefore ended up with six short stories (four from the competition and two from ghost-writers) of varying genres which all approached the topic from different angles (Appendix 1).

With respect to cost-effectiveness, if the full costs of running the competition are included, such as hosting the website, the submission platform, prizes and promotion of competition, then the competition was a more expensive choice. However, the additional costs of adding this competition to a platform that was already in existence resulted in the two methods of sourcing stories being broadly equivalent in terms of cost.

### 3.2 Study design and sampling

The study ran from August to October 2022. Participants were sourced via a Facebook advert offering £30 for readers to read six short stories and complete three surveys. We specified that the target audience should live in the UK, be over 18 and listed reading as a hobby and use an eReader. The first survey was completed before reading the stories (pre-survey) (n = 252 participants). The second survey was completed directly after reading the stories (post-survey) (n = 106 participants). The third survey was completed three weeks after reading the stories (follow-up-survey) (n = 86 participants). Participants that had not completed all three surveys, completed the survey multiple times, or had incomplete responses were removed, leaving a total sample of 77. Upon the completion of all surveys, the participants received a £30 voucher.

### 3.3 Measures

The surveys measured behaviour change across three cleaning dimensions: laundry, personal hygiene, and domestic cleaning. All behavioural measures were developed specifically for the purposes of this study. Whilst the pre-survey and follow-up-survey measured actual reported behaviour, the post-survey asked about participants' behavioural intentions using the same measurement scales. The first question explored laundry behaviours and contained four items. The first asked about the temperature at which respondents washed their laundry before reading the stories, their intentions after reading the stories, or their actual reported behaviour three weeks after reading the stories. Data were collected on a five-point Likert scale with one being the coldest possible setting and five being the hottest possible setting. The second item asked about the temperature used when doing a 'hot wash', inviting a numerical response (in degrees Celsius). The third item asked how often respondents washed clothes, inviting responses on a scale from one (after each use) to three (when dirty). The fourth item asked about the quantity of detergent used, inviting a response on a scale from one (as much as possible) to five (as little as possible).

Personal hygiene behaviours were measured using four items. The first asked about the respondents' shower temperature, inviting a response on a scale from one (coldest possible) to five (hottest possible). The second item asked about shower regularity, inviting a response from one (multiple times per day) to five (once per week). The third items asked for typical shower length, inviting respondents to indicate the length in minutes. The fourth asked respondents about the quantity of cleaning products used, from one (large amounts) to three (minimal amounts). The domestic cleaning section contained three items. The first asked respondents how often they cleaned their home, inviting a response from one (multiple times per day) to five (less than once per week). The second item asked about the types of products used, inviting a response from one (the strongest possible) to four (natural cleaners). The third item asked about the quantity of cleaning products used, inviting a response from one (large amounts) to three (minimal amounts).

The pre-survey included items on socio-demographic information, including gender, age, household composition, and the countries in which the participants grew-up and now currently live. Respondents were also asked 'what is your attitude towards climate change' and invited to respond on a five-point scale from 'not concerned at all' to 'very concerned'. The post-survey and follow-up-survey also contained open questions inviting free text responses (details below) to provide further insight into the reasons behind the stories' effectiveness (or ineffectiveness) at influencing attitudes and behaviours.

### 3.4 Thematic analysis

Free-text responses were invited to an open-ended question posed in the post-survey: *"If any of the stories inspired you to change your household cleaning practices/products, please give more details in your own words. For example, what aspects of the story were inspirational? What kinds of change did they inspire (e.g., using less/different cleaning product, or washing at lower temperatures or less frequently)?"* The responses were subjected to inductive thematic analysis whereby a categorisation scheme was developed that identified patterns (or themes) in the responses provided by participants (in line

with [34]). Several iterations were required to arrive at a thematic coding scheme. A first pass served as a familiarisation exercise, the second to develop an initial scheme, a third to apply the scheme and make changes where appropriate, and a fourth to re-apply the finalised scheme. The coding scheme comprised eight themes subdivided into a total of 22 sub-themes.

The coding scheme was then applied to the 82 free-text responses provided to the follow-up survey question “*In your own words, please share with us what aspects of what stories were most effective in changing your behaviours.*” That second thematic coding process resulted in the addition of three further themes (under which were eight sub-themes). A single analyst performed all analyses.

Responses across the two data sets (post and follow-up) were then subjected to an inter-rater agreement analysis to validate the reliability of the thematic coding scheme. As a single response could have attracted more than one thematic code (e.g., “*washing at lower temperatures, using different cleaning products*” refers to both products and practices) the responses were first broken down into individual segments to which a single code was applied. Ten percent of the individual segments were then randomly selected from each data set. A second individual not previously familiar with the coding scheme was then introduced to the thematic codes and asked to assign one thematic code to each. Cohen’s kappa and percentage agreement were then calculated. Although inter coder reliability is a controversial topic in qualitative research, and Braun and Clarke do not advocate for such a practice [35], it has transparency, communicability, and systematicity benefits [36], hence our use of it here.

### 3.5 Ethics statement

The research was reviewed and approved by University of Southampton FEPS Ethics Committee, prior to data collection, application reference number: ERGO/FEPS/72946. Informed Consent was obtained from all the participants involved in the study as per university guidelines.

## 4 Results

### 4.1 Quantitative analysis

#### 4.1.1 Sample

The sample consisted of 71 female respondents and six males. All respondents resided in the UK at the time of the research. Five of the respondents were born outside of the UK and 72 were UK nationals. On attitude towards climate change, 42% were partially to somewhat concerned, while 58% were strongly to very concerned. Table 1 summarises responses to the demographic questions.

