

Green gamification: Changing habits through long-term engagement and stories

by

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BA, University of Bergen, 2011

MPhil, Norwegian University of Science and Technology, 2013

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In the Department of Psychology

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Supervisory Committee

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Abstract

Gamification offers methods for influencing human behaviour that are not available with other approaches to behaviour-change interventions. Its widespread and successful use in business, education, and health care notwithstanding, it has so far not been extensively used for improving sustainability, nor have its underlying psychological principles been studied in depth. This dissertation investigates gamification with a special focus on the role of perspective taking and emotion. A gamified behaviour-change app was compared with a standard app and a webpage for its effect on participants' sustainable behaviours. During the one month period the participants engaged with the intervention, they kept diaries about their experience with sustainability and the technology. Furthermore, the influence of dramatic elements was tested through an augmented reality approach. Gamification encourages longer engagement with the intervention, thereby influencing behaviour. Specifically, gamification increases knowledge about and willingness to invest effort into sustainable behaviours. Dramatic elements, using the power of narrative persuasion and immersion, are important aspects to consider in gamification. The theory of behavioural choice can fruitfully serve as a psychological model of how gamification affects behaviour.

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The Need for New Sustainability Interventions

Climate change is the biggest problem facing humanity (Guterres, 2018). Mitigating the adverse effects of climate change requires not only industry and governments to act, but individuals as well. Merely increasing awareness of the problem is not effective in changing behaviour; other approaches are necessary. The apparent gap in beliefs and understanding of environmental issues between scientists and the population is a serious and problematic obstacle to attaining a sustainable society (Cook et al., 2016; Lewandowsky, Oreskes, Risbey, Newell, & Smithson, 2015; McCright, Dunlap, & Xiao, 2013). Improved science communication and ways to alter attitudes and behaviour could be a solution to this obstacle. The environmental field is in need of these improvements to change the ways in which humans interact with the environment if considerable environmental destruction and deterioration of human living conditions is to be averted.

Two approaches to environmental campaigns and education are common: increasing knowledge in hopes of altering behaviour, or invoking moral emotions (Geller, 2002; Kals & Müller, 2012; Schultz & Kaiser, 2012; Wals, 2012). Unfortunately, framing environmentalism in terms of moral emotions, and an implied moral superiority of humans living sustainably, leads, not surprisingly, to reactance towards environmental campaigns. Humans are not rational beings, but are more accurately described as bounded rational (Simon, 2000) and hedonism-driven (Cialdini, Darby, & Vincent, 1973; Scarpi, 2012).

The question arises: can this hedonism be utilised to influence behaviour in positive ways? The obvious first answer to this would be behaviour modification through conditioning, and although this is a valid and often successful strategy (Geller, Abrahamse, Guan, & Sussman, 2016), an intervention run and monitored by experts is required for this.

Instead, this dissertation's aim is to explore ways in which to make the science communication itself enjoyable, easing the way toward attitude and behaviour-change by harnessing the enjoyment of learning.

Enjoyment in this context does not mean positive emotions exclusively. A good story can be dramatic and sad, but nevertheless enjoyable to consume, or even better, to experience. Humans have a long history of storytelling and can understand complex situations more easily through relatable stories and anecdotes than through statistics (Pahl & Bauer, 2013). Persuasive media is harnessing this by letting persons interact with a problem directly. What is meant by interactivity in this context? The term is defined differently in each field it is used in (Bucy, 2004; Kiouisis, 2002; Sedig, Parsons, & Babanski, 2012); however, for the purposes of this dissertation, a combination of the definitions from computer sciences, sociology, and psychology serves best: "Interactivity is the interaction between a user and an application that is flexible enough to a) respond to the user's input in real time, and b) continuously alter options based on previous input, to facilitate smooth two-way communication."

The interactivity of persuasive media is important because, compared to static forms of information and situation presentation, interactive presentation leads to better decisions (Coyle & Thorson, 2001; Lutz & Lutz, 1977; Pavlou & Stewart, 2000; Stolk, Alexandrian, Gros, & Paggio, 2001). The research establishing the advantage of persuasive media has so far focused solely on the interactivity of the information without considering whether fun or narrative engagement could further improve the presentation. This shortcoming can be remedied through the use of a medium that often combines all three factors: games.

Games possess several features that increase their potential to influence behaviour compared to other interactive media (GartnerInc., 2011):

- Direct feedback from the user's decision
 - o Rather than making a decision and then being forced to wait for another person's feedback or evaluation, games provide feedback the moment a decision is made
- Goals and rules are clear
 - o In contrast to the complexity of the real world, games provide all goals and rules in the beginning while making clear what the changeable factors are
- Sustaining engagement with the goals through a narrative
 - o In the real world, doing tasks is rarely framed in terms of a "story of your life" whereas games bind all actions into one overarching narrative
- Balance between task challenge and task achievability
 - o By offering difficulty levels, games provide the user with tasks that are neither boring nor frustrating to ensure that the user can achieve goals
- Interaction with games is autotelic, i.e. enjoyable on its own without the need for external rewards

Gamification has some features in common with other forms of persuasive technology; however, games are superior in that the user can customize them to their¹ specific needs (Huber & Hilty, 2015) by, for example, choosing difficulty settings, when and how the user receives feedback, and what goals are fitting for the user.

¹ I use the singular "they" when referring to persons in general. I am aware that this is a divisive and debated practice in academic writing and editing at the moment. However, I use it deliberately as part of my goal to help evolve accepted usage in English in the service of facilitating improved attitudes towards persons who are outside the binary gender spectrum.

The integration of gaming elements into non-gaming applications is a possible remedy to the problems that more traditional persuasive media has had with influencing individuals' behaviour (Huber & Hilty, 2015).

One of the main issues is that the applications are often based on the assumption that merely increasing knowledge will alter behaviour. This assumption is, in turn, based on the knowledge-deficit model, the idea that lay persons make decisions that baffle experts because they do not know enough about a topic. In reality, knowledge is only one among several factors driving decisions. Personal value systems and context are equally important when individuals make decisions (Hansen, Holm, Frewer, Robinson, & Sandøe, 2003).

In contrast to methods that rely on remedying knowledge deficits to alter behaviour, gamification transforms the user from passive observer to active collaborator. The user engages in the desired behaviour and sees immediate feedback and results. This feedback is given within the specific context of the game to make it easier to understand, and through interactive design that can be adjusted to fit with the personal value system of the user to make it more personally relevant.

Another disadvantage of traditional persuasive media is that the developers are often only able to present a single generalised set of information about which behaviours are best, which might not be applicable to the user's personal circumstances. With gamification, the users retain more self-determination over what their goals are, how the feedback should be structured, and how they want to relate the experience with the game to their own life. For example, the feedback feature in a game can be customized to take into account whether a person reacts better to success or failure feedback by changing the presentation framework from a promotion focus to a prevention focus (Förster, Grant, Idson, & Higgins, 2001).

Gamification has successfully been used on the corporate scale to improve sustainability by helping employees understand the environmental consequences of their behaviours, and transforming previously annoying chores, such as recycling, into a fun competition between departments (Stevens, 2013). However, consistent scientific confirmation of gamification's effect on sustainability is missing, as is a model to better understand and optimize this effect.

With these challenges in mind, I propose to answer the following two overarching research questions:

- Can gamification help with sustainability education, attitude change, and behaviour change?
- What part do affect and perspective taking play in the potential effects of gamification?

Gamification and Serious Games

Although this dissertation focuses on gamification, a related and equally important concept could be employed to similar results: serious games. Generally discussed as different concepts, the author presents a more synthesis-oriented approach to the relation between serious games and gamification.

Gamification

The shortest definition of gamification is “the use of game elements in non-gaming situations” (Huber & Hilty, 2015). At first glance, this may appear to be a simple definition. However, it is plagued by several issues: To understand the definition, one must first understand what constitutes a gaming situation, what does not, and possess knowledge of what *game elements* are.

When considering a wide array of gamification definitions, the following characteristics are repeatedly mentioned: User experiences and gamefulness (or game elements) are more important than the situation in which the game is used, or the desired end goal that the game is meant to support (Burke, 2014; Huotari & Hamari, 2012; Marczewski, 2012, 2015; Rackwitz, 2014). Based on these core characteristics the best-suited definition of gamification for this dissertation is: *Gamification is the process of creating opportunities for gameful interactions and experiences that have the potential to motivate and engage the user in non-entertainment purposes.*

Serious Games

A useful definition of serious games cannot restrict them to computerized games, or to educational and training purposes, and should leave open the possibility of these games not being designed for serious purposes. The final point is important because any game can be used as a

serious game. After considering the advantages and disadvantages of the various existing definitions, I propose a definition that takes inspiration from Michael and Chen (2006) with one important alteration: *Serious games are games that do not have entertainment, enjoyment, or competition as their primary purpose.*

The small alteration of replacing “fun” with competition is important because of the rise of video game sports. Competing for millions of dollars in prize money is serious business (Valve, 2016), but does not constitute a serious game in the sense that the game is used for an *improvement* purpose. In contrast, serious games aim to teach, train, inform, engage, improve behaviour, or heighten empathy.

My Position

At first glance, gamification and serious games may seem as if they are two very different concepts, gamification being much further removed from games than serious games. I postulate that this is potentially more because of the overuse of pointsification than gamification in itself. Pointsification is the exclusive use of badges and scores to gamify the target application, thereby ignoring any underlying motivational factors of games (Robertson, 2010).

My definition of gamification stated above is intentionally formulated so that it encapsulates serious games as well. Gamification is often seen as the use of game elements in non-game situations (Huber & Hilty, 2015), but what constitutes the difference between a non-game and a game situation? The same situation and experience can be perceived as a game by one individual but as a non-game by another individual depending on their subjective and social understanding of what constitutes playful behaviour (Arjoranta, 2014; Huotari & Hamari, 2012). Ergo, a gamified application that the user finds playful is also a serious game.

This issue of grey zones between gamification and serious games becomes obvious when the same application is being discussed as gamification by some theorists and as a serious game by others. One example of this is the application “FoldIt” in which users, or players if seen as a serious game, help researchers at the University of Washington figure out possible ways in which proteins structures are folded into themselves. The solutions with the highest scores are then investigated by biochemists, who reported that the players, with no prior knowledge of biochemistry, outperformed algorithm-based computer simulations and sped up research by years (Cooper et al., 2010).

FoldIt has been discussed as gamification because it takes a non-game application, in this case chemical simulation of structures, and makes it into a puzzle (Good & Su, 2011). FoldIt has also been discussed as a serious game because players voluntarily and with no reward have spent cumulatively thousands of hours on it, clearly enjoying the experience and perceiving it as gameful (Cooper et al., 2010; Marczewski, 2013a).

How can gamification and serious games be differentiated? Marczewski (Marczewski, 2013b) postulated that gamification and serious games have game thinking and game elements in common but only serious games have “gameplay.” Gameplay, however, is exactly the elusive and subjective concept that each user must decide on for themselves. Based on this, one can conclude that no hard delineation exists between gamification and serious games. The two concepts should be understood as two points on a continuum rather than entirely distinct from each other.

Model of Gamification

Building on Gifford's theory of behavioural choice (2015), I postulate the following model of gamification's influence on human behaviour:

Figure 1. Original theory of behavioural choice

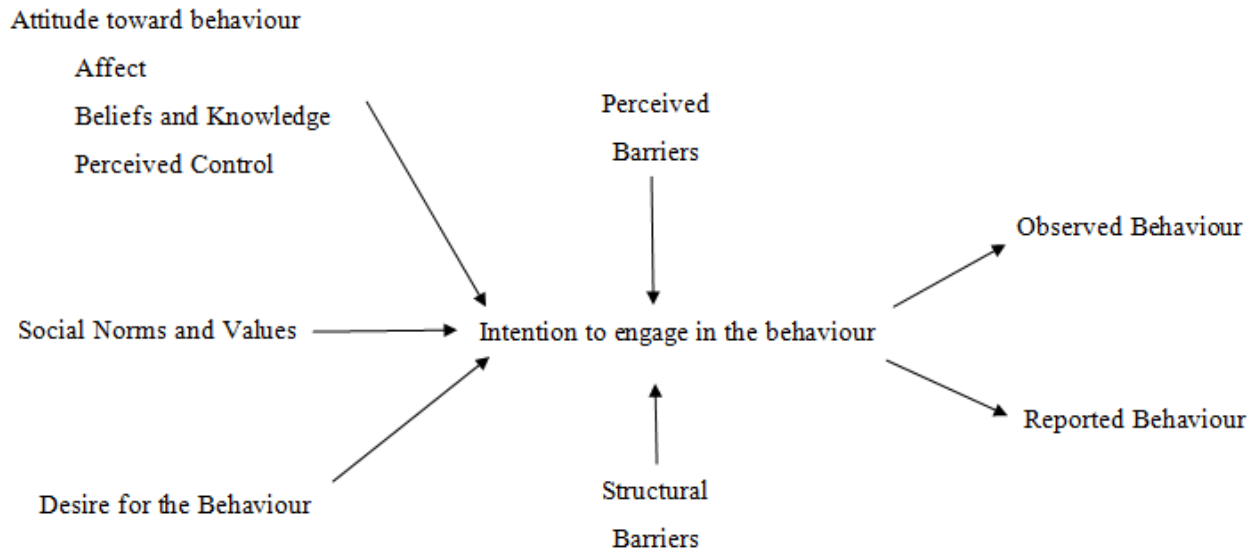
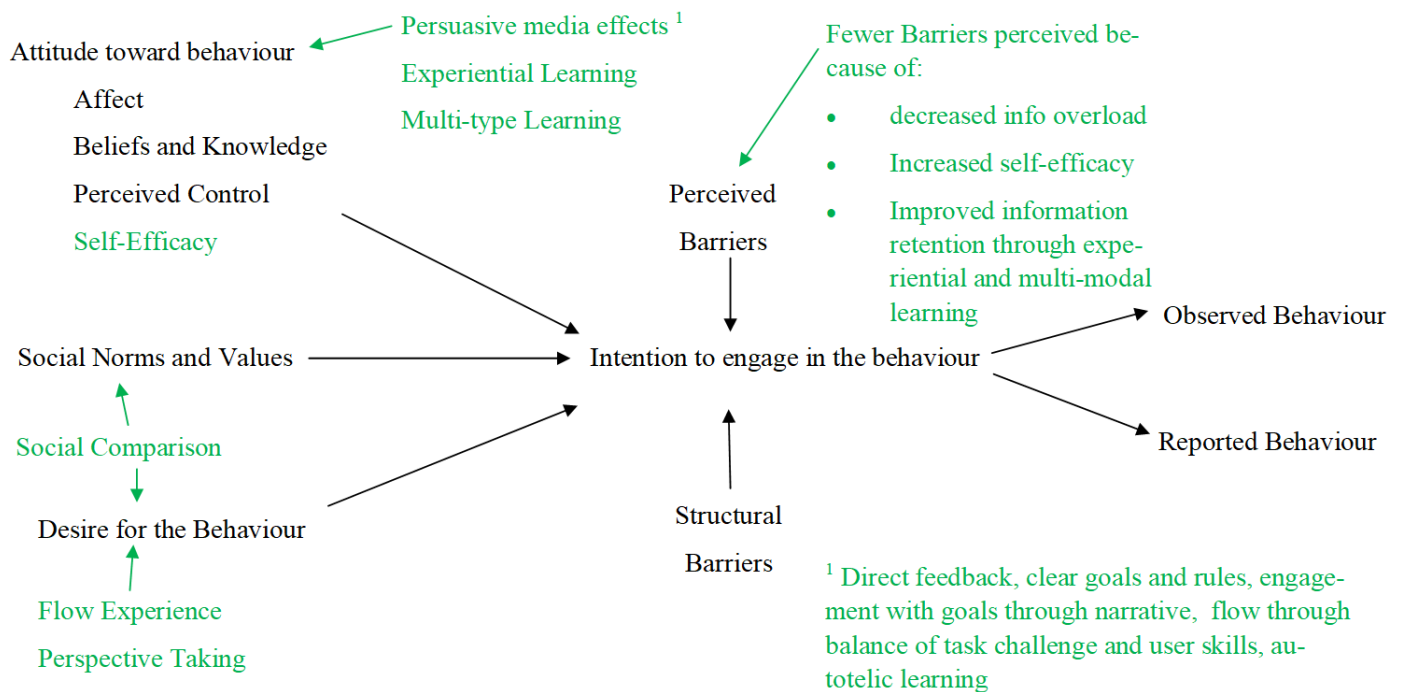


Figure 2. Theory of behavioral choice with gamification aspects added



Predictions on how gamification influences behaviour, barrier perception, and attitudes were added in green to the original model. Most changes describe how gamification influences and interacts with the existing parts of the model, with one exception: Self-efficacy should be added to the model. The perceived control aspect speaks to a person's beliefs about how much of an effect their behaviour will have. Self-efficacy, however, is important to the person's belief that they are capable of actually performing the behaviour. Learned helplessness, when an individual believes that they are incapable of performing any behaviour that will have an effect on their situation, already has been shown to moderate the effects of environmental concern on environmental behaviour (Landry, Gifford, Milfont, Weeks, & Arnocky, 2018). Lack of self-efficacy likely has a similar effect.