#### 4.1.2 Laundry behaviour change

Descriptive statistics for the four questions asked in this section are presented in Table 2. A Friedman test revealed a statistically significant difference in laundry temperatures between the three time points,  $\chi^2(2) = 23.160$ ,  $p = < 0.001$ ,  $W = 0.150$ . Post hoc analysis with Wilcoxon signed-rank tests, with Bonferroni correction applied, revealed a statistically significant reduction in laundry temperature in the post-survey compared to the pre-survey ( $Z = -3.840$ ,  $p = < 0.001$ ,  $r = -0.438$ ). There was also a statistically significant difference between the follow-up-survey and pre-survey results ( $Z = -2.921$ ,  $p = 0.003$ ,  $r = -0.333$ ). There were no significant differences between the follow-up-survey and post-survey results ( $Z = -1.533$ ,  $p = 0.125$ ,  $r = -0.175$ ).

The second laundry-related question asked about the temperature that respondents used for a ‘hot wash’. As the dependent variable “hot wash temperature” was continuous, we used a one-way repeated measures ANOVA to compare the mean differences over time. The ANOVA, with a Greenhouse–Geisser correction applied, determined that mean ‘hot wash’ temperatures significantly differed between time points ( $F = 9.239$ ,  $p < 0.001$ ). Post-hoc analysis with a Bonferroni adjustment revealed that temperatures reported in the post-survey were significantly lower than those reported in the pre-survey (6.31 (95% CI 2.63 to 9.99) degrees C,  $p < 0.001$ ) and those reported in the follow-up survey (−4.75 (95% CI −8.47 to −1.04) degrees C,  $p = 0.008$ ). The difference between pre-survey and follow-up-survey results was not statistically significant (1.56 (95% CI −2.34 to 5.46) degrees C,  $p = 0.99$ ).

**Table 1** Participants characteristics

Characteristics	Scale	Readers (no.)	Readers (%)
Age	18–29	20	26
	30–49	34	44
	50–64	16	21
	65–74	7	9
	75 and over	0	0
	Rather not say	0	0
Gender	Female	71	92
	Male	6	8
	Non-binary, third gender	0	0
	Prefer to self-describe	0	0
	Rather not say	0	0
Household type	One person	12	16
	Couple, no dependent children	23	30
	Couple with dependent child(ren)	23	30
	Single parent and dependent child(ren)	6	8
	Other multi-person household	13	17
	Rather not say	0	0
Continent in which grew-up	Africa	1	1
	America	0	0
	Asia	4	5
	Australia	0	0
	Europe	72	94
Continent in which live currently	Africa	0	0
	America	0	0
	Asia	0	0
	Australia	0	0
	Europe	100	100
Attitude towards climate change	Not concerned at all	0	0
	Partial concern	6	8
	Somewhat concerned	26	34
	Strong concern	25	32
	Very concerned	20	26
	Rather not say	0	0

**Table 2** Means (and standard deviations) of the responses to the four questions concerning laundry temperatures, regularity, and detergent quantity

	Pre-survey	Post-survey	Follow-up
Laundry temperature (n = 77) 1 = lowest, 5 = highest	2.96 (1.49)	2.34 (1.27)	2.50 (1.09)
'Hot wash' temperature (n = 61) In temperature (°C)	52.4 (14.5)	46.1 (11.6)	50.8 (13.5)
Laundry use (n = 76) 1 = after each use, 3 = when dirty	1.96 (0.53)	2.21 (0.52)	2.07 (0.44)
Detergent quantity (n = 76) 1 = as much as possible, 5 = as little as possible	4.64 (1.48)	5.88 (1.47)	5.29 (1.64)

Next, we asked how soon after using a piece of clothing the respondents decided to wash it, using a three-point Likert scale, with one being after each use, and three being only when clearly dirty/smelly. The Friedman test was used to compare means between the pre-survey, post-test survey and follow-up-survey results. There was a statistically

significant difference in laundry use depending on the time at which the survey was taken,  $\chi^2(2) = 19.316, p = < 0.001, W = 0.127$ . Post hoc analysis with Wilcoxon signed-rank tests, with Bonferroni correction applied, showed a statistically significant difference between pre-survey and post-survey results ( $Z = -3.800, p = < 0.001, r = -0.436$ ). There was also a statistically significant difference between the post-survey and follow-up-survey results ( $Z = -2.668, p = 0.008, r = -0.306$ ). There were no significant differences between the follow-up-survey and pre-survey results ( $Z = -2.138, p = 0.33, r = -0.245$ ).

Lastly for this section, we asked how much laundry detergent respondents used or intended to use, a five-point Likert scale, with one being as much as possible and five being as little as possible. Descriptive statistics are displayed in Table 2. A Friedman test indicated group differences were statistically significant,  $\chi^2(2) = 36.029, p = < 0.001, W = 0.237$ . Post hoc analysis with Wilcoxon signed-rank tests, with the Bonferroni correction applied, revealed significant differences between the post-survey and pre-survey ( $Z = -5.695, p = < 0.001, r = -0.653$ ), the post-survey and follow-up survey ( $Z = -2.811, p = 0.005, r = -0.322$ ), and between the pre-survey and follow-up survey ( $Z = -3.484, p = < 0.001, r = -0.400$ ).