When gamification aligns with Gifford's guidelines on how to eradicate the dragons of inaction (2015), a gameful approach would be a synthesis of cooperation with other disciplines,

and creation and testing of new interventions. This dissertation aims to work with the discipline of computer science or ludology while exploring the best ways of communication to make sustainable choices seem attractive.

The expected effects of this synthesis are accomplished through gamification's utilisation of the advantages of persuasive media described above and the following psychological concepts and theories: Gamification, by virtue of being interactive technology, decreases information overload (Kimura et al., 2008; Mayer & Moreno, 2003; Scielzo & Greenwood-Ericksen, 2003) and helps with information retention (Fang, 2012; Gao, Zhang, Wang, & Ba, 2012; Hoek, Gendall, Rapson, & Louviere, 2011; Schwartz & Plass, 2014; Shang, Chen, & Chen, 2011). Even if a person is motivated to be sustainable, a quick online search on how to "go green" results in a flood of tips and guides, some of which are contradictory. Reading through a large number of material and engaging in source criticism, judging the quality and trustworthiness of information (Rieh, 2002) for each article requires a large amount of cognitive work. In contrast, a gamified app, if designed by a reliable and trusted scientific source, decreases information overload by engaging the user through interactive and experiential learning procedures, which also have a strong likelihood of catering to different learning styles. The effectiveness of this is already documented in other fields (Coyle & Thorson, 2001; Evans & Gibbons, 2007; Fleming & Mills, 1992; Lurie, 2004).

Gamification by its very nature follows the guidelines of goal-setting theory's recommendations on how to make a task motivating and engaging. The guidelines include: 1) the goal must be clear, with well-defined ways of achieving it, 2) the goal must be challenging but not too difficult, 3) the goal must evoke commitment to it, 4) feedback on one's progress must be available, and 5) the task complexity must fit with the person trying to achieve the goal.

These goal-setting theory guidelines can be applied to gamification to help explain why gameful design is motivating: clarity through pre-defined rules and goals, balanced challenge and complexity based directly on the user input, and direct feedback. Finally, commitment to the goal is facilitated through a combination of the game's reward system and narrative structure. This structure should lead to gamified sustainability interventions that have high retention and at the same time strengthen participants' self-efficacy (Locke & Latham, 2002).

Bandura's (1977) self-efficacy theory describes the level of confidence one has in being capable of completing a task. Stronger self-efficacy tends to increase a person's persistence and effort on a task (Schunk, 1990). Self-efficacy can be increased through four main routes: experience, observation, persuasion, and emotional arousal (Bandura, 1977). Gamification increases a person's self-efficacy through a mixture of all of these. While interacting with the game, the user gains experience with the sustainability behaviour in a failure-tolerant environment, meaning that the user is free to attempt different strategies with the knowledge that any mistakes can be undone. The tutorial section, other players, or the game's narrative allow observation and modeling of sustainability behaviours. The positive feedback and social comparison with other players act as a form of persuasion. Finally, the narrative of the game and the potential flow experience elicited through learning to master the game serve as emotional feedback to the player (Backlund, Engström, Johannesson, Lebram, & Sjöden, 2008; Kato, 2012).

Even mastering simple motor-perceptual tasks, with no added meaning, can invoke positive emotions (Pagulayan et al., 2012). When adding meaning and a balance between challenge and user skill, gamification has a strong likelihood of eliciting flow experiences in the users (Nakamura & Csikszentmihályi, 2009). Flow has been shown to improve engagement with

a task in previous studies (Koivisto & Hamari, 2014), to constitute part of the reason for immersion in video games (Weibel & Wissmath, 2011), and to facilitate gamified education (Beylefeld & Struwig, 2007).

In sum, I postulate that gamification can influence attitudes through a mix of learning and goal-setting strategies in addition to improving the user's self-efficacy, their social norms and values through social comparison within the game, will increase the desire for the behaviour through flow experiences and perspective taking, and lower perceived barriers via effective learning and improved self-efficacy. As such, I postulate that the theories of goal-setting and flow interact synergistically to improve the model presented by the theory of behavioural choice's ability to predict and explain gamification's effect of behaviour. Furthermore, the theory of self-efficacy should be added as a subcategory of the theory of behavioural choice's 'attitude toward the behaviour'-category.

This view is similar to the social psychology perspective of gamification's long-term engagement and influence as linked to self-efficacy and social factors, rather than to the motivational power of adding points to behaviours (Antin, 2012).

Study Overview

Longitudinal studies on emotions, motivation, and perceptions around sustainability are rare. The studies presented here advance knowledge on how these three concepts fluctuate throughout a month of engaging with a sustainability resource and scheduled reminders to report on what sustainable behaviours the participants performed that day and what barriers they encountered. This helped improve the theory of behavioural choice and informs how it can be implemented for the design of effective behaviour-change interventions.

Study 1 investigated how pre-existing behaviour-change interventions, utilising different levels of gamification, influence sustainability knowledge, sustainability motivation and willingness to invest effort, environmental concern, sustainability self-efficacy, and self-reported behaviour.

Study 2 qualitatively investigated participants' reported sustainable behaviours, feelings towards sustainability, motivation to be sustainable, and their encountered barriers while they used the behaviour-change intervention during study 1.

Study 3 focused on a specific subtype of gamification, augmented reality, which accesses gamification through the use of story elements and visualisation. Virtual reality (Ahn et al., 2016) and perspective taking (P.-S. Lee, Sung, Wu, Ho, & Chiou, 2018; Pahl & Bauer, 2013) independently can influence environmental concern and motivation. Augmented reality could combine both, so study 3 advances knowledge on whether and how this can be done.

Study 1

In this quasi-experimental intervention study, participants' sustainability knowledge, motivation to engage in sustainable behaviours, concern about the environment, self-efficacy for sustainability behaviours, and self-reported sustainability behaviours were measured. Then, for one month, the participants used either Sustainability@BU (gamified sustainability app, condition 1), For Good (sustainability app with customised footprint and tips, condition 2), or the webpage Greenchoices.org (information page on how to be more sustainable, condition 3, which served as the control condition). After the month, the participants were measured again with the same battery of tests as before.

Hypotheses

A gamified sustainability app leads to significantly greater improvements than a standard sustainability app and webpage in:

H1) Sustainability knowledge acquired

H2) Motivation to engage in sustainable behaviours

H3) Concern about environment generated

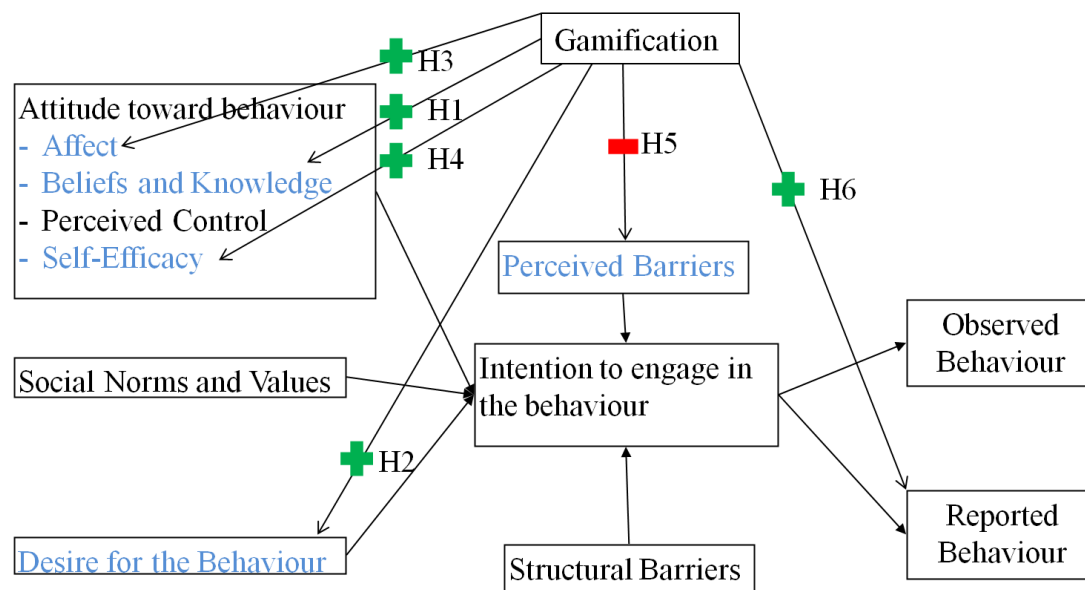
H4) Self-efficacy to be sustainable

H5) Perception of barriers towards sustainability

H6) Amount of self-reported behaviour change

H7) The participant's level of sustainability knowledge, motivation to engage in sustainable behaviours, concern about the environment, self-efficacy, and lack of perceived barriers will positively influence the amount of self-reported behaviour change.

Figure 3. Visual representation of hypotheses based on theory of behavioural choice



H7: Aspects influencing reported behaviour change

Method

Choice of materials. The study utilised three digital resources: two apps and one webpage. Both apps were free of in-app purchases at the time of the study to ensure that all participants using the app received the same experience with their resource.

For the normal app condition, *For Good* was chosen because it offers personalised feedback on behaviours such as transportation and food, general tips on improving one's sustainability, calculates the person's ecological footprint, and compares it to other users.

For the gamified app condition, *Sustainability@BU* was chosen, because it shares *For Good*'s feedback functions. However, rather than general tips, it provides lists of behaviours with a short explanation why each of them is environmentally important and the ability to click on them to indicate that the user performed the behaviour. The user receives a visual reward for this act, the amount of times the behaviour is performed is tracked, displayed, and can be compared to other users, including the ability to take part in competitions.

For the webpage condition, serving as a control condition, the first webpage that provided information of comparable quality to the apps that appeared in a google search on *how to be more sustainable* was chosen to simulate a realistic way of how individuals may choose to find out more about ways to alter their life. Through this approach, *greenchoices.org* was chosen.

Participants. The sample in this study were 160 students at the University of Victoria, recruited through the departmental research webpage for extra credit in their courses. As is common for psychology students the sample was skewed towards females ($n = 131$), with the remainder consisting of 29 males and no participants indicated identifying as a gender other than male or female. Average age was 22 ($SD = 4.6$, range = 18 - 45). The sample size was determined based on power analysis to satisfy the following requirements with three conditions: effect size = .25, significance level = .05, power = .80.

The original sample size was 163 participants but three participants did not fill out the follow-up survey and therefore were excluded from the study.

Procedure. After participants registered for the study based on the information that they would engage with a digital resource helping them be more aware of the environmental implications of their actions for a month, they were invited to the laboratory. Upon entering they were randomly assigned to one of three conditions (webpage, standard app, or gamified app) and presented with the appropriate informed-consent form. After they signed it, they were instructed to install an app on their phone or tablet (Sustainability@BU for the gamified condition, and For Good in the standard app condition), or to investigate the webpage *greenchoices.org*. A link was sent to their email immediately in the control condition. Once the researcher ensured that the app started correctly, they explained to the participants that they should interact with it naturally, as much or as little as they would had a friend recommended it to them after they engaged with it

initially. If the participants had no further questions, they filled out a survey and were informed that they would be contacted in a month to fill out another survey. This survey was sent to them electronically via email, so participants had no further in-person contact with the researcher after the initial day in the laboratory.

Scales. To better represent the breadth of environmentally relevant behaviours and to mimic the categories presented in the intervention, the knowledge and self-efficacy question split questions across the following sub-categories: energy use, transportation, use of toiletries and cosmetics, waste and recycling, choice of cleaning products, decisions around clothing, food and drink.

These categories overlap with categories utilised in the study underlying the scale used to measure perceived behaviour-barriers, the dragons of inaction psychological barriers (DIPB) scale (Lacroix, Gifford, & Chen, 2019), hitherto referred to in text and tables as dragons of inaction. This scale is comprised of twenty four questions about various reasons persons do not engage in sustainable behaviours, for example, temporal distance from negative consequences (1 – 5 scale from ‘strongly disagree’ to ‘strongly agree’). After reverse coding several items average scores across questions constitute the total score spanning -2 to 2, with higher scores indicating more perceived barriers. In addition to this quantitative barrier-scale, the survey contained one open ended question asking the participants what they perceive as the biggest barriers in their life to living more sustainably.

Knowledge was assessed via a question about how much each of the above categories affect the environment on a sliding scale of 0 – 100 from ‘minimal impact’ to ‘very high impact.’ Answers to these seven questions were averaged out into one overall knowledge score and for the purposes of this study knowledge that all of these categories have a large effect on the

environment was treated as ‘better understanding of environmental issues’, therefore a higher average score represents more knowledge.

The study’s self-efficacy scales are modeled after Bandura’s (2006) recommendations directly, not a pre-existing scale. Utilising the same categories as the knowledge question, participants were asked how well they believe they know how to improve their sustainability in each category (sliding scale 0 – 100 from ‘I don’t know what to do at all’ to ‘Highly certain I know what to do’), and how much effect they can have in each category (sliding scale 0 -100 from ‘my behaviour won’t have an impact at all’ to ‘I am certain I make a difference with my behaviour’). Answers across all fourteen questions were averaged into a compound score of self-efficacy.

The environmental concern scale used is the revised new environmental paradigm scale (Dunlap, Van Liere, Mertig, & Jones, 2002). In this scale, participants have to answer fifteen questions about how much they agree (five-point Likert scale from ‘strongly disagree’ to ‘strongly agree’) with statements about the relation between humans and the environment. Several questions were reverse scored before all were combined into one compound measure spanning -2 to 2 with higher scores indicating higher concern. After Cronbach alpha investigation of the scale two problematic items were deleted from both T1 and T2.

Motivation measures are comprised of only *personal feeling of motivation* and *effort willing to invest*, because the other normally evaluated factors *concern* (perceived susceptibility and severity), *perceived barriers*, and *self-efficacy* are measured in other parts of the survey (Floyd, Prentice-Dunn, & Rogers, 2000). Both questions utilised a 0 – 100 sliding scale from ‘very little’ to ‘very high.’ Initially these two questions were combined into an average score but the aspect of ‘effort willing to invest’ was found to have distinct effects, therefore each question

was used as a single-item measure of the variables of ‘motivation’ and ‘effort willing to invest’ respectively.