### 4.1.3 Personal care behaviour change

The first question concerning personal hygiene asked how hot a respondent's bath or shower would be, on a five-point Likert scale from the coldest possible to the hottest possible setting. Descriptive statistics for this and the other questions in this section are displayed in Table 3. A Friedman test indicated there to be statistically significant difference in results across the three survey time points,  $\chi^2(2) = 28.366, p = < 0.001, W = 0.184$ . Post hoc analysis with Wilcoxon signed-rank tests, with a Bonferroni correction applied, showed statistically significant differences between results the post-survey and pre-survey ( $Z = -4.874, p = < 0.001, r = -0.555$ ), and the post-survey and follow-up survey ( $Z = -3.427, p = < 0.001, r = -0.391$ ). The follow-up survey results did not differ significantly to pre-survey results ( $Z = -2.167, p = < 0.030, r = -0.247$ ).

We also asked about respondents' behaviours and intentions concerning how often they showered or bathed. This construct was measured on a five-point scale from multiple times a day to once a week. A Friedman test revealed significant differences between results collected in the pre-, post-, and follow-up-surveys,  $\chi^2(2) = 30.094, p = < 0.001, W = 0.195$ . Post hoc analysis with Wilcoxon signed-rank tests, with a Bonferroni correction applied, indicated statistically significant differences in shower or bath frequency between the post-survey and pre-survey ( $Z = -4.456, p = < 0.001, r = -0.508$ ), between the post-survey and follow-up-survey ( $Z = -2.496, p = 0.013, r = -0.284$ ) and between the pre-survey and follow-up-survey ( $Z = -3.350, p = < 0.001, r = -0.382$ ).

Next, we asked respondents to state for how long they typically showered in minutes. The dependent variable was continuous (measured in minutes, rather than on an ordinal scale), hence a repeated measures ANOVA was used. The data was cleaned to remove answers that gave vague responses, e.g., "as short as possible". If a range was provided e.g., 5–10 min, the data point was recoded to the highest number provided, i.e. 10 min. The study assumes the highest number rather than the average, as there is no related information on the frequency of the shower duration, i.e. one participant may take six 5 min shower and one 10 min shower per week, or six 10 min shower and one 5 min shower per week. The results of the ANOVA indicated a significant time effect, Wilks' Lambda = 0.62,  $F(2, 70) = 21.089, p = < 0.001, \eta^2 = 0.38$ . Post-hoc, pairwise comparisons (with Bonferroni correction applied) showed each to be significant at the  $p < 0.001$  level, except

**Table 3** Means (and standard deviations) of the responses to the four questions concerning personal hygiene temperatures, regularity, shower length, and product quantity

	Pre-survey	Post-survey	Follow-up
Shower / bath temperature (n = 77) 1 = coldest possible, 5 = hottest possible	4.25 (0.63)	3.58 (0.94)	4.03 (0.81)
Showering / bathing regularity (n = 77) 1 = multiple times per day, 5 = once per week	2.60 (0.75)	3.03 (0.95)	2.83 (0.88)
Typical shower length (n = 77) In minutes	9.25 (4.67)	7.12 (3.72)	7.82 (4.09)
Cleaning product quantity (n = 77) 1 = large amounts, 3 = minimal amounts	2.22 (0.48)	2.83 (0.38)	2.62 (0.49)

between the post-survey and follow-up-survey, which was not significant ( $p = 0.11$ ). There was a significant decrease of showering in minutes over time, suggesting that reading the stories did lead to a reduction in showering time.

The final question in this section asked how much cleaning a respondent used when showering or bathing. This was measured on a three-point scale ranging from large amounts to minimum amounts. A Friedman test indicated a statistically significant difference across survey time points,  $\chi^2(2) = 59.280$ ,  $p = < 0.001$ ,  $W = 0.385$ . Post hoc analysis with Wilcoxon signed-rank tests with a Bonferroni correction applied, indicated statistically significant differences in results between the post-test and pre-survey ( $Z = -6.451$ ,  $p = < 0.001$ ,  $r = -0.735$ ), between the post-survey and follow-up-survey ( $Z = -3.024$ ,  $p = 0.002$ ,  $r = -0.345$ ), and between the pre-survey and follow-up-survey ( $Z = -5.240$ ,  $p = < 0.001$ ,  $r = -0.597$ ).

#### 4.1.4 Domestic cleaning

In this section of the survey, we explored respondents' domestic cleaning practices. The first question referred to the frequency with which the respondents' home is cleaned, measured on a four-point scale ranging from multiple times a day to once a week. An 'other' option was included. The consensus of respondents that had selected 'other' was either less frequently than once a week or it depended on the object being cleaned e.g., "Some things are cleaned regularly e.g., surfaces wiped, but it might be a few weeks before I Hoover etc.". Due to the nature of responses, the 'other' option was recoded to 'less often than once a week'. A Friedman test revealed no statistically significant difference in results,  $\chi^2(2) = 5.496$ ,  $p = 0.064$ ,  $W = 0.036$ . Table 4 displays the descriptive statistics for this and the other two questions in this section.

Respondents were then asked about the type of cleaning product they used on a four-point scale, including "the strongest possible cleaner" (one), "a standard cleaner" (two), "a probiotic cleaner" (three), to a "a natural cleaner (e.g. bicarbonate of soda and white vinegar)". A fifth 'other' option was included to capture responses that did not fall into the categories provided. Most responses tended to highlight a mixture of natural cleaners and standard cleaners e.g., "Combination standard and eco—whatever is cheapest" therefore the response was recoded to reflect its new position in between standard and natural cleaners. Missing values were replaced with the group average. A Friedman test revealed a statistically significant difference in domestic cleaning product choice depending on the time at which the survey was taken,  $\chi^2(2) = 84.567$ ,  $p = < 0.001$ ,  $W = 0.549$ . Post hoc analysis with Wilcoxon signed-rank tests, with a Bonferroni correction applied, indicated statistically significant differences between post-survey and pre-survey results ( $Z = -6.841$ ,  $p = < 0.001$ ,  $r = -0.780$ ), between follow-up-survey and post-survey results ( $Z = -4.876$ ,  $p = < 0.001$ ,  $r = -0.556$ ), and between follow-up-survey and pre-survey results ( $Z = -4.295$ ,  $p = < 0.001$ ,  $r = -0.489$ ).

The final question asked respondents about their use of cleaning products over time and was measured on a three-point scale, ranging from one, large amounts to three, minimum amounts. A Friedman test revealed there to be statistically significant differences between responses given at the three times points,  $\chi^2(2) = 74.802$ ,  $p = < 0.001$ ,  $W = 0.486$ . Post hoc analysis with Wilcoxon signed-rank tests, with a Bonferroni correction applied, showed significant differences between post-survey and pre-survey results ( $Z = -7.086$ ,  $p = < 0.001$ ,  $r = -0.808$ ), between follow-up-survey and post-survey results ( $Z = -3.400$ ,  $p = < 0.001$ ,  $r = -0.387$ ), and between follow-up-survey and pre-survey results ( $Z = -5.778$ ,  $p = < 0.001$ ,  $r = -0.658$ ).

**Table 4** Means (and standard deviations) of the responses to the three questions concerning home cleaning frequency, types of products used, and amounts of products used

	Pre-survey	Post-survey	Follow-up
Home cleaning frequency (n = 77) 1 = multiple times per day, 5 = less than once per week	3.67 (1.05)	3.85 (0.88)	3.92 (0.89)
Type of cleaning product (n = 77) 1 = strongest possible, 4 = natural cleaner	2.13 (0.53)	3.36 (0.83)	2.70 (0.92)
Cleaning product quantity (n = 77) 1 = large amounts, 3 = minimal amounts	2.14 (0.45)	2.84 (0.37)	2.62 (0.51)

**Table 5** Thematic coding scheme summarising parent and sub-themes, with descriptions and representative quotes from the responses to the open questions asked in the post-survey (77 responses) and the follow-up survey (82 responses)