Behaviour was assessed through a nine-point visual slider scale, without specific labels, in answer to the question: “In your own estimation, how often do you engage in environmentally relevant behaviours?” This constitutes a single-item measure of the participants’ self-perceived amount of behaviours they engage in.

In addition to these measures taken both at the beginning and end of the month, the post-intervention study included a self-reported single-item measure of how much time the participants had spent with their intervention (app or webpage), asking them to indicate on a scale of ‘once or twice’ through ‘several times weekly’ to ‘several times daily’ (0 – 100) how often they had used their resource.

Results

The reliability of the scales was tested both for T1 and T2 to ensure that change variables would produce reliable measures.

Table 1. Cronbach’s alpha scores for all multi-item scales in study 1

Scale	<i>Mean</i>	<i>SD</i>	<i>Cronbach’s α</i>
Knowledge T1	453.55	113.64	.85
Knowledge T2	465.04	111.68	.85
Environmental concern T1	13.54	6.14	.72
Environmental concern T2	14.39	6.41	.77
Self-efficacy T1	816.54	222.18	.87
Self-efficacy T2	938.01	226.282	.91
Dragons of inaction T1	-16.46	8.46	.75
Dragons of inaction T2	-18.50	11.75	.89

Inspecting the normal distribution of variables by way of Q-Q plots showed some distortion at the endpoints. Generally, as is common with socially desirable topics like

sustainability, fewer people than required for a normal distribution chose the minimum values on each scale. Additionally, some participants scored exceptionally high because they were highly invested in sustainability before they underwent the intervention. However, the only variable that showed concerning levels of being skewed (above 1), was *amount of behaviour* at the end of the intervention month. This was arguably the hoped-for outcome of the intervention and the analysis was focused on behaviour change, the lack of an ideal normal distribution was deemed unproblematic. A more complete table of descriptive statistics sorted by condition can be found in the appendix (see APPENDIX A1-A4).

Table 2. Descriptive statistics for study 1

	Range	Min	Max	Mean	SD	Variance	Skewness		Kurtosis	
							Stat.	SE	Stat.	SE
Behaviour T1	8.00	1.00	9.00	6.05	1.70	2.90	-.55	.20	-.10	.39
Motivation T1	91.00	9.00	100.00	69.95	18.62	346.76	-.72	.19	.73	.38
Effort willing T1	93.00	7.00	100.00	67.39	16.43	270.00	-.56	.19	.94	.38
Knowledge T1	77.29	22.71	100.00	56.03	15.76	248.24	.33	.19	-.30	.39
Self-efficacy T1	100.00	0.00	100.00	60.55	19.90	396.13	-.14	.19	-.10	.38
Environmental Concern T1	2.27	-.27	2.00	.87	.43	.18	-.22	.19	-.17	.39
Dragons of inaction T1	1.92	-1.58	.33	-.69	.35	.12	.12	.19	.24	.38
Behaviour T2	8.00	1.00	9.00	6.16	1.45	2.11	-1.20	.20	1.49	.39
Motivation T2	94.00	6.00	100.00	72.44	17.23	296.74	-.97	.19	1.47	.38
Effort-willing T2	91.00	9.00	100.00	66.80	18.57	344.83	-.68	.19	.21	.38
Knowledge T2	84.00	16.00	100.00	66.39	16.67	278.00	-.22	.19	-.53	.38
Self-efficacy T2	88.57	11.43	100.00	67.59	18.78	352.66	-.42	.19	.10	.39
Environmental Concern T2	2.40	-.40	2.00	.94	.47	.23	-.23	.19	-.36	.39
Dragons of inaction T2	2.63	-1.88	.75	-.77	.49	.24	.29	.20	.27	.39
Behaviour change	10.00	-5.00	5.00	.11	2.02	4.10	.15	.20	-.11	.40
Knowledge change	112.14	-45.14	67.00	10.63	23.76	564.43	-.11	.20	-.36	.39
Environmental concern change	3.33	-1.53	1.80	.07	.64	.41	-.02	.20	-.26	.39
Dragons of inaction change	2.29	-1.04	1.25	-.07	.41	.17	.20	.20	.32	.39
Self-efficacy change	150.43	-68.57	81.86	7.28	28.56	815.66	-.03	.20	-.04	.39
Motivation change	155.00	-74.00	81.00	2.49	24.24	587.37	-.04	.19	.67	.38
Effort willing change	140.00	-63.00	77.00	-.59	23.89	570.91	.10	.19	.01	.38
Time spent with intervention	92.00	0.00	92.00	33.74	23.50	552.16	.38	.19	-.80	.38

Correlation and MANOVA analysis of the entire data set revealed an unexpected problem. The conditions had no statistically relevant connection with any of the dependent variables, $F(14,234) = .59$, *ns*, Wilks' $\Lambda = .93$.

Table 3. Correlations of condition effects, time spent with the intervention and T1, T2, and change-variables

Condition	Time spent	Behaviour T1	Behaviour T2	Knowledge T1	Knowledge T2	Efficacy T1	Efficacy T2	Concern T1	Concern T2	Dragons T1	Dragons T2	Motivation T1	Motivation T2	Effort-Willing T1	Effort-Willing T2	Behaviour change	Knowledge change	Concern change	Dragons change	Efficacy change	Motivation change	Effort willing change
Condition	1																					
Time spent	-.24**	1																				
Behaviour T1	-.07	-.08	.25**	1																		
Behaviour T2	-.05	.25**	.17*	.26**	1																	
Knowledge T1	-.01	.05	.26**	.07	.1	-.08	.57**	.03	.12	-.09	-.07	-.02	.41**	.03	.36**	.01	-.16	-.72**	-.15	.02	-.42**	-.30**
Knowledge T2	-.06	.24**	-.03	.40**	-.08	1	-.03	.66**	.08	.31**	-.12	-.40**	-.09	.53**	.58**	.32**	.75**	.17	-.34**	.47**	.44**	.47**
Self-Efficacy T1	.03	.10	.36**	.06	.57**	-.03	1	-.07	.28**	.04	-.14	-.04	.47**	-.03	.43**	.01	-.26**	-.41**	-.17	.18	-.75**	-.39**
Self-efficacy T2	-.07	.17*	.01	.30**	-.03	.66**	-.07	1	.05	.27**	-.17*	-.46**	-.10	.50**	-.06	.52**	.20*	.47**	.16	-.38**	.71**	.42**
Concern T1	.01	-.02	.31**	.05	.12	.08	.28**	.05	1	-.03	-.17*	-.02	.27**	-.02	.24**	-.02	-.20*	-.68**	.11	-.17*	-.22**	-.17*
Concern T2	.06	.01	.24**	.18*	-.09	.31**	.04	.27**	-.03	1	-.31**	-.41**	.08	.36**	.03	.37**	-.06	.29**	.75**	-.21**	.16	.19*
Dragons T1	-.09	.12	-.23**	-.25**	-.07	-.12	-.14	-.17*	-.17*	.31**	1	.57**	-.18*	-.16*	-.33**	.00	-.07	-.11	-.18*	-.02	-.05	-.14
Dragons T2	-.06	-.11	-.17*	-.28**	-.02	-.40**	.04	-.46**	-.02	-.41**	.57**	1	-.06	-.43**	-.08	-.45**	-.05	-.27**	-.26**	.71**	-.32**	-.27**
Motivation T1	-.10	.12	.58**	.12	.41**	-.09	.47**	-.10	.27**	.08	-.18*	-.06	1	.09	.76**	.05	-.39**	-.34**	-.15	.07	-.41**	-.71**
Motivation T2	-.02	.23**	.09	.61**	.03	.53**	-.03	.50**	-.02	.36**	-.27**	-.43**	.09	1	.12	.82**	.35**	.36**	-.25**	.36**	.64**	.55**
Effort-Willing T1	-.09	.13	.52**	.17*	.36**	-.04	.43**	-.06	.24**	.03	-.16*	-.08	.76**	.12	1	.07	-.30**	-.27**	-.15	.03	-.35**	-.50**
Effort-willing T2	-.06	.28**	.06	.65**	.01	.58**	.01	.52**	-.02	.37**	-.33**	-.45**	.05	.82**	.07	1	.41**	.41**	.27**	.22**	.34**	.73**
Behaviour change	.06	.22**	-.70**	.58**	-.16	.32**	-.26**	.20*	-.20*	-.06	.00	-.05	-.39**	.35**	-.30**	.41**	1	.33**	.09	-.06	.32**	.54**
Knowledge change	-.02	.13	-.18*	.24**	-.72**	.75**	-.41**	.47**	-.02	.29**	-.07	-.27**	-.34**	.36**	-.27**	.41**	.33**	1	.23**	-.23**	.60**	.52**
Concern change	.04	.01	-.03	.08	-.15	.17*	-.17*	.16	-.68**	.75**	-.11	-.26**	-.15	.26**	-.15	.27**	.09	.23**	1	-.21*	.23**	.29**
Dragons change	.02	-.19*	-.03	-.12	.02	.18*	-.38**	.11	-.21**	-.18*	.71**	.07	-.25**	.03	-.22**	-.06	-.23**	-.21*	1	-.37**	-.25**	-.20**
Self-efficacy change	-.07	.04	-.24**	.15	-.42**	.47**	-.75**	.71**	-.17*	-.02	-.32**	-.41**	.36**	-.35**	.34**	.32**	.60**	.23**	-.37**	1	.56**	.50**
Motivation change	.06	.07	-.37**	.34**	-.30**	.44**	-.39**	.42**	-.22**	-.19*	-.05	-.27**	.71**	-.50**	.54**	.54**	.54**	.29**	-.25**	.56**	1	.77**
Effort willing change	.01	.13	-.31**	.39**	-.24**	.47**	-.29**	.44**	-.17*	-.14	-.30**	-.49**	.55**	-.63**	.73**	.53**	.50**	.31**	-.20*	.50**	.77**	1

** $p < 0.01$ * $p < 0.05$ Condition: 1) Gamified 2) Interactive 3) Control

Table 4. MANOVA of T2 and change variables by condition (control, interactive, gamified)

	<i>Sum of Squares</i>	<i>Df</i>	<i>Mean Square</i>	<i>F</i>	<i>Sig.</i>
Knowledge T2	777.67	2	388.83	1.41	.25
Knowledge change	320.68	2	160.34	.26	.77
Sustainability behaviours T2	4.14	2	2.07	1.10	.34
Behaviour change	4.20	2	2.10	.54	.59
Motivation T2	74.86	2	37.43	.14	.87
Motivation change	429.56	2	214.78	.38	.68
Environmental concern T2	.94	2	.47	2.03	.14
Concern change	.52	2	.26	.63	.54
Self-efficacy T2	819.34	2	409.67	1.24	.29
Self-efficacy change	2002.21	2	1001.11	1.23	.30
Dragons of inaction T2	.69	2	.35	1.42	.25
Dragons change	.07	2	.04	.21	.81
Effort willing to invest T2	360.06	2	180.03	.53	.59
Effort willing change	98.76	2	49.38	.09	.91
	<i>Value</i>	<i>F</i>	<i>Hypothesis df</i>	<i>Error df</i>	<i>Sig.</i>
Wilk's lambda	.93	.59	14	234	.88

Therefore, hypotheses H1 through H6 were not confirmed. However, a correlational analysis indicated that the condition was related to how much time the participants spent with the intervention, which in turn was correlated with most dependent variables.

Table 5. Correlations of ‘condition’ (gamified-interactive-control) and ‘time spent with the intervention’ with DVs

	Condition	Time spent
Condition	1	-.24**
Time spent with intervention	-.24**	1
Knowledge T1	-.01	.05
Knowledge T2	-.06	.24**
Knowledge change	-.02	.13
Self-efficacy T1	.03	.10
Self-efficacy T2	-.07	.17*
Self-efficacy change	-.07	.04
Environmental concern T1	.01	-.02
Environmental concern T2	.06	.01
Environmental concern change	.04	.01
Dragons of inaction T1	-.09	.12
Dragons of inaction T2	-.06	-.11
Dragons of interaction change	.02	-.19*
Sustainable behaviours T1	-.07	-.08
Sustainable behaviours T2	-.05	.25**
Sustainable behaviours change	.06	.22**
Motivation T1	-.10	.12
Motivation T2	-.02	.23**
Motivation change	.06	.07
Effort willing to invest T1	-.09	.13
Effort willing to invest T2	-.06	.28**
Effort willing to invest change	.01	.13

* $p < .05$ ** $p < .001$

Condition: 1 = Gamified 2 = Interactive 3 = Webpage

Dummy coding revealed that the difference in time spent was caused by the contrast of the gamified app to the webpage condition. The mere interactivity of the standard app did not lead to a significant difference in time spent with it between the app and webpage conditions.

Following the recommendation that a direct effect should not be seen as a gatekeeper for mediation (Hayes, 2009; Shrout & Bolger, 2002), the relation between gamification, time spent with the intervention, and the various dependent variables at T2 (after the intervention) was further investigated via mediation. The bootstrapping method was utilised in order to test rigorously to avoid misinterpretation given the lack of direct effect (Mackinnon, Lockwood, & Williams, 2004). Upon running mediation models, time spent with the intervention appeared to have a full mediation effect on the condition itself because C' paths remained non-significant as the following models show. The unlabelled numbers are regression coefficients.

Figure 4. Mediation model for gamification's effect on knowledge through intervention usage

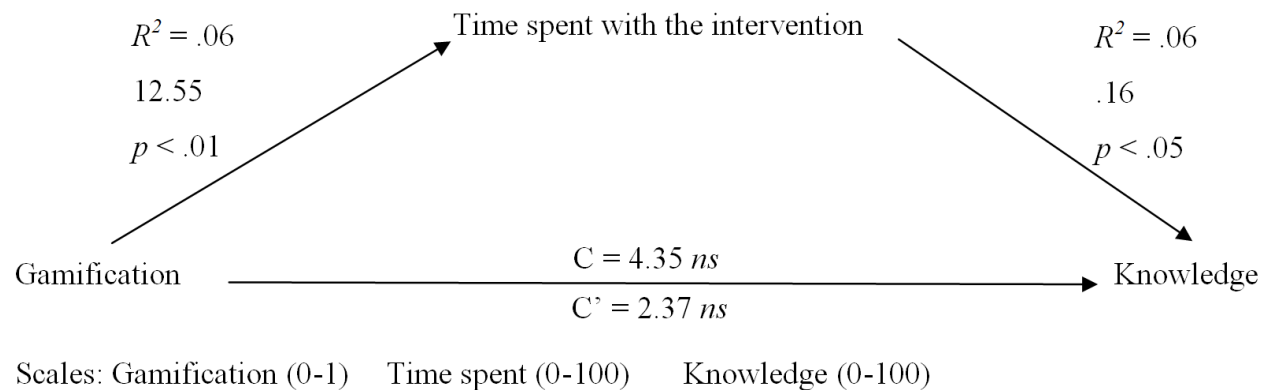
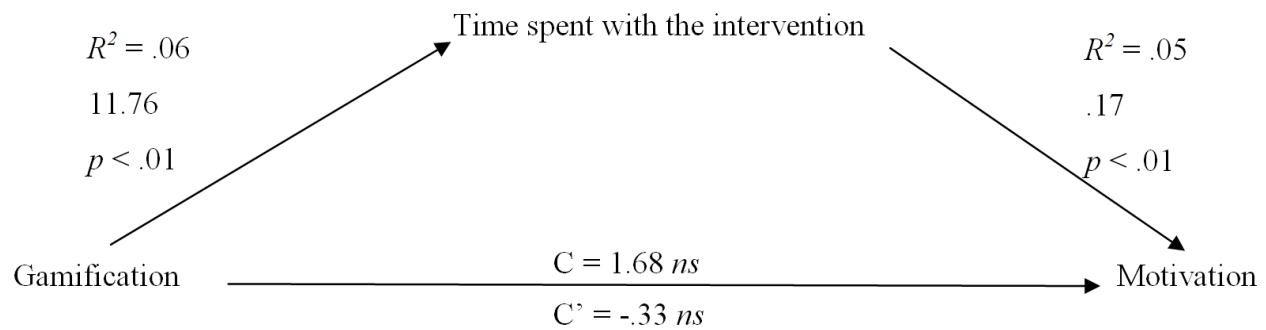
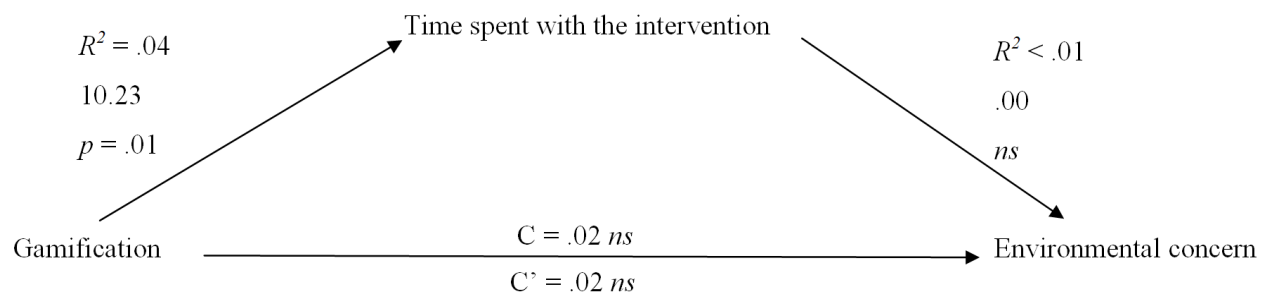


Figure 5. Mediation model for gamification's effect on motivation through intervention usage



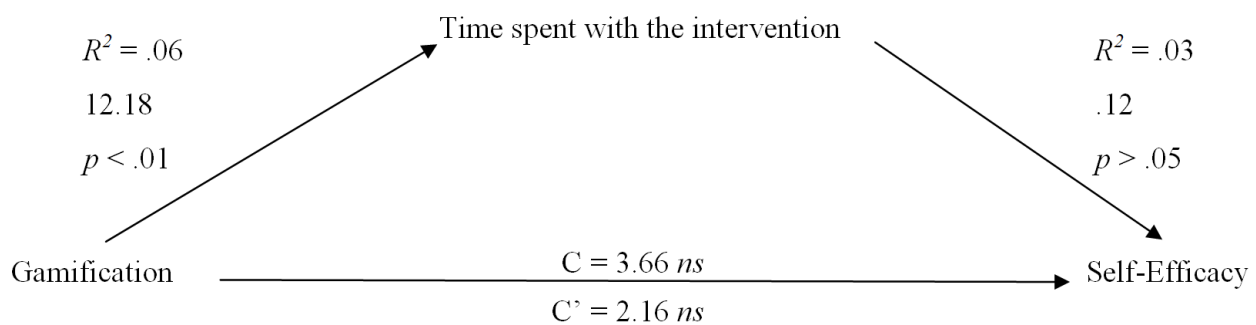
Scales: Gamification (0-1) Time spent (0-100) Motivation (0-100)

Figure 6. Mediation model for gamification's effect on environmental concern through intervention usage



Scales: Gamification (0-1) Time spent (0-100) Concern (0-100)

Figure 7. Mediation model for gamification's effect on self-efficacy through intervention usage



Scales: Gamification (0-1) Time spent (0-100) Self-Efficacy (0-100)

Figure 8. Mediation model for gamification's effect on perceived barriers through intervention usage

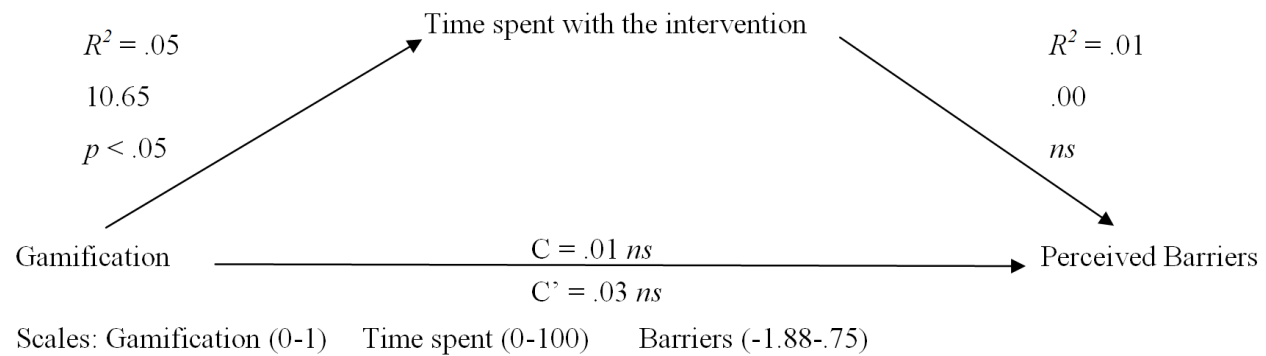
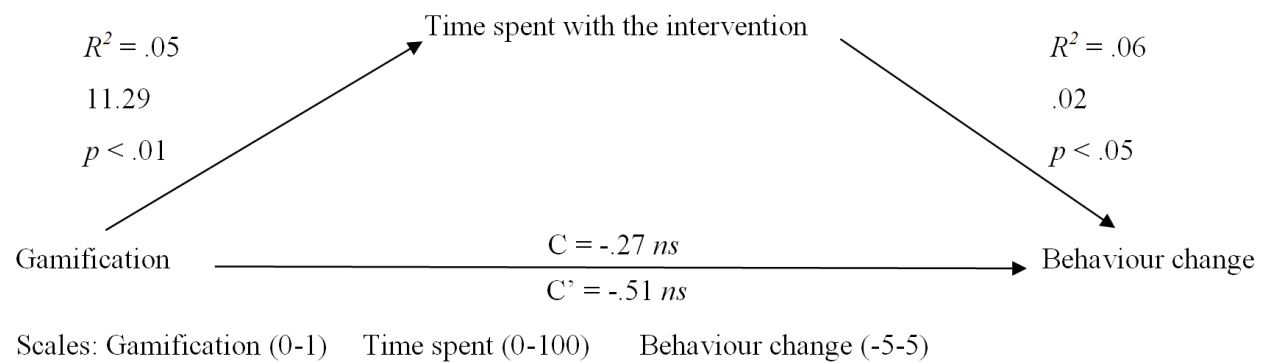
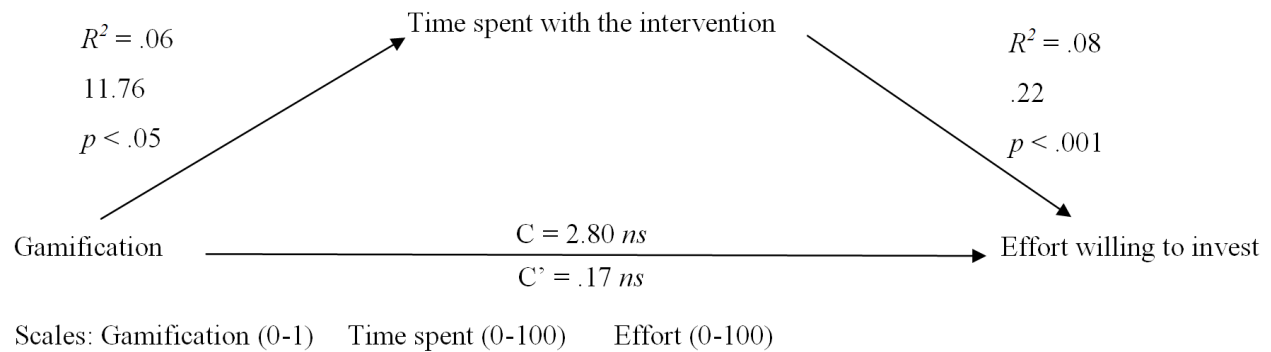


Figure 9. Mediation model for gamification's effect on behaviour change through intervention usage



In addition to the variables originally postulated by the hypotheses, an additional investigation was conducted into whether the time spent with the intervention correlated with the participants' willingness to invest effort into being sustainable. This aspect was chosen for closer examination based on participant responses to the qualitative section of the study that indicated that perception of effort played a substantial role in sustainable behaviours.

Figure 10. Mediation model for gamification's effect on effort willingness through intervention usage



None of the direct effects of gamification on the dependent variables were significant; however, apart from environmental concern, perceived barriers, and self-efficacy, all dependent variables are affected by the amount of time the participants spent on the intervention.

Despite this consistent effect of how much time participants reported having spent with their intervention on most DVs at T2, mediations of time spent on the various change variables all turned out nonsignificant. Correlations confirm the pattern (see Table 4 above) with only 'dragons of inaction'-change being correlated with time spent with the intervention.

Concerning H7, the correlation analysis showed all but environmental concern and perceived barriers being correlated with behaviour change, both at T2 and the change from T1 to T2.

Table 6. Correlations of T2 and change IVs with behaviour change

	Behaviour change
Motivation T2	.29**
Motivation change	.54**
Effort willing to invest T2	.37**
Effort willing to invest change	.53**
Knowledge T2	.31**
Knowledge change	.33**
Self-efficacy T2	.19*
Self-efficacy change	.32**
Environmental concern T2	-.09
Environmental concern change	.09
Perceived barriers T2	-.03
Perceived barriers change	-.06

* $p < .05$ ** $p < .001$

Following this initial investigation, regression analyses were performed which indicated that not all relations with behaviour change were statistically significant. First the regression was run on T2 scores, based on H7, then another regression was run on change scores. In accordance with recommendations to avoid inflated R² values, biased regression coefficients, and issues in case of collinearity, the regression was performed via entry, not stepwise (Babyak, 2004; Judd, McClelland, & Ryan, 2011; Tibshirani, 1996).

Table 7. Regression model for behaviour change based on T2 variables

	Unstandardized Coefficients		Standardized Coefficients	Sig.
	<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	
(Constant)	-2.98	.81		< .001
Motivation T2	.01	.02	.02	.88
'Effort willing to invest' T2	.04	.02	.40	.01
Knowledge T2	.03	.01	.23	.03
Self-Efficacy T2	-.01	.01	-.08	.47
Environmental concern T2	-1.00	.36	-.25	.01
Perceived-barriers T2	.41	.37	.10	.27
Model Summary	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Sig.</i>
	.48	.23	.20	< .001

Variance inflation factors indicated some collinearity between the different aspects, with collinearity diagnostics identifying the relations to be between *motivation* and *effort willing to invest*, and *knowledge* and *self-efficacy*. No VIF values were above five and the collinear aspects are conceptually related, therefore this does not pose an issue.

Only *effort willing to invest*, *knowledge*, and *environmental concern* remained significant. *Motivation* and *self-efficacy* did not predict behaviour change. The previously unconnected *environmental concern* is revealed to have predictive value. *Effort* and *knowledge* are associated with behaviour-change in the expected direction, where participants who reported more knowledge and were willing to invest more effort alter their behaviour more. Surprisingly, environmental concern had the opposite effect. The greater one's concern, the less behaviour-change was reported.

To investigate whether this might be an artefact caused by individuals with a greater level of environmental concern having reported similar levels of sustainable behaviours at the beginning and end of the intervention, a regression was run on post-intervention behaviour. However, the only remaining predictor in that model was effort willing to invest, environmental concern was insignificant. Consequently, the negative effect of concern on behaviour-change was not caused exclusively by reporting issues.

Table 8. Regression model of behaviour change based on change variables

	Unstandardized Coefficients		Standardized Coefficients	<i>Sig.</i>
	<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	
(Constant)	.03	.17		.88
Knowledge change	.01	.01	.10	.31
Environmental concern change	-.30	.25	-.10	.24
Dragons change	.38	.40	.08	.34
Self-efficacy change	.00	.01	-.07	.53
Motivation change	.03	.01	.32	.01
Effort willing change	.03	.01	.29	.02
Model Summary	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Sig.</i>
	.57	.32	.29	< .001

When examining the change variables, instead of T2 scores, the only significant predictors are motivation and effort willing to invest, although they show signs of collinearity so they likely can be collapsed into an overarching motivation change score. This would indicate that absolute scores of *knowledge* and *concern* (see T2 regression model), but only improvements in *motivation*, predict behaviour change.

Because the time participants reportedly spent with the intervention was correlated with behaviour change, a further regression was run to investigate if the model could further be improved by the addition of the variable of time spent with the intervention in addition to the hypothesised variables.

Table 9. Regression model of behaviour change based on change variables and time spent with intervention

	Unstandardized Coefficients		Standardized Coefficients	Sig.
	<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	
(Constant)	-.61	.27		.03
Knowledge change	.01	.01	.07	.46
Environmental concern change	-.21	.24	-.07	.39
Dragons change	.59	.39	.12	.13
Self-efficacy change	.00	.01	-.05	.66
Motivation change	.03	.01	.34	.01
Effort willing change	.02	.01	.27	.03
Time spent	.02	.01	.22	< .01

Model Summary	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Sig.</i>
	.61	.37	.33	< .001

The addition of time spent improved R² over the model only including the change variables. Motivation and effort willing to invest remained predictors. This indicated that the amount of time spent with an intervention has a direct effect on behaviour change unrelated to the hypothesised predictors.

In sum, hypotheses 1-6 were not confirmed because no direct effect of gamification existed on knowledge, motivation, concern, self-efficacy, perceived barriers, and behaviour

change. However, mediation models showed that the lack of direct effect for some of the variables was because of a full mediation through ‘time spent with the intervention’ at T2. The mediation models applied to knowledge (H1), motivation (H2), behaviour-change (H6), and approached significance with self-efficacy (H4). Environmental concern (H3) and perceived barriers (H5) were not associated with either gamification and the amount of time spent with the intervention. However, no such mediation existed for the amount of change in these variables between T1 and T2.

H7 was partially supported because absolute value of knowledge and environmental concern at T2 and motivation change correlate with behaviour change. In addition to these foreseen predictors, effort willing to invest at T2 also had an effect. The addition of time spent improves the predictive model further, indicating an effect not based on any of the originally posited predictors.

Qualitative question. In addition to the quantitative scales, the participants in both the before- and after-intervention survey were asked what they perceived as their personal biggest barriers against being sustainable. Their answers were classified according to the dragons of inaction model.

The dragon genera ideology or discredence did not appear to be present in this sample. Although one participant did state that they come from an “Albertan oil family,” this was mentioned as a factor in the lifestyle they were used to, not which they believed to be best. Limited behaviour was only mentioned by one participant in the form of their statement that their life was already as sustainable as they could make it.

Across all conditions, limited cognition decreased from before to after the intervention. Interestingly, all conditions reduced the number of persons who listed this as their largest barrier

by about six individuals which essentially eliminated it in the app and webpage condition (seven participants each). However, the gamified condition initially contained the largest number of participants (eleven participants) in this category and therefore only halved the number. Among all mentions in this category, most concerned a lack of easily-accessible information on more than a limited selection of topics of sustainability (e.g., lack of information on small, easy everyday changes, or that choice of clothing and toiletries are environmental issues). Some participants mentioned information overload and the need to invest time to actually research which information is worthwhile and correct.