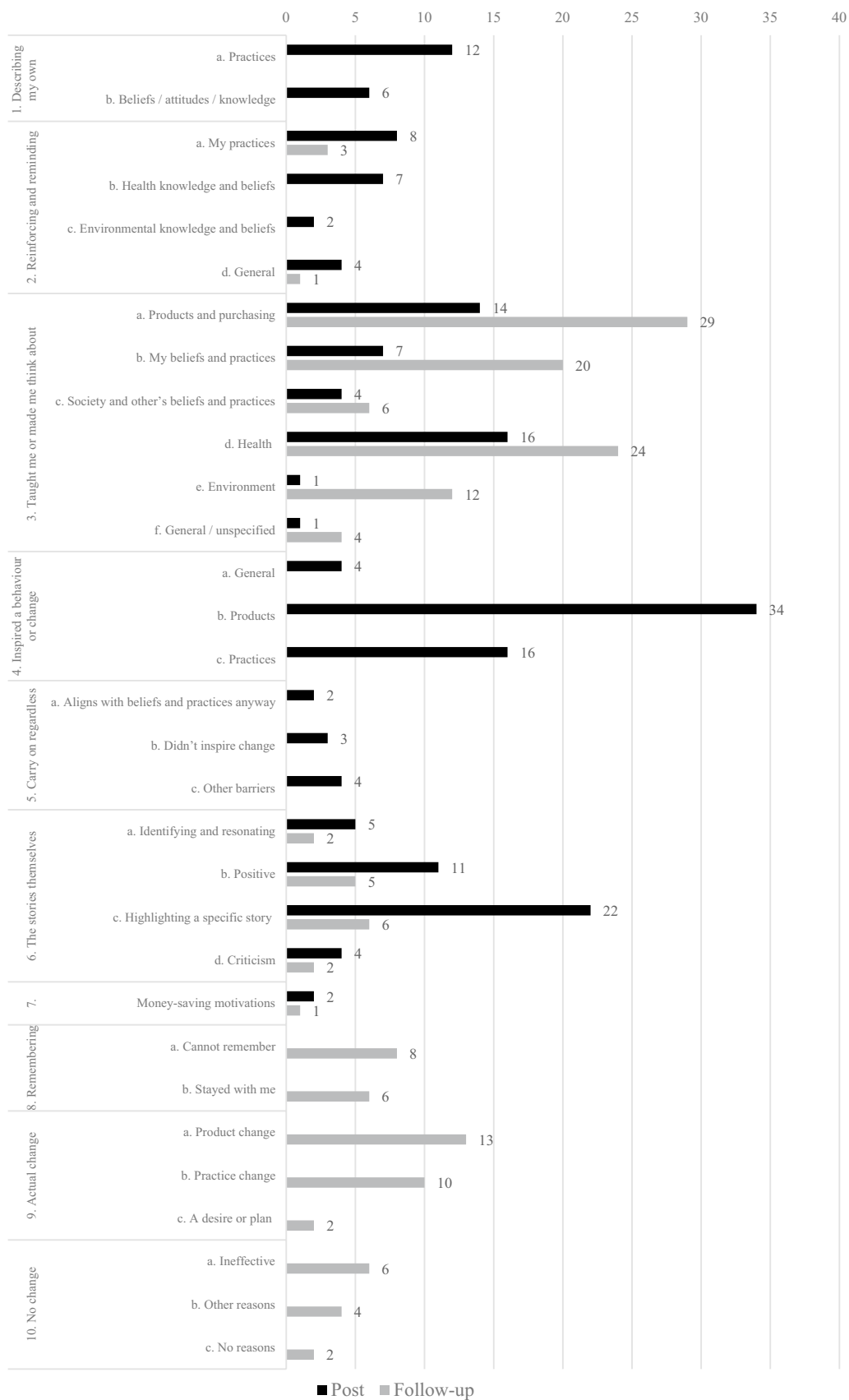
Theme	Sub-theme	Description	Quote
1. Describing my own	a. Practices	Comments describing what a respondent already does, without directly linking to stories	"I clean very regularly because, like the character in Germ Counselling, I'm very bothered by dirt" ppt 22
	b. Beliefs / attitudes / knowledge	Comments describing what a respondent already believes or knows, without directly linking to stories	"I've never been a big clean freak and always more on the side of a bit of exposure to different bacteria is good for the immune system" ppt 37
2. Reinforcing and reminding	a. My practices	Comments describing what a respondent already does, framed in terms of the stories reinforcing those practices or reminding them of the reasons	"With regards to my current practices, I believe I'm reasonably on track with the theme of the stories in that I tend to lean towards a more natural aspect" ppt 6
	b. Health knowledge and beliefs	Comments describing a respondent's existing health beliefs and knowledge, framed in terms of the stories reinforcing those beliefs	"Just a general reminder that we can be too clean and harm our immune system" ppt 65
	c. Environmental knowledge and beliefs	Comments describing a respondent's existing environmental beliefs and knowledge, framed in terms of the stories reinforcing those beliefs	"It wasn't so much that the stories presented new information, more that they reminded me that there was an ethical duty (e.g. pointed out really well by Mostly For You) in buying/making environmental products" ppt 13
3. Taught me or made me think about	d. General	General, non-specific comments about having their knowledge or beliefs reinforced, or being reminded about what a respondent already knew	"The stories collectively reminded me to be more aware of natural cleaning products and how effective changes can be in making an impact" ppt 9
	a. Products and purchasing	Highlighting where stories taught, made a respondent think about, or be more aware of cleaning and hygiene products (without mentioning planned behaviour change)	"The lady with the cleaning business was inspiring because she gave details of what to use instead of chemicals" ppt 35
	b. My beliefs and practices	Highlighting where stories taught, made a respondent think about, or be more aware of their exiting behaviours and beliefs (without mentioning planned behaviour change)	"some of the stories made me think I maybe should get washed less often and do laundry less often" ppt 52
	c. Society and other's beliefs and practices	Highlighting where stories taught, made a respondent think about, or be more aware of other's or society's beliefs or practices	"Made me think about how much of the marketing behind products is about capitalism not health" ppt 52
	d. Health	Highlighting where stories taught, made a respondent think about, or be more aware of something related to health	"Being more aware of the importance of bacteria—not seeing it all as 'bad', therefore thinking about what 'clean' really means or requires" ppt 30
	e. Environment	Highlighting where stories taught, made a respondent think about, or be more aware of something related to the environment	"Made me think about using less products, effect of my actions on the environment" ppt 48
f. General / unspecified	General comment stating that the stories made a person think, without specifying the subject	"the stories that presented either a children's perspective, or how children might be targeted, did make me think" ppt 38	

Table 5 (continued)

Theme	Sub-theme	Description	Quote
4. Inspired a behaviour or change	a. General	Inspiration to change or to do further research without referring to a specific activity or product	"looking after the microbiome of myself and my home more" ppt 7
	b. Products	Inspiration to investigate or switch to green or home-made products	"I will definitely be trying natural cleaning products for my home next!" ppt 49
	c. Practices	Inspiration to change one's practices, including length of showers, temperatures, amounts of product, etc	"Will use less products than before" pt 67
5. Carry on regardless	a. Aligns with beliefs and practices anyway	Commenting that the stories did not encourage change as the respondent did or believed those things already	"No because I do it anyway" ppt 16
	b. Didn't inspire change	Unqualified comment that the stories did not encourage change with an implication that the stories were ineffective at encouraging change	"None of the stories really inspired a change in my behaviour" ppt 4
	c. Other barriers	Comments highlighting other, much stronger barriers to or drivers of behaviour change	"If eco-products were cheaper, that would be the biggest thing that would change my usage... not from reading stories that laboured a point" ppt 41
6. The stories themselves	a. Identifying and resonating	Comments describing how a respondent identified with or relating to characters or with ideas encouraging behaviour change	"the play of characters and stories made me feel that this could be an incident in my life too, instead of conveying the message like a preaching" ppt 17
	b. Positive	Comments highlighting a positive aspect of the narrative itself, generally or more specifically for encouraging behaviour change	"The story was well written so pulled me in, made me feel something" ppt 68
	c. Highlighting a specific story	Comments single out or highlighting one or more specific stories by name	"Definitely the girl who worked in the cleaning brand company!" ppt 47
7. Money	d. Criticism	Of the stories themselves, including comments suggesting they were poorly written, preachy, laboured, or unbelievable	"They felt like they were wrote [sic] by conspiracy theorists" ppt 59
	Money-saving motivations	Comments discussing a money saving (rather than health or environmental) motivation to change	"It made me want to try natural stuff, mainly cause it's cheaper" ppt 35
	Unique to follow up survey	Comments describing the inability to remember details hence unable to comment further	"It's a while now since I read the stories, so it's hard to recall much detail" ppt 63
8. Remembering	b. Stayed with me	Comments specifically mentioning a story or aspect that stuck in the mind of the respondent	"The story about the microbiome and the father and daughter story stayed in my mind" ppt 27
	a. Product change	Description of actual behaviour change related to products, including researching about a product (but not just thinking about it)	"I'm currently looking into ecoball laundry detergents" ppt 7

Table 5 (continued)

Theme	Sub-theme	Description	Quote
10. No change	b. Practice change	Description of actual behaviour change related to practices, including researching about a product (but not just thinking about it)	"The way how Miriam changed her cleaning habits for sake of her customer's health has made me using less harsh cleaners at my home too." Ppt 15
		Descriptions of having thought about or planned something without mention of actual performance of behaviour	"I recall a sense of poignancy that may have triggered an innate 'desire to help'" ppt 75
	a. Ineffective	Comments stating (implicitly or explicitly) that the stories were ineffective at encouraging behaviour change	"None, thought they were all ridiculous. Had no bearing on my cleaning activities." Ppt 39
		Comments describing a lack of behaviour change due to other barriers, including (perceived) cleanliness requirements and using up products	"I have a physical job so still feel the need to shower daily and wash clothes often" ppt 8
	c. No reasons	Comments describing a lack of behaviour change without further elaboration (i.e., reasons unclear)	"I'm not sure my behaviours have changed dramatically" ppt 31



**Fig. 1** Graph indicating the presence of each theme in the two data sets. Note that themes 8 to 10 were added following analysis of the follow-up survey responses

## 4.2 Thematic analysis

As described in the method section, responses to the open-ended questions were subjected to thematic analysis. The average length of responses provided to the question posed in the post-survey was 39.5 words ( $SD = 45.3$ , range three to 274). A total of 2960 words were provided by the 77 respondents that answered the question. In the follow-up survey, responses were, on average, 30.6 words long ( $SD = 23.5$ , range seven to 110), with a total of 2510 words of text provided across the 82 responses. The thematic coding scheme categorising the responses across the two data sets is presented in Table 5, with a description of each sub-theme and an example quote. Figure 1 displays the number of times each theme was identified in each of the two response sets.

The number of themes identified in each participant's response to the post survey question ranged from one to 12 ( $M = 2.5$ ,  $SD = 1.8$ ), with a total of 189 individual segments to which a single theme was applied. For the follow-up survey questions, each response contained an average of 2.1 themes ( $SD = 1.2$ ), with a range of zero to six (with one respondent providing a response not connected to the question, hence no theme applied). A total of 171 individual segments were identified to which a single theme could be applied. The inter-rater reliability analysis was therefore undertaken using 19 segments from the post survey data set, and 17 from the follow-up survey data set. For the post-survey analysis, Cohen's kappa was calculated at 0.94 ( $p < 0.001$ ) and percentage agreement was 94%, indicating excellent agreement. For the follow-up survey analysis, Cohen's kappa was calculated at 0.74 ( $p < 0.001$ ) and percentage agreement was 82%, indicating very good agreement. Given these figures, the themes identified were considered a valid representation of the data collected [37].

Three themes were added following analysis of the follow-up survey hence do not appear in the responses to the post survey. Moreover, three of the themes initially identified did not appear in the responses to the follow-up survey. Themes four (*Inspired a behaviour or change*) and five (*Carry on regardless*) were absent due to the three additional themes encompassing such remarks. Theme one (*Describing my own...*) was absent for its own sake, i.e., no respondent discussed their own current practices in the same way as they had done in response to the post survey. This is likely due to question wording, with the follow-up question asking specifically "...what aspects of what stories were most effective in changing your behaviours", rather than asking for general details around practices, as was asked in the post survey.

In the post-survey, several respondents took the opportunity to describe their own current practices, or their beliefs and attitudes, and how the stories reinforced or reminded them of why they undertake those practices (or hold those beliefs and/or attitudes). More referred to health beliefs in this way compared to environmental beliefs, i.e., participants spoke more of the over-use of cleaning products in terms of damage to the body's microbiome, for example, than in terms of damage to environmental systems.

This pattern was reflected in comments referring to being taught or made to think about something (i.e., themes 3a to 3f), with more respondents to the post-survey discussing health impacts compared to environmental impacts. Although the pattern was still evident in the follow-up survey results, the difference was greatly reduced, with a far more mentions of being taught or made to think about environmental impacts.

A positive finding in the post survey results (in terms of evidence for the use of narratives as a behaviour change intervention) is that far more respondents commented that the stories inspired a new behaviour, or a change in behaviour (themes 4a to 4c), than commented that they would carry on with their current behaviours (themes 5a to 5c). Most comments under the *Inspired a behaviour or change* theme (34 of the 54 comments) referred to changing use of products (e.g., using a different surface cleaner) rather than practices (e.g., washing at lower temperatures).

This was also seen in the follow-up survey results, whereby more comments were made that described having made a change (whether in product choice or practices or plans to do that effect; theme nine) than comments stating that no change had been inspired (theme 10). That said, the effect was not so pronounced in the follow-up survey results as it was in the post survey results. That some respondents mentioned that they could not remember the stories (i.e., theme eight, *Remembering*) likely contributed to this, though it is interesting to note that six individuals specifically highlighted how the stories, or a part of one or more of them, *stayed with me* (sub-theme 8b).