Apathy towards the problem was rarely mentioned; however, participants expressed a lack of certainty or belief that their individual behaviours actually “make any difference.” As one participant stated, their own effect was invisible to them, so it was “difficult to feel motivated.” Another interaction with motivation was a participant requesting specific and mandatory instruction on how to live sustainable in specific living situations to make the time and effort it takes to learn how to be sustainable effective or worthwhile.

The third most mentioned genera was social comparisons. Although some mentions of norms within their families and roommate groups were expected, across all conditions a specific conceptualisation of society arose. Participants felt deeply restricted and unable to fulfill the ideal of being sustainable because of the society they lived in. The two following quotes illustrate this view well:

- “In this day and age, you have to go out of your way to live a sustainable life.”
- “I am currently habituated to my current lifestyle, as such, breaking free from that will be my biggest barrier. Additionally, society offers us little incentive to behave more sustainably but rewards us heavily for our unsustainable (sic) behaviours; going against

these ingrained norms to behave how I think is ethically/ sustainably right will also prove to be a challenge.”

As the second quote shows, many participants were aware that part of the issue was their habituation to the lifestyle our society prescribed as the norm, but they nevertheless felt that the burden to go against the grain was too much. This ranged from deep frustration with lacking transit systems, recycling systems being inconsistent or non-existent in some locations, campus residence students feeling that the university forced them into unsustainable eating habits with the lack of residence kitchens, and most everything being packaged in non-recyclable plastic, to society being so consumerist that individuals were conditioned to buy more than they really needed. Some of them suffered emotionally from this by personally trying to maximise their effect but felt depressed about all the persons around them who simply lived in a way that is normal for our society.

This sense of effortful fight to be sustainable played directly into the genera of sunk costs. Some participants directly acknowledged that they were “too lazy” to alter their habits, others were willing to admit that some of their habits and lifestyle luxuries were unsustainable but not everybody considered change possible or worth the effort. Conflicting goals played a role for a large number of participants. Even though they would be interested in being more sustainable, the importance of other goals in their lives surpassed the amount of effort and motivation they were willing to invest into changing their behaviour.

The culmination of these assessments was the repeated mention of *convenience*. Across all conditions the picture that emerged was that when the easiest, most societally-accepted option was unsustainable, then that was the behaviour that participants would show. As one participant stated very succinctly: “It needs to be convenient or I won’t do it.”

This requirement for convenience went hand in hand with the final genus, perceived risks. Some participants mentioned fear of “being the weird one” in their group. However, the overwhelming number of mentions in this category were about sustainability being risky in terms of cost, either time costs, money costs, or both. One participant commented that thanks to the intervention, they no longer saw sustainability as a financial risk, but time constraints nevertheless were prohibitive.

Perceiving no financial barrier to sustainability, however, was not the general view among participants, most of whom found the increased costs of buying eco-friendly or local goods prohibitive for students, fearing being unable to sustain themselves on their budget. One participant also mentioned that the “costs often tend to reinforce pre-existing behaviours” which exemplified how the financial cost barrier overlapped with the sunk cost dragon, because pre-existing bad habits became reinforced when altering those behaviours appeared worse than investing effort to circumvent the prohibitive costs.

Fear of time costs, apart from concern that more sustainable behaviours simply won't leave enough time for other (more) important aspects of their lives, also overlapped with other genera. One participant stated: “I also still feel my other ecofriendly habits which I do have are irrelevant as there are much larger issues at hand, out of my control. Canada plays such a small part in the world's carbon emissions, and I feel my attempts are futile in the case of saving my children's children. I think a more useful use of my time would be to send complaints/letters to different organizations in an attempt to provoke international regulations to be put in place.” This showed an overlap with limited cognition (“time is money” and low personal influence) and was a good example of how the different barriers interacted to lower the willingness and perceived ability of the participants to behave sustainably.

The general attitude towards the time-costs of sustainability was summarised well by another participant: “Everyday responsibilities outweigh in importance compared to tasks such as recycling or walking to school. Because we are so busy all the time it's easy to just say I'll just throw it in the garbage cause it's closer and one can isn't going to make a difference.”

Taken together, these answers revealed that sustainability was being conceptualised as time and money intensive, conflicting not only with many personal goals but on a large scale with the society participants live in. Persons felt restricted in how much of an effect they could have when they wanted to act sustainable because of the way that society appeared to be set up to distract individuals away from sustainability. This was seen as being caused by a lack of focus on it in media and education, and making the most convenient, readily-available option be the unsustainable one.

Discussion

Summary. This study compared three electronic resources on their effect on participants' sustainability knowledge, motivation to engage in sustainable behaviours (broken into self-reported motivation and effort willing to invest), concern about the environment, self-efficacy, perception of barriers to sustainable behaviours, and amount of reported sustainable behaviour. It was hypothesised that the base condition (webpage) would show less effect than an interactive app, that in turn, would show less effect than a gamified app. All variables were measured before the intervention and again after one month. No direct effects of gamification existed. However, the gamified app kept participants' attention for the longest, increasing the time they spent with the intervention. In turn, the time spent with the intervention increased knowledge, motivation, behaviour-change, and potentially self-efficacy at the post-intervention time. Increased absolute post-intervention values of knowledge, environmental concern and effort willing to invest, as

well as increased change in motivation and effort willing to invest, are associated with the reported behaviour change. Absolute values at T2 were correlated with time spent with the intervention and time spent also showed a direct predictive effect on behaviour change.

In this manner, knowledge and effort willing to invest were the two model variables through which gamification, by way of prolonging an individual's willingness to engage, are associated with behaviour change. In addition to this, qualitative findings showed that sustainability was construed as time and effort intensive with little effect of personal actions because of society at large being unsustainable.

Limitations. The participant sample was not representative of the wider population and therefore the findings' generalisability was limited. More specifically, the sample was 82% female and although age ranged from 18-45, the average age at 22 is low. In addition, the sample consisted of WEIRD (Western, educated, industrialised, rich, and democratic) individuals (Rad, Martingano, & Ginges, 2018). Because of this, all findings must be seen as most indicative for individuals who resemble the participants.

These peculiarities of the sample furthermore likely influenced which barriers to sustainability were encountered and perceived. A less urban and privileged sample would face different and likely more structural barriers. The apps and webpage utilised for the intervention were appropriate for this sample but need to be re-examined for use in more rural areas and especially non-Western countries.

Another limitation of the materials used was that they were not designed specifically for the study. Although consideration was taken to choose two apps and a webpage that fit the parameters of the conditions (base information, interactive, gamified) as best as possible, experimental validity was decreased by opting to use real-world resources. The increase in

ecological validity was deemed to compensate for this shortcoming because of the applied nature of the experiment.

Finally, this study relied on self-reported data and therefore suffered the common shortcomings of this methodology (Barker, Pistrang, & Elliott, 2002; Lavrakas, 2008): response bias including social desirability bias, participants' varying level of capability for accurate introspection (Nisbett & Wilson, 1977), varying interpretation of the questions asked between participants, and the restrictiveness of closed-questions. Observational data would be superior to self-report in gaining a more accurate representation of the objective reality of participants' behaviours. Self-report of behaviour is fraught with issues of participants' lack of awareness as to why they perform any given behaviour (Baumeister, Vohs, & Funder, 2007). However, the participants' subjective perception of their levels of concern, knowledge, self-efficacy, motivation, and willingness to invest effort were of particular interest to this study.

The knowledge scale in particular should be regarded with caution. It was chosen to assess a wide range of knowledge, basing itself on an understanding that all subcategories listed in the scale have effects on climate change. Higher scores thereby should represent better knowledge of the variety of everyday aspects that influence sustainability. Fifty-three participants indicated lowered scores after the intervention. Although lowered scores on knowledge scales may represent an increase of understanding that one is lacking in knowledge, the setup of this scale should not lead to lowered scores. Future research should endeavour to use a more quiz style evaluation of knowledge to avoid this issue.

Qualitative analysis. The dragons of inaction model held some problems for classifying the responses to what the biggest barrier in participants' lives towards being sustainable was.

Perceived financial risks are one of the dragons. However, in contrast to the model's 'will this make financial sense?'-uncertainty many participants expressed knowledge of their unsustainable shopping habits and interest in changing them but inability to do so within their financial means.

The dragon of 'conflicting goals and aspirations' was most prevalent in the sample on a mundane level. Rather than conflicting with life goals or aspirations towards other values than sustainability, participants were far more concerned with everyday goals and aspirations, such as being on time.

These examples indicate that the qualitative description of barriers showed more shades to how each dragon is encountered than the overall model can easily account for.

Implications. The finding that gamification has no direct effect contradicted positive results from other studies (Berengueres, Alsuwairi, Zaki, & Ng, 2013; Grossberg, Wolfson, Mazur-Stommen, Farley, & Nadel, 2015; J. J. Lee et al., 2013). However, in contrast to these studies, three forms of intervention were directly compared. Gamification affects the time individuals spend engaging with an intervention. Previous studies showing effects of gamification, without comparison to other interventions or over a shorter amount of time, may not have uncovered the mediation effect. However, in an educational context, specific aspects of gamification, rather than the gamification itself, may be at the core of gamification's general effectiveness (Sailer, Hense, Mayr, & Mandl, 2017), indicating that this study's findings may not be unique.

Because the field of gamification research advances quickly, that gamification, if indirectly, has an effect on sustainable behaviours is of less interest or surprise than it would have been a few years ago (Nacke & Deterding, 2017). More important are the improvements to a

theory of what psychological mechanisms drive gamification's effect. Namely, that its effect is mediated through the length of time for which the intervention can engage the user, and that the variables affecting behaviour change are knowledge (as an absolute score post intervention) and effort willing to spend (both the absolute score post-intervention and change during the intervention). In addition to these mechanisms the time spent with the intervention independently increases behaviour change, indicating that it may affect aspects of the model of behavioural choice not measured in this study or that there are mechanisms not accounted for in the model.

Knowledge has been used in environmental campaigns to mixed results (Geller, 2002; Geller et al., 2016; Schultz & Kaiser, 2012) but generally, knowledge alone is not enough to engage in or change a behaviour (Gross, 2012; Rimal, 2000). Other factors are necessary to be either pre-existent in the individual or also improved through the intervention for knowledge to show effects.

Self-efficacy is one factor that decreases the disparity between knowledge and behaviour (Rimal, 2000) and is potentially increased through gamification. Environmental concern was associated with behaviour change, although this effect was not caused by gamification, and is likely to interact with knowledge by way of increased knowledge moderating anxiety, which then, in turn, may influence how experiences with the environment are interpreted (Finger, 1994).

Values are another factor influencing environmental behaviour, both directly and through interaction with knowledge (Ajaps & McLellan, 2015; T. Braun, Cottrell, & Dierkes, 2018; Finger, 1994; Latif, Omar, Bidin, & Awang, 2013). Although values were not directly measured, motivation and effort willing to invest, both associated with gamification, may be indicators of values the individuals hold. Knowledge and effort willing to invest are the two variables through

which gamification is associated with behaviour change. I conclude that a higher level of knowledge post-intervention (no matter if it increased or not) is effective because of the intervention's effect on the presence (or increase) in effort willing to invest.

This interpretation is supported by the qualitative findings. An increase in effort willing to invest could counter the perception of sustainability as too effortful, while at the same time the increase in knowledge could counter the perception of one's actions being meaningless within the context of an unsustainable society, because the effects of smaller actions are now apparent to the individuals.

Future research. A replication study should be conducted with a sample more representative of the general population and utilising observation in addition to self-report measures.

In order to build upon, rather than simply validate, this study, the next step should be a large scale study with a sample size sufficient to detect lower power effects to test the full mediation effect of 'time spent with the intervention' on gamification's direct association with *knowledge, motivation, behaviour-change, and self-efficacy*.

Further research is also required on gamification's association with *knowledge* and *effort willing to invest* because these are the venues by which sustainable behaviour is influenced. This research is necessary to investigate if my conclusion that the often ineffective knowledge increase is moderated by effort willing to invest.

The lack of effect of time spent with the interaction on change from T1 to T2 but effect on T2 variables opens up the question what causes this discrepancy. Did the mere exposure to an intervention change the interpretation the participants have of the measures? The lack of correlation between the same construct at T1 and T2 might indicate as much. Only the scores on

the dragons of inaction scale correlate between T1 and T2 but at the same time show no association with behaviour change. If the effects found for time spent with the intervention, knowledge, and motivation or effort willing to invest are truly present or merely artifacts of a change in mindset upon the second exposure to the measures remains to be determined by future research using different measures and preferably less self-report based scales.

As to the question whether the independent variables influence behaviour change or merely correlate with it, the direction of the influence is based on the theory of behavioural choice. With behaviour and the independent variables having been measured at the same time it is not possible to determine in which direction the influence is exerted. A future study may endeavour to answer the question by measuring the independent variables at an earlier point than behaviour, or holding more variables steady to isolate connections. However, for the purpose of building a psychological model to guide gamification research and programming that this dissertation focuses on, the direction of the influence is of less interest than the possible recommendation for which characteristics gamification should seek to influence.

Which target group might be most fruitful to investigate for sustainable behaviour change is also something to be considered. This study focused on end consumers and everyday tasks, but arguably the highest effect would be achieved by targeting producers. In particular, agricultural producers ought to be a target demographic, given the heavy toll current agricultural practices have on the environment (Poore & Nemecek, 2018).

Study 2

During the month in which the participants in study 1 used the apps or webpage they received diary prompts every third day to inquire about their behaviour, feelings, motivation level, and encountered barriers.

Research Questions

The goal of this study was exploration rather than theory testing. Therefore, the following research questions were proposed in lieu of hypotheses:

Q1: What is the lived day-to-day experience around the topic of sustainability during a one month period?

Q1a: What sustainability behaviours do participants report?

Q1b: How do their emotions around the topic of sustainability fluctuate?

Q1c: How does their motivation fluctuate?

Q1d: What barriers to sustainability do they encounter and perceive?

Q2: How can data from Q1 be incorporated with the theory of behavioural choice?

Method

Participants. This study was conducted with the same participants as study 1. To reiterate, these participants were 160 (Females = 131, Males = 29, Others = 0) students attending the University of Victoria, recruited through the departmental research webpage for extra credit in their courses. The average age was 22 ($SD = 4.6$, range = 18 - 45). These 160 participants handed in altogether 1299 diary entries over the span of one month, ranging from four to ten entries per participant.

Procedure. While the participants were in the laboratory for their instructions for study 1, they were also informed that during the month between the two surveys they would be sent emails every third day with a prompt to fill out a short diary consisting of four questions:

- Whether they did something sustainable today and if so, what
- How they felt about living a sustainable life and whether those feelings changed after using their resource
- How motivated to be sustainable they felt today
- Whether they encountered barriers towards being sustainable today

This procedure was chosen to reduce any researcher effects by avoiding any further in-person contact with the participants after the first day in the laboratory.

Analysis approach. The diary answers were subjected to several rounds of open and then axial coding (Corbin & Strauss, 2014) to identify themes. However, rather than a full-grounded theory analysis, a thematic analysis was performed using these coding methods, because the data are not in the form of interviews, the research questions are not focussed on social processes, and, although the themes are positioned in relation to each other, developing a complete model to explain the full breadth of the phenomenon is beyond the scope of a single study (Pidgeon & Henwood, 1997).

The first round of open coding was conducted inductively, without a preconceived coding frame under consideration when choosing which features of the data to include. The second round of open coding switched from a semantic level to an interpretative level, because the study's focus lay in a description and mapping of the entire data set, rather than a detail view of only some aspects. This produced the initial themes, or axial codes, which were finalised in a

review round of coding, before axial coding was applied to map the relations between the identified themes (V. Braun & Clarke, 2006).

This process was repeated for each of the diary questions in turn, leading to themes around the topics of ‘sustainable behaviour,’ ‘feelings about sustainability,’ ‘motivation towards being sustainable,’ and ‘encountered barriers against being sustainable’. These four sub-categories were then combined into a theme map of the complete data to compare it to the theory of behavioural choice (Gifford, 2015).

Results

Theoretical saturation was achieved with the sample. On average, no new themes emerged from the data for each question after about the five hundredth diary entry. Nevertheless, all 1299 diary entries for each question were analysed to confirm this saturation.

Distributions. This section presents a numerical overview of the different questions, followed by a richer description of the diary entries. The overview was made manually by fitting a subsample of five hundred entries for each question into an appropriate model or system in hopes of gaining a first impression of how participant sentiment trended towards each question.

Sustainable behaviours. In addition to the categories of environmentally-important behaviours taken from the dragons of inaction paper (Lacroix et al., 2019), the categories nothing at all and green activism needed to be appended. The necessity for the category nothing at all should be taken as a positive sign concerning the honesty of participants’ answers, because social desirability would dictate that they always report at least some minor behaviour. The need for the green activism category is based on three types of reported behaviours: participating in environmental rallies, participating in beach cleanups, and taking care of other’s waste, both outside by picking up litter or by sorting family or roommates’ waste

for recycling. Most participants reported more than one behaviour, yet only one behaviour per category was counted, leading to the following distribution:

Waste-related behaviours made up more than a third of all reported behaviours (35%) with the most common actions being recycling and using a reusable cup.

Transportation-related behaviours were the next most common behaviour category (21%) and “taking the bus” was mentioned in most cases.

“Nothing at all” comprised 16% of all reported sustainable behaviours, followed by energy-related behaviours, which accounted for 11% and mainly consisted of switching the lights off and reducing the thermostat setting.

At 9%, water-related behaviours were the final group of behaviours mentioned with moderate frequency and participants reported showering shorter and stopping the tap while brushing their teeth most often.

At 3% each, food- and purchasing-related behaviours made up only a small percentage of all behaviours and consisted of reduction of meat, dairy, or egg consumption, which was, for the most part, an all-or-nothing decision made by the participants, and buying more locally sourced products.

The new category of *green activism* accounted for only 1% of all behaviours and primarily involved recycling for other individuals, including going through one’s roommates’ waste to sort it correctly.

Affect about sustainability. The interconnected questions of how participants felt about sustainability on that day and if using their resource changed their feeling were first analysed for the presence of specific emotions. What emotions to monitor for was decided based on a recent survey of the academic field of emotional research (Ekman, 2016). Analysis of the

data revealed that these general categories were too broad for most responses. Therefore, the subcategories of Frustration and Stress under Anger, and Hope and Contentedness under Happiness were added.

Not all participants answered in a way that inferred an emotional state and the most common answer was that they feel “as usual,” “like yesterday,” or “normal” (21%). This lack of any specific emotion was the second most-reported category.

The emotions of *Disgust* or *Embarrassment* were not mentioned by any participants at all and *Fear* and *Sadness* comprised less than 1% of the sample each.

Surprise made up 1% of the answers and was related to surprise about how much effect small behaviours can have or how participants’ habits changed now that they were monitoring for them.

Although *Anger* itself was not mentioned by any participants, the two added categories of *Frustration* (6%) and *Stress* (2%) were mentioned. *Frustration* was repeatedly about either other persons around participants not being sustainable or about feeling their own attempts being futile, insufficient or difficult; whereas *Stress* often was related to how busy their days were and that they felt too busy to be able to devote any time towards thoughts about sustainability.

Shame constituted 7% of all reported emotions but for the most part was clustered around the same participants rather than occasional instances across a larger number of individuals.

The largest number of responses belongs to *Happiness* (8%) and the two added subcategories of *Hope* (12%) and *Contentedness* (20%). More specifically, *Contentedness* was expressed as ‘good,’ which was the single most common response. When taking this into account it is likely that a substantial number of the answers counted towards *no discernable emotion*, in fact, reflected a state of *Contentedness*.

Of the respondents, 29% indicated not having used their sustainability resource on the day they filled out the diary. However, among those that gave no indication whether they had used the app or webpage, the direct emotional effect was not substantial. Only 10% reported that their feeling about sustainability changed after using their resource, and 12% reported that the resource supported the feeling they already had. These two effects were irrespective of the emotions being negative or positive, so the resource both could lead to improving or worsening mood, or support pre-existing good or bad mood.

However, the resources in general, and the two apps specifically, were described as having a mood-improving effect when participants could see that small changes to their lives also had an effect on their sustainability, or when some of their pre-existing habits turned out to be sustainable. The visualised feedback of their action's effect provided by the two apps appeared to have the strongest influence on participants' mood.

Motivation. Using the popular theory of self-determination (Ryan & Deci, 2000) respondents' answers to the question: "How motivated to be sustainable do you feel today?" were assessed for extrinsic versus intrinsic motivation in addition to how high or low the participant judged their motivation to be. Although the theory is commonly in use, the data showed very little indication of substantial differences between the kinds of motivation, where identifying whether motivation was intrinsic or extrinsic was possible at all. The only noticeably extrinsically or intrinsically-motivated entries were both in the highly-motivated category, mentioning the enjoyment of the app specifically or the personal relevance of sustainability.

The most common answer to the level of motivation was "moderately," followed by "pretty" and "fairly." The majority of answers bunched around the middle point, on a scale of ten

nearly all answers were between 5 and 7.5, with some at the lower end markedly described as “meh.”

Concerning changes in motivation among participants, the entries suggested that motivation was fairly stable. “As usual” constituted the most common answer. In addition, the level of motivation and the actual amount of reported behaviours did not appear to be linked.

Barriers. When asked whether they encountered any barriers to being sustainable on the day of the diary entry the majority (59%) answered they did not encounter any barriers. This did not, however, mean that they were sustainable on that day. For the most part, the perception of barriers on any specific day did not alter the average for the respective participant’s level of sustainability.

When barriers were perceived, the most common ones were *structural* (19%). The single most often mentioned barrier was a lack of recycling bins, followed by transportation being gasoline-based, food being packaged in plastic, restaurants providing plastic cutlery and straws unasked for, appliances being so old that they did not have an eco-setting, and could not be exchanged because of the living situation, which also led to a lack of control over the lights or thermostat.

If no structural barriers impeded the participants, conflicting goals could pose an issue (9%). These goals were, for the most part, not life goals or aspirations taking precedence over the environment, but everyday conflicts. Scheduling conflicts or unreliable public transit led to taking the car because participants could not arrive in time otherwise, recycling was unavailable nearby or difficult so they deemed it too inconvenient in that instance, participants were in a bad mood or stressed and therefore avoided anything inconvenient, or they were avoiding inconveniencing others.

In some instances (4%), participants reported that they would have liked to be more sustainable but could not because of workplace rules or conventions (e.g., food safety regulations or mandates against taking the time to recycle not to slow customer service) or because no industrial scale options were available (e.g., eco-friendly cleaners in bulk).

Lack of knowledge also was mentioned by participants (4%) as a barrier, with recycling again being a larger topic, e.g., confusion as to where some waste can even be recycled. Insecurity about which options are truly sustainable when shopping was another knowledge barrier mentioned repeatedly.

Some participants were aware that certain unsustainable behaviours of theirs are based on a lack of habits or difficulty establishing new habits (3%). The exemplary case for this were the participants who bought reusable bags to avoid plastic bags when doing their groceries but kept forgetting the bags at home when they went shopping.

Each of the following categories constituted less than 1% of responses: tokenism (“I already am sustainable enough and don’t need to do more”), interpersonal influences (“my roommates do not recycle so I cannot either”), or the view that change is unnecessary because the environment is a lost cause anyway.

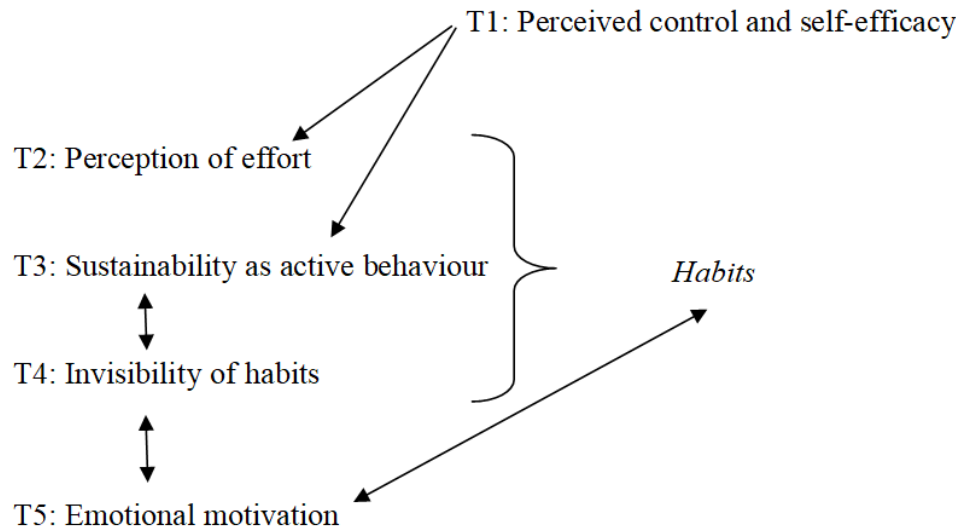
Themes. Although the diary sections’ themes showed heavy overlap and could also be seen as variations of the same themes throughout the entire data set, they are reported as distinct theme-sets to highlight the importance of the variations. The contrasts between theme-sets revealed differences in how participants conceptualized essentially the same theme depending on what frame of mind they took. These variations were highlighted in an effort to remain cognisant of the social construction of climate change (Pettenger, 2007), although a discourse analytical approach to the analysis was not employed.

Table 10. Complete theme overview

Theme	Diary Question			
	Behaviour	Affect	Motivation	Barrier
1	Control and self-efficacy	Control and self-efficacy	Self-efficacy	Controlled by society/work, self-efficacy
2	Perception of effort	Effort, effortful remembering and time costs	Effort and cost	Cost and effort, structural barriers
3	Sustainability as active behaviour	Active and all-or-nothing sustainability	Active, all-or-nothing, must fit schedule	Active, conscious deliberation, lack of habit, all-or-nothing
4	Invisibility of habits	Lack of awareness of own habits		
5	Emotional motivation	Motivation emotional, social, and individual	Individual differences in motivation	Motivation and emotion affected by barriers
6		Meaning to my actions	Meaning to my actions, visualisation	
7			Behaviour informs motivation	
8			Motivation influenced by external factors	
9				Sustainability in conflict with 'normal life'

Themes from the 'reported behaviour' question. In the following theme overview, the term Habits is italicised because it was not directly present in the data but crystalized out as a superordinate theme influencing behaviour more strongly than any other factor.

Table 11. Theme overview for ‘reported behaviours’



An overall finding was that the entire sample showed a lack of change and a lack of variation in their reported sustainable behaviours. Most commonly, participants selected a certain behaviour or set of behaviours and reported it repeatedly. However, the conceptualisation of what constitutes sustainability with these sets of behaviours was primarily influenced by perception of effort.

This difference in perception led to some participants reporting that they had been sustainable that day because they remembered to recycle the wrapper from their lunch, while other participants list dozens of behaviours but lamented that they only performed their “basic everyday sustainable actions.” For participants who had not established sustainable habits, the act of having to remember a reusable shopping bag was perceived as difficult, or the act of turning off lights when leaving a room was presented as an accomplishment, whereas participants who already incorporated sustainable habits into their lives reported the same behaviours as “nothing out of the ordinary.”

The perception of “(I) stuck to (my) routine” played into the theme of habits becoming invisible to the person over time. The actual amount of sustainable behaviours was more difficult to gauge in participants who had a higher sustainability baseline. They may have reported that they “don’t feel like I did sustainable behaviours today,” but then, unbeknownst to them, revealed in the other diary sections that they kept up several sustainable behaviours that would have been reported by other participants. The flipside to this was that unsustainable habits required conscious effort (see perception of effort) to even be noticed as behaviours the participants engage in.

This lack of awareness of which behaviours one engaged in interacted with the emotional effect, or lack thereof, that behaviours caused. When participants attempted new behaviours or remembered to act on a newly-formed sustainable habit they often reported it in conjunction with a positive emotional reaction. However, participants who habitually engaged in sustainable behaviours did not report any emotional effects any longer. Although this lack of emotional reward appeared to be linked to successfully-acquired habits, which decreased the perception of effort linked to sustainable behaviour, it also appeared to lead to complacency, because only one participant with a pre-existent high baseline of sustainable behaviours reported that they tried to include new sustainable behaviours. Furthermore, it could lead to frustration in the sustainable participants because their sustainable habits felt as if they were accomplishing “too little” and they should add “exceptional” behaviours.

This formulation of a need for exceptional acts could be traced to the same underlying theme as participants’ tendency to focus on *great effort and conscious sustainable behaviours*; namely the conceptualisation of sustainability as an active behaviour. Throughout all diary entries, irrespective of number of sustainable behaviours performed, participants had an

understanding of the society they live in as being built on a fundamentally unsustainable system. Participants viewed sustainability as an active act that went against the most convenient and low-effort option for any course of action. Therefore, being sustainable was seen as difficult to achieve in their “busy” and “stressful” lives because it required “focus.” Even participants who spent their day in bed because of illness and thereby avoided many of the usual unsustainable behaviours “don’t believe I did anything sustainable today.”

This conceptualisation of necessary active behaviours also led to an attitude of ‘all or nothing,’ where committing one unsustainable act such as “I took a long shower” emotionally overshadowed a generally sustainable routine.

The societal backdrop to this conceptualisation of sustainability as an active, all-or-nothing act was highlighted by its interaction with participants’ perception of their control over and belief in their capability to act sustainably. “Not driving anywhere” and thereby staying at home offered participants greater a sense of control than when they “had to work all day” or were “at a hotel,” which could lead to notions such as “(I) don’t know where (I) would have had opportunity.” More than location, however, lifestyle showed the largest effect with “stress” and “being busy” leading to participants feeling incapable of integrating sustainable behaviours into their already hectic lives.

In sum, sustainable behaviours were conceptualised as requiring active, conscious, and thereby great-effort acts that were seen as difficult in a society that took control over those elaborate acts away and predisposed individuals towards (unsustainable) habitual behaviours that lacked emotional effects that could influence motivation to alter habits. Overall, the strongest indicator of a person engaging in sustainable behaviours was these behaviours being ‘invisible habits,’ which thereby were seen as effortless.

Themes from the ‘affect’ question.

Table 12. Theme overview for ‘affect’

T1: Control and self-efficacy
T2: Effort (of remembering)
T3: Sustainability as active behaviour and all-or-nothing
T4: Lack of awareness of own habits
T5: Motivation as emotional, social, and individual
T6: Meaning to my actions

The diary question for this section was a compound question, asking participants not only about their current feeling about living a sustainable life but also about the influence of the intervention on said feeling. The two apps were mentioned much more frequently than the webpage as having made a difference. However, overall all three conditions reported their intervention as supporting both positive and negative emotions they had before using it on the day of the diary entry, and being capable of improving or worsening their feelings.

Marked improvements through using the intervention came from three sources: realising that small actions are a viable option to increase one’s sustainability, realising that some of the behaviours they already engage in are in fact sustainable, and seeing the effect of their actions visualised.