## 5 Discussion

This research explored the extent to which storytelling can influence behaviour in the context of bacteria in the home environment, and the environmental impact of common cleaning behaviours. We specifically asked whether pro-environmental messages that discourage over-use of harsh cleaning chemicals and high washing temperatures, incorporated into fictional stories, could influence people's self-reported behaviours, and behavioural intentions, related to laundry, domestic cleaning, and personal hygiene.

### 5.1 Quantitative analysis

Similar patterns of results were seen across the three survey dissemination time points for all questions asked. After reading the stories, participants typically reported an intention to use less product, or more sustainable (or less harsh) products, and to use less energy for cleaning, either through time (e.g., shorter showers) or heat reductions (e.g., cooler showers and laundry cycles). The trend towards more sustainable practices was maintained three weeks later, with responses to the follow-up questionnaire indicating that participants had put into practice the more sustainable practices they had reported as intentions in the questionnaire they completed immediately after reading the stories. In other words, self-reported behaviour three weeks after reading the stories was more sustainable than behaviours reported before reading the stories. These results therefore contribute positively to the literature on the use of fictional narrative as a behaviour change intervention tool [19, 31, 38], highlighting its potential to influence climate-related attitudes, intentions, and behaviours (albeit self-reported).

Notwithstanding this generally positive result, it is important to highlight that the differences between pre-survey results and those gathered three weeks later were only significant for five of the eleven items (laundry detergent quantity, shower/bath frequency, personal cleaning product quantity, domestic cleaning product choice, domestic cleaning product amount), and in all but one case, there was some return to baseline. This reflects results reported elsewhere on the dwindling impact of such interventions over time [31].

### 5.2 Thematic analysis

The finding that people referred more to learning about products (e.g., *"I didn't know about probiotic cleaners"* female, 30–49) rather than practices or behaviours implies a higher level of knowledge around the impact that hotter or longer washing has on the body or environment, but lower levels of knowledge concerning the potential to replace harsh chemicals with low-impact and/or home-made cleaning solutions (*"I liked the stories that described natural cleaning products—something I hadn't thought of"* female, 30–49).

Similarly, the finding that people referred more to being made to think about health impacts versus environmental impacts implies an existing level of knowledge that many of our practices are not good for our natural environment, but a lower level of knowledge that those practices could also be bad for personal health (e.g., *"Hadh't considered laundry liquid / shower gel having a negative effect on my body"* female, 18–29; *"Knowing that stripping good bacteria from our homes does more harm than good and understanding where probiotic cleaners can help too"* female, 30–49). This is indicative of the persistent myth that complete removal of germs from the household is necessary (or even beneficial) for human health [3].

Although Schneider-Mayerson [26] reported reading climate fiction to have little impact on behaviour (reporting only attitudinal effects), the stories cited in his research were more problem than solution-focused, in that they raised awareness of environmental issues without explicitly tying them to solutions. The stories presented in our research highlighted more beneficial practices and products, which encouraged behaviour changes. Several participants reported changing their choice of products (e.g., *"Changed my cleaning products use soap not shower gel and don't use sponges or micro cloths"* female, 50–64) and their cleaning practices (*"Making my own cleaning products; using less will still clean as efficient"*, female, 30–49). There were also participants that reported an intention to change behaviour once some condition had been met (*"Although I am still using up remaining products, I intend to buy kinder products for showering, washing and cleaning and I intend to use less of them as I think previously maybe I used more than necessary"* female, 30–49). That said, in a pro-environmental context, behavioural intentions do not always translate into performed behaviours [39], and many more participants discussed making a behavioural change in the post-survey

(completed immediately after reading the stories; e.g., *“I will look into probiotic cleaning products”* female, 30–49) than did so in the follow-up survey (completed three weeks later).

Previous research has highlighted the style and quality of stories to influence their persuasive impact, with narratives based on fear to be less likely to lead to pro-social behaviours [27, 29]. This came through participants' comments, with one noting *“I liked that ‘what lives in the ice’ was more positive about bacteria and more about the different types of bacteria that exist”* (female 18–29). In addition to positivity being linked with greater impact, Baden [33] recently proposed that ‘smuggling’ pro-environmental messages into stories, whereby environmental messages and information emerge naturally from the plot rather manifesting as the story's principal theme, has a greater potential for impact. This also came through in the participants' comments, with participants less positive about the stories perceived as ‘preachy’: *“The most enjoyable stories were the least preachy ones”* (female, 30–49); *“I preferred the stories where the message was subtle and maybe a bit funny”* (female, 50–64). Such a technique may prove particularly useful in the promotion of eco-friendly cleaning products in instances where people doubt their effectiveness. Research suggests implicit appeals are more effective (than explicit messaging) at encouraging sustainable consumer behaviours in such contexts [20].

The general quality of the stories was also highlighted as an important factor (*“The last two stories felt clunky and forced and were actually a bit off putting. Well written ones are more persuasive!”* female, 30–49). This builds on research showing that people consider a story to be more compelling when they also rate it as being well-written [40]. The issue is complex, however, and the extent to which an individual can identify with characters and storylines is important (e.g., [41, 42]), something that several of our participants commented on (e.g., *“I liked the characters from What lives in the ice. They were relatable and it made me think about microbiome.”* female, 30–49). The way facts are incorporated into stories have also been shown to impact on persuasion [43]; however, these nuances did not come through in our participants' responses.