The visualisation and personalised feedback features of the two apps were mentioned repeatedly as a source of emotion and were described as “motivating,” “encouraging,” “shocking,” “thought-provoking,” “reminder,” “increases awareness,” and “helpful.”

Participants who were already highly motivated to be sustainable described their interactions with the apps, rather than the webpage, in several distinct ways. They felt validated or rewarded for their already-established sustainable behaviours, especially if they did not previously realise that some of these behaviours were sustainable. The app served as a reminder

to live up to their own ideals, which could lead to a feeling of not doing enough. They felt motivated by seeing the effects of their own behaviour visualised, which helped buffer against the occasional feeling of their contributions being insignificant. These positive effects notwithstanding, they did not report any specific change in feeling motivated after using the app. However, the interaction could lead to either a feeling of satisfaction or a feeling of not doing enough, and a feeling of enjoyment from learning new possibilities to be sustainable.

Participants who were not highly motivated from the beginning, by contrast, did report an increased feeling of motivation to be sustainable. Some reported this being caused by a sense of shame at not being sustainable enough or only now realising their own personal effect on the environment. These participants tended to feel reaffirmation for their motivation when they kept utilising the app throughout the month, even more so when they learnt that being sustainable is not necessarily an all-or-nothing state (T3), and that they could improve through smaller actions rather than being required to shift their entire lifestyle.

Interaction with the app was influenced by personal differences in motivation (T5). For some participants, sharing the app with their friend circle and then seeing them log in was motivating. Others did not require knowing the other users but were motivated to see that others were interested in being sustainable. For some, the social comparison or simply the feedback from the app led to apprehension about reporting on their behaviours in fear of not being good enough. The challenges included in the gamified app were highly motivating for some participants, whereas others did not make use of them. The same applied to the pointsification feature, which rewards users with an audio-visual effect each time they reported a sustainable behaviour in the app.

Across all conditions, use of the intervention declined over the course of the month. However, the gamified app was mentioned more consistently as remaining in use at the end of the month than the other conditions. How it was used differed between participants. Some continued to report their behaviours because they gained enjoyment and motivation from the personalised feedback, some treated the app as a reminder by merely seeing the icon on their phone without actually using it, and some used it as a social incentive because they knew they were part of a community of individuals trying to be sustainable.

Participants who reported having stopped using the app but nevertheless engaged in sustainable behaviours mentioned that they did no longer need the app because they now were aware of what behaviours they should alter and had built new habits. Others felt the app “boosted (their) ability” to know how to act more sustainably and made it enjoyable and easy to “quantify their sustainability.”

In sum, the apps, and the gamified app in particular, influenced emotions and thereby motivation by engaging participants through a wider range of potential motivators than a webpage could. Visualised and personalised feedback was the most important facet to evoking emotions in the participants, but the gamified app kept users’ attention longer by offering more social incentives (challenges and community), more novelty, and instant gratification (pointsification features).

Concerning the themes, a new theme emerged in this question in addition to the previous question’s five themes: *Meaning to my actions*. This theme was characterised by participants struggling with sustainability because of a sense of both social isolation and isolated action. The other themes had already made apparent that sustainable behaviours were seen as requiring great

effort, active engagement, and going against convenience. The meaning theme added to this by highlighting participants' misgivings about the significance of even attempting these behaviours.

This lack of perceived meaning could lead to cynicism, where the value of one's sustainable actions was questioned because the entire social system was viewed as "rigged" against sustainability. Meaning also came from social contexts. Participants described frustration and a wish to decrease how much they cared about the environment when watching others behave unsustainably to protect themselves from negative emotional backlash about being "the only one" (T5).

The flipside to this social contextualisation of meaning was that participants reported increased motivation and positive feelings when seeing other individuals, especially friends, on the apps. The sense of *being a part of a group* made each of their actions appear more meaningful and engaged them because they now had a sense of "your (behaviours) are a part of something bigger" and "feels good to contribute."

Not having this sense of community combined with a general lack of awareness about which of their actions specifically had consequences and therefore nothing felt meaningful. However, the personalised feedback and visualisation helped with this. The "app makes it seem more real" by having given participants the means to "record proof" that was "concrete and provable." Seeing their behaviour tracked and summarised instilled a feeling that they "might make even the smallest difference" and that sustainability "doesn't have to be so complicated."

Accuracy of the feedback was highly important for this sense of meaningfulness, the non-gamified app occasionally not distinguishing between sitting in a car or on the bus led to frustration and caring less, as did the same app providing general tips rather than ones tailored to the user. This need for accuracy interacted with the all-or-nothing theme (T3) because with

“keeping track” participants gained a new understanding and overcame their surprise and disbelief that small actions had an effect on how sustainable they lived.

Examining the differences in these themes and the previous diary question’s, the theme of control and self-efficacy had a stronger focus on self-efficacy than in the first section, with participants feeling “more comfortable because I felt I had resources at my disposal,” less frustrated and helpless because the app “boosted my ability,” leading to them trying “where I could to some extent” because they did not feel they were “being forced” but rather “empowered.”

The theme of *perception of effort* had gained a new aspect: remembering to be sustainable was seen as effortful. Participants reported improved awareness of the harm of their actions but tended to forget to act on their newly learned mitigation behaviours. They also wrote about having “forgotten about sustainability” up until they either saw the app on their phone screen or received the email-prompt for their diary of the day. Time costs were also mentioned now as an additional factor to how effortful sustainability was perceived to be. Some participants performed a cost-benefit analysis in deciding whether they were choosing the sustainable option and only opt for it if it was convenient. “Easy changes” that did not feel “patronising” were met with high motivation and appeared to be integrated into habits fast, which decreased the effort they required and shifted them over into invisible habits (T4).

Theme four, the lack of awareness of one’s own behaviours once they had become habit, partially merged with theme five, because it was mentioned primarily in conjunction with the lack of emotional effect of habits. Once participants had established a routine, no matter whether it is harmful or not, they essentially followed it unthinkingly and automatically unless something specifically reminded them of the potential to choose their actions consciously. This took the

form of lack of negative feelings about harmful behaviours, frustration and negative feelings about a constant lack of improvement in themselves when their sustainable behaviours no longer felt rewarding, and a lack of awareness around one's own sustainability. In essence, long-term sustainability was being engaged in out of habit with little emotional significance attached to the feelings which, over time, decreased motivation to be sustainable. The apps helped with a renewed positive emotional reaction and a sense of one's behaviours being important and meaningful (T6).

What is perceived as important and meaningful, however, was strongly individual. Theme five, *Emotional Motivation*, had expanded to include social aspects and differs more distinctly between participants. On the emotional side, participants expressed a range of feelings, including "guilt" and "fear" on the avoidance side, and "pride at improving" and "happy" about living a sustainable life on the approach side. Participants appeared to have an underlying understanding of sustainability being "right;" however, none of them actively voiced why this is the case.

The emotional side to motivation was apparent in the repeated report of "motivated" as an emotional state directly rather than as having any additional emotions linked to it. Feeling good was a recurring theme about their motivation, including statements such as "(I) feel good about not not (sic) living a sustainable life."

The social side to motivation was expressed in the social incentive of the apps, which was repeatedly mentioned, either by merely seeing other users, or by participants having encouraged their own social circle to sign up, for example, by having enjoyed to see "(my) roommate's progress." Some participants felt motivated to be sustainable because they could now talk to others about the topic. However, the presence of others could also decrease sustainability if one felt that nobody else in the group one is with cares about the environment.

Those differences were merely some examples of the variation in what participants described as prompting positive feelings and motivation towards sustainability in them. Some felt motivated by good weather because they remembered that they actually value the environment, some enjoyed the feeling of completion they gained from doing their normal sustainable behaviours, for some participants the instant gratification of the gamification worked because they “want to do more sustainable actions so I can hit the buzz button and get more points,” others “feel good to contribute in these small details, (and to) make habit of them.” Some participants gained motivation to be sustainable from sources unrelated to sustainability, such as monetary incentives for recycling, competing in the challenges in the gamified app, or wanting to use more sustainable technology because of “how cool” it was.

In sum, the emotional effects of sustainability were influenced by how meaningful and connected to a larger framework one’s actions appeared, how easy the actions were perceived as, especially in terms of time and memory costs, one’s belief that one was capable of performing said actions and that smaller actions had an effect, and personal factors that determined what kinds of motivation was emotionally and socially meaningful to the individual.

Themes from the ‘motivation’ question.

Table 13. Theme overview for ‘motivation’

T1: Self-efficacy
T2: Effort and cost are more important than motivation
T3: Sustainability conceptualised as active, all-or-nothing, and required to fit schedule
T5: Individual differences in motivation
T6: Meaning to my actions best seen through visualisation
T7: Behaviour informs motivation
T8: External factors influence motivation (busy, weather, others, only sustainable not enough reason)

This question produced the most divergent themes, and the largest number of themes overall, potentially indicating that motivation is the part of sustainability that participants thought most about. This possible explanation was further substantiated by the pre-existing theme of motivation having split into two full themes. Where before social and emotional aspects of motivation merely played into individual differences, in this question two independent influences to motivation emerged: individual differences and external factors.

Individual differences in motivation spanned a wide range of possibilities and showed the difficulties of finding one approach to encouraging sustainability that works for a majority of persons. Participants who were “excited to see what other actions I can do to gain points on the app and learn” or gained motivation from a feeling of “getting the hang of being more sustainable” both reacted well to the gamified tracking system of the apps. However, participants who merely “do not plan on doing anything unsustainable” required a different structure of feedback. Although some participants could not be motivated by being sustainable, others primarily struggled with sustaining their motivation longer-term. These participants appeared to find motivation to keep going in social factors. Some “want to help other people to be sustainable,” others surrounded themselves with like-minded individuals so they could “motivate each other day to day.” Social norms and responsibility appeared for the first time in the answers, as did the group-based sense of “contributing” and “part of change.”

This more social aspect was where the *Individual Differences* theme overlapped with the *External Factors* theme. After comparing the way social aspects were mentioned across diary entries, both themes were retained because the differences were larger than the overlap. The social aspects to individual motivation mentioned above were more about ways that felt motivating or were actively used to motivate oneself, whereas as an external factor, social

aspects took on the form of *the role of others* in one's relation to being sustainable. On the passive side this came in the form of observing others be highly motivated or engage in even greater-risk or unusual sustainability behaviours, e.g., becoming friends with a dumpster diver, while others were more motivated by taking the active role and "teach my roommate about when she can recycle her garbage, sometimes I go through the trash if they make mistakes."

Apart from these social external factors, the weather appeared to play a large part in participants' motivation. As one participant put it, they were "More (motivated) than usual because the weather's nice and motivates me to be more aware of my actions." This notion was repeated throughout all diary questions, good weather was seen as making sustainable behaviours easier to perform, increasing positive emotions around the environment, directly motivating, and bad weather was mentioned as a barrier towards being sustainable. Participants were less motivated to avoid taking long, hot showers and lower their thermostat in colder weather, while they were more willing to use any form of transportation other than their own car in warmer and sunnier weather.

By far the most mentioned external factor on motivation, however, was how busy or stressed the person feels. This played into the perception of sustainability as an active behaviour (T3), which in this question had acquired the additional aspect of 'sustainability being required to fit into the person's time-schedule'. When participants experienced their days as hectic or tiring, sustainability was prioritised down and despite similar motivation levels seen as not worth investing time towards, which must be taken from other parts of their day. Although for some, this issue could be alleviated if specific time schedules were involved with their sustainable behaviours, e.g., "Maybe a little more than usual because I know that the recycling is getting

picked up tomorrow and I know I need to get it organized properly so they will take it all,” for many the underlying issue was that “when I’m busier I’m less conscious of my choices.”

Habits were seen, and in fact were, less affected by external factors, including how busy the participants felt. However, many did not believe that sustainability could be habitual. It was seen as requiring conscious effort, “think(ing) ahead in situations,” “time to focus on,” active consideration that one could become “distracted” from, and a consistent perfect track record because of the all-or-nothing concept. Therefore, a common notion among participants was that they “won’t go out of (their) way.” They might have been motivated to practise sustainable behaviours if these fit into their schedule and they were neither too busy to remember nor having too “laidback” a day.

However, even if participants felt motivated, they might nevertheless not have engaged in sustainable behaviours if they felt the effort or costs were too great. Sustainable habits that were already established were not perceived as incurring costs or requiring effort, so they were engaged in even when motivation was low, they simply “keep doing what I’ve been doing” but “nothing above and beyond.” A wish for more “attainable ways” to be sustainable while “do(ing) what I can with the resources I have available,” but feeling little motivation because of lack of convenience of sustainable behaviours permeated the responses. Effort was seen as great for changes “that require me to break my cherished routine” and participants viewed it as “difficult changing lifestyles.” Costs were not only monetary, although these are mentioned, but primarily about time and energy, with some participants having fully admitted to “being lazy.” Many were willing to make “small” or “easy” changes, but bigger changes were seen as requiring too much time investment, too much going out of their way, and too many mental resources. All of these

were also mentioned by participants as decreasing barriers once they established the behaviours as habits.

This could have been partially linked to the self-efficacy of participants, where participants who engaged in habitual sustainability also talked about their sense of being able to do these behaviours more habitually. In contrast to the other questions where control was a prevalent theme, in this diary section, only a few participants mentioned a lack of control e.g., because of where they worked, whereas self-efficacy was mentioned through several of its aspects. Participants improved their self-efficacy through “focus(ing) on one little thing at a time,” better understanding how they could be sustainable by increasing their knowledge, observing others do the same behaviours they did, reminding themselves that they were “only one person, so should be satisfied with a small difference,” and several explicitly “feel like I do more after using the app.”

The app’s influence was highlighted even more in the theme of *meaning to my actions*, which was overwhelmingly tied to the visualisation of the effects of one’s behaviours in this diary section. When participants had a great cognitive distance to their effects they perceived that “there are more pressing and important matters I have to deal with right now.” In contrast, when they were “reflecting on my relationship with nature, as well as the future of a close and young family member” or “excited” about their own experiences with nature they perceived sustainability as important. Mental visualisation of the environment, either close by or in the future, was one part of making sustainability appear meaningful to their lives. The other was the aforementioned visualised feedback participants received from their interaction with the app. Seeing their effects made them aware that “simple fixes (...) will add up over time and I’ll actually feel like I’m making a difference” and once they were aware of their effects they felt

“more motivated because of the progress the app was showing me.” Seeing that one’s behaviour did indeed have an effect and seeing how changes to one’s behaviour accumulated over time made the conscious effort perceived to be necessary for sustainability meaningful and worthwhile.

Finally, a unique theme was the dynamic influence of behaviour on motivation. In previous questions, participants presented a unidirectional relation between their emotions and behaviours. By contrast, motivation appeared to be as influenced by the behaviour as the behaviour was influenced by the motivation. More specifically, participants made statements that indicated that their motivation to be sustainable dropped after they engaged in unsustainable behaviours, e.g., “less (motivated) since purchasing the take-out food.” As one participant stated, they were “Not very motivated as I did not start my day being sustainable,” but these lows tended to be on a day-to-day basis, whereas the flipside, participants feeling more motivated to do more sustainable acts right after having done any, showed less daily fluctuation, e.g., “I did many sustainable things today so feeling pretty motivated to keep it up during the whole week.”

This pattern was seen no matter why they initially tried the sustainable behaviour, as was seen with the individual differences and strong influence of external factors on motivation. Shifting one’s attitude about sustainability is easier than shifting one’s behaviour (Gifford, 2011), however, this cognitive dissonance response only was triggered if the discrepancy between the behaviour and the previously held attitude led to some emotional arousal. Repeating the same sustainable behaviours to the point where they became habit lowered the positive emotional feedback one got from them and also lowered active motivation to do the behaviours (T4). At the same time, the participants had acquired a more conscious positive attitude towards sustainability through the repeated behaviours and some felt more motivated to attempt new sustainable

behaviours once their initial ones had turned into habits: “I’ve been doing the same sustainable actions over and over each day. Today I am going to try to do new sustainable actions.”

In sum, motivation was the aspect of sustainability which was the most multi-faceted, and the one most consciously deliberated on by the participants. It was influenced by strongly divergent factors between individuals, but also by external factors that affect most participants, including whether they already engaged in sustainable behaviours influencing their attitudes. More important than high motivation, however, was whether one believes oneself capable of sustainable actions, whether they appeared worth the effort and costs, fit one’s time schedule, and were meaningful in the first place.

Themes from the ‘barriers’ question.

Table 14. Theme overview for ‘barriers’

T1: Controlled by society/work and self-efficacy
T2: Cost (money and time) and effort, structural barriers
T3: Sustainability as active, requiring conscious deliberation, all-or-nothing, and non-habitual
T5: Motivation and emotion affected by barriers
T9: Sustainability as conflicting with ‘normal life’

Some specific categories of barriers emerged; however, the overall impression was that all of them blurred together to some extent to produce a general perception of sustainability as difficult. This was most clearly shown in the newly-emerged theme of sustainability as conflicting with normal life. Scheduling meant participants “ha(ve) to drive my car.” Recycling was “hard and annoying.” Social expectations led to double flushing toilets and increased dryer use to not litter the shared space with laundry or to appear more acceptable in public. Busses were avoided because the “bus I would have taken tends to be unreliable and I needed to be on campus on time today.” The heat was continuously on “to keep us all comfortable.” “There was

no way” to avoid “using an immense amount of energy” for long distance travel. Generally, their “busy schedule prevented me from doing many of the usual sustainable things I do” and even if no barriers were perceived, sustainability is an “inconvenience.”

As previous diary parts showed as well, a large part of this perceived inconvenience was based on the construction of sustainability as an active behaviour. A participant who could “only (...) lay on the bed, (...) cannot do anything sustainable,” which fits together with reports about participants being “not actively sustainable.” When their time schedule was hectic, they viewed it as “more difficult to find the time to go out of my way to live sustainably currently, as I don't always have the time.” Even when no barriers were perceived, sustainable behaviours were not habitual but constrained by circumstances, especially when “not very many opportunities jumped at me.”

Sustainability required conscious deliberation because when participants did not expend mental resources on it, they unthinkingly followed the unsustainable affordances of their surroundings and constantly “forget” reusable bags and containers, did not “plan ahead,” or did not “stop to think about my environmental impact.” They preferred to remain with their “automatic routine” because it protected them from the *stress of being sustainable* because they were preoccupied with “other stressors,” so they could not “focus on being sustainable” and even when they attempted to do their best within their circumstances, it was not sustainable enough, so some “didn't try.” Participants conceptualised sustainability as an all-or-nothing, always inconvenient and deliberate set of behaviours that one was predetermined to fail, rather than sustainability merely requiring work to decrease the effort by establishing habits. The participants who had established sustainable habits viewed them as normal.

With this perception of normalcy came a reduced sense of costs and efforts. The difference in perception as to what was normal to do with one's banana peel serves as an example of the perception of cost and effort and how it interacted with some supposedly *structural* barriers. Participants repeatedly listed a lack of recycling and especially composting options as a structural barrier to being sustainable. However, although some participants "have to" throw their waste into the landfill bin because no other bin was close by (which can mean outside of the room they currently are in) or the signage about how to correctly recycle was not understood immediately, others viewed the same situation in a different light: "There were no bottle recycling bins close by so I carried my bottle until I found one."

These differences in what constitutes normal exertion showed a tendency for participants to choose what they personally perceived to be the path of least resistance. Rather than addressing the underlying issue, participants adapted or made assumptions, e.g., "The shower in my building takes a really long time to get even slightly warm, so it has to run for a few minutes before I actually use the water" or did not ask whether alternatives are available and then end up having "to use dairy in my coffee when I would have rather used almond or soy milk."

While the above barriers were strongly dependent on participants' perception, the money-related cost barrier could interfere even if effort and time were not perceived as a barrier to a sustainable behaviour. Several participants reported spending time on researching alternatives to their conventional grocery choices only to find that they lack the budget to switch to the less packaged alternative. The peculiarities of student life interfered with the ability to make sustainable choices, e.g., "As I was shopping the products with significantly more plastic packaging were on sale, so being a student with little funds I couldn't pass up on some of those

deals.” or “Don't have the cash flow to buy all my own groceries, so have to depend partially on family's decisions around what food to buy (organic or not, meat vs. veg proteins, etc).”

Taken together, this perception of cost and effort highlighted that sustainability was a question of capacity in terms of financial, mental, and energy resources. The more effort it took a participant to perform any sustainable behaviour, the higher the chance that the behaviour would only be performed when it was convenient. The only changes to their habitual and therefore low-effort behaviours that participants were willing to make were the ones that were seen as requiring a correspondingly low effort.

Because much of this unwillingness to expend effort was unconscious, the theme of control and self-efficacy in this diary section had, in contrast to the motivation section, a nearly exclusive control focus. More specifically, participants expressed a feeling of being controlled in their ability to act sustainable by the society they lived in and the places they worked at. Workplace regulations forced them to behave in ways they perceived as unsustainable. However, they were powerless to alter the regulations, e.g., “Yes, while working I was required to offer plastic bags to every customer and had to throw out paper receipts because a recycling bin was not provided.”

Where a lack of control over societal conventions was concerned, many perceived a distinct at home vs outside dichotomy. When at home, they “find the days that I spend at home (as opposed to going out and doing things in the city) are quite easy to be sustainable.” whereas “Being on the go means sometimes not having the resources to be sustainable.” But even in their own homes, participants felt different levels of control. Both residence students and participants who rented found their control over their sustainability limited by everything from unnecessarily flushing sensor-steered toilets (“Went to blow my nose in the school washroom and the toilet

flushed 3x because of the sensors, when it shouldn't have flushed at all.”) to constantly overflowing and therefore inaccessible recycling bins. This extended to their home community, when visiting friends was impossible without driving because they “live not on a bus route” to lack of recycling options. “I received a package in the mail with lots of styrofoam and my community has nowhere to recycle styrofoam. I store it and give it to my mom when I see her because her community has a facility.”

The control-issue mentioned the most often by far, however, was the ubiquitous use of single use items and plastic, e.g., “It's hard to feed yourself from the uvic caf and bibliocafe etc etc without your food and drinks being packaged in plastic, paper, cardboard, and the likes.” or “Styrofoam food containers at restaurant when a paper bag would have been just as good.”

Experiencing these barriers had an emotional effect on the participants. On the positive side, frustration with encountering the same barrier repeatedly could facilitate an alteration in behaviour and a subsequent decrease in frustration (“Not since trying to use only reusable materials”). At its worst, it could lead to a complete “lack of motivation to try and make a difference when I think it is a lost cause.”

Socially “it is kind of awkward” to make others aware of sustainable options and occasionally participants were “judged for recycling,” but some participants “felt good about encouraging other(s) to think sustainably.” This social side to sustainability kept some participants from speaking up in the company of individuals they cared about even when they broke with their own sustainable habits, which then was rationalised as at least they did something else, e.g., “My boyfriend doesn't recycle paper and I am staying at his apartment but we recycled bottles and cans.”

Some participants experienced substantial levels of anger and frustration in combination with a perceived lack of control over their own level of sustainability, e.g., “The recycling company won't take ‘soft’ plastics and this pisses me off. I don't care if it ‘isn't cost efficient’ to recycle it!” This was the case especially when they were unaccustomed to encountering this barrier.

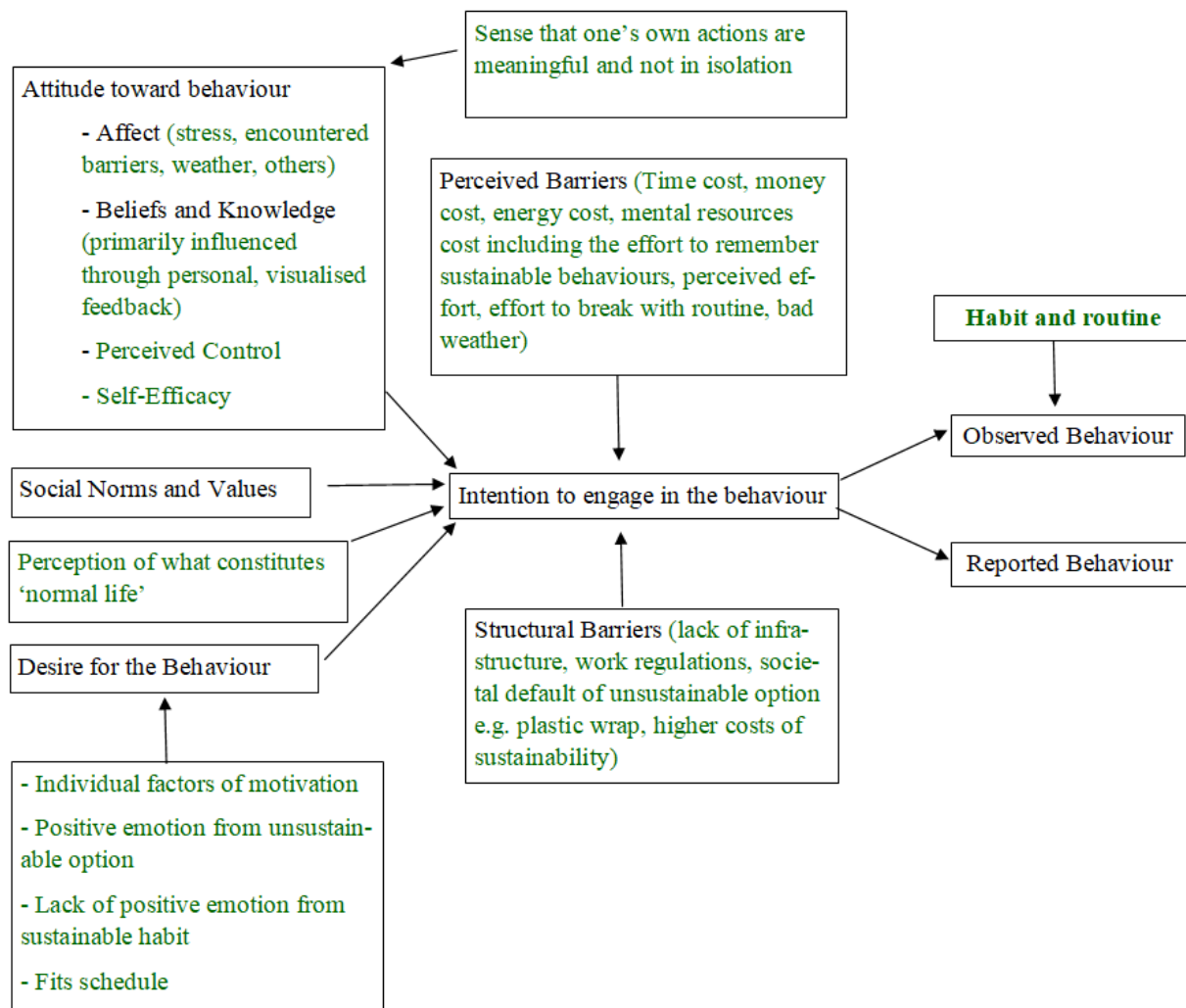
Some unsustainable behaviours elicited specifically positive emotions (“wanted to take a nice shower to treat myself” or “Sometimes I feel bottled water is more teasing than tap water.”), while a high level of care about sustainability could lead to guilt even when trying to do their best (“Today I have to drive up island, 5 hours. I am hoping to borrow my friend's veg-oil powered vehicle but I don't think that will be possible. Instead, I am driving one car with 5 people who all also need to go up island.”).

And yet again, the weather was mentioned repeatedly as an emotional barrier. Cold weather led to participants reporting they “couldn't save water while showering and it's too cold today. I kept showering since it's so comfy” and they “took the car instead of the bus.”

In sum, the perception of sustainability as being costly in time and money, requiring effort and active, conscious deliberation, conflicting both with normal life and the society participants live in, and having the potential to cause feelings of awkwardness and frustration, whereas unsustainable options are enticing, blurred together into a construction of a tremendous number of barriers against choosing a sustainable lifestyle.

Expansion of theory of behavioural choice. In answer to the second research question (How can the data be incorporated with the theory of behavioural choice?), the themes were integrated into the theoretical model (Gifford, 2015).

Figure 11. Theory of behavioural choice with integrated themes



Themes are marked in green and all themes could be integrated into the model. Many of the themes could be fitted underneath pre-existing points of the model, especially barriers and affect. However, some themes required additions to the model. Self-efficacy is a new point under *Attitude toward behaviour*, which also gained a new influence through *Sense that one's own actions are meaningful and not in isolation*. *Perception of what constitutes 'normal life'* is a new influence on *Intention to engage in the behaviour*. *Desire for the Behaviour* gained a new box of influences in the form of the individual differences to motivation, the positive emotional effects

of engaging in unsustainable behaviours rather than sustainable ones, the lack of positive, emotional reinforcement for sustainable habits, and the requirement for behaviours to fit one's pre-existing schedule.

Most importantly, and therefore marked in bold, is the addition of *Habit and routine* as a direct influence on observed behaviour. It was placed as an influence on observed rather than reported behaviour because although the data are self-reported, the diary and longitudinal structure resembled self-observation rather than reporting to a survey. Participants readily reported not being sustainable, which indicates that the rate of social desirability bias in the data was low. Therefore, I am confident in stating that force of habit, sheer behavioural momentum, is a much larger factor in what behaviours are engaged in than many of the other points of the model. Habit repeatedly determined whether the participants engaged in both unsustainable and sustainable behaviours to a larger extent than their beliefs, convictions, motivation, external circumstances, and stress-levels.

Discussion

Summary. This study followed participants throughout a month of engaging with a sustainability resource: a webpage, an interactive app, or a gamified app. In intervals of about three days, the participants answered diary prompts inquiring about their sustainable behaviours, their emotions about sustainability, their motivation to be sustainable, and whether they had encountered barriers towards being sustainable. A thematic analysis of the diaries revealed nine themes across the data, four of which were present in all questions:

- Control and Self-Efficacy
- Effort and Cost
- Sustainability as active and all-or-nothing

- Motivation as emotional and individual

The five other themes were respectively present in two sections: Invisibility of habits (behaviour and emotion question), and need to see meaning to my actions (emotion and motivation question); or one aspect: behaviour informs motivation (motivation), motivation influenced by external factors (motivation), and sustainability in conflict with ‘normal life’ (barriers).

Habit was the strongest indicator for any behaviour being performed, especially performed consistently throughout the month despite changes in how stressed and busy participants were. These habits were invisible to the participants to a large degree, causing neither emotional reactions (positive or negative) nor affecting perceived effort in upholding any level of pre-existing sustainability. This was paramount, because effort and costs (time, personal energy, and money) were strong factors in which behaviours were being attempted or performed.

When a behaviour was perceived as being under one’s control, oneself capable of performing it, the consequences of the behaviour as meaningful, aligning with one’s individual and emotional motivations, and fitting into one’s normal life, it easily became habit. However, because sustainable behaviours were conceptualised as requiring constant conscious deliberation, complete dedication, and being inherently contrary to the society participants live in, behaviour change towards greater sustainability was difficult, more so because participants felt isolated