### 5.3 Limitations and future work

Berger and colleagues [32] pointed out that the impact of persuasive fiction is limited by the fact that most examples reported thus far in the literature have involved an element of preaching to the converted. That limitation does not apply to our research in the sense that we targeted a sample who liked reading, with no mention made of environmental issues. Nevertheless, the readers who took part in the study all cited concern about climate change. It would be of interest in future research to seek out those who are less concerned about climate change to demonstrate whether persuasive climate fiction is effective on a more resistant audience.

The self-report criticism that can be levelled at all data collection efforts relying on questionnaire completion can of course also be levelled at our research. Just as stated intentions do not always translate into behaviour, there also is a gap between what people say they do and what they actually do [44]. Future research in this domain would therefore do well to employ direct observation of behaviour. It would also be beneficial to explore the persistence of the effect over a greater expanse of time. The timescales of our research, i.e., three weeks, do not allow us to comment on the longer-term impacts of the stories, hence research with a longer time horizon would be highly welcome.

Our sample was heavily biased towards women, with 92% of the sample identifying as female. Women typically show greater concern for environmental issues and are more open to sustainable practices and interventions [45]. Relationships between gender, sustainability, and consumption in the household are complex [46], with men and women taking different roles at different stages in the uptake of sustainable practices at home [47]. Targeted research exploring these dynamics would be valuable.

Many of the comments made in response to the open-ended questions referred to changes in knowledge or attitudes towards products and practices; however, we did not include questions to quantitatively measure knowledge or attitude change, focussing only on behaviours and behavioural intentions. The impact narratives have on knowledge and attitudes has been demonstrated in the health (e.g., [48, 49]), environmental [e.g., 50], and prosocial behaviour domains (e.g., [51]), hence it would be interesting to more deeply explore the mechanisms by which narratives impact upon behaviour in a context that has both health and environmental implications.

It would be particularly interesting to explore the extent to which knowledge of action strategies (such as making one's own cleaning products or using probiotic products, as was highlighted by our participants) influences the development of agency, as de Meyer and colleagues [52] put it. Those authors highlighted the fact that our actions can change our beliefs and attitudes, and that the one-way conceptualisation prevalent in the literature (i.e., that changes

in beliefs and attitudes precede changes in behaviour) is flawed. They discuss self-persuasion and self-justification as a coming from an understanding of *how* to act, with that agency (i.e., knowing how) [52]. We can learn agency vicariously; hence storytelling can provide a powerful tool to help people change behaviour. Importantly, it is not about the issues, rather it is about the actions. This came through in our participants' comments; they did not state that they had learned more about climate change, but they did talk of learning about new strategies they could themselves implement. Exploring this in the context of message framing (i.e., positive, or negative) would be important here, as feelings of agency can impact upon the way people respond, with significant individual differences therein [53].

## 5.4 Conclusions

Fact-based strategies aimed at encouraging sustainable behaviours are not always successful, often resulting in minor effects that do not last. Drawing on research into health behaviour change, there has been growing attention paid to storytelling, or persuasive narratives, as a potential tool to encourage change in a sustainability context. The analysis presented above contributes to a growing body of literature in this field by demonstrating the impact of reading stories on behaviours that have both sustainability and health implications. Immediately after reading stories concerned with household and personal cleaning behaviours, within which were embedded messages about the negative environmental and health impacts of excessively high cleaning temperatures and the use of strong cleaning chemicals, readers reported more sustainable behavioural intentions. The impact of reading the stories was still detectable three weeks later (albeit reduced), with participants reporting having put into practice the intentions they had reported immediately after reading the stories. Analysis of qualitative data gathered alongside quantitative self-report measures provided further insight, with improved knowledge of more sustainable products highlighted by many participants. This research therefore adds to the growing body of evidence demonstrating the power of storytelling to influence behaviours. As such, we posit that policymakers at local and global levels could capitalise on the persuasive power of narratives to encourage sustainable cleaning behaviours, particularly in terms of improving knowledge and awareness of sustainable products.

**Author contributions** Conceptualisation—DB, RM, SG, SW Methodology—DB, RM, SG, SW Formal analysis—RM, JS, JB Investigation—DB, RM, SG, SW Writing—Original Draft—DB, RM, SG, SW, JS, JB Writing—Review & Editing—DB, RM, SG, SW, JS, JB Project administration—DB, RM, SG, SW.

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**Data availability** Data available upon request from corresponding author.

## Declarations

**Competing interests** The authors declare no competing interests.

## Appendix 1

The stories used

- 'Germ Counselling' by Jamie Mollart, 4946 words. A drama about a couple undertaking counselling due to one partner's excessive cleaning.
- 'The New Normal' by Rab Ferguson, 2602 words. A story aimed at children about a girl who finds herself shrunk to the size of a microorganism and is amazed to meet the friendly bacteria that keep her skin safe.
- 'Mostly for You' by Jenni Clarke, 2991 words. An engaging romance about a crisis of conscience for a professional cleaner who discovers many of the harsh detergents she uses can have negative effects on personal health and the environment.
- 'What Lives in the Ice' by Eleanor Rycroft, 2139 words. The theme of protecting the friendly bacteria that keep our skin healthy is woven in with themes of grief and starting afresh.

- ‘The Smell of Success’ by Catherine Kerr, 1962 words. This story highlights how marketing plays on our fears to encourage us to buy beauty, skin and cleaning products that can do more harm than good.
- ‘The Society for Organ Welfare’ by Adrian Ellis, 1123 words. A comic account of a society where organs—in this case the skin—have rights.

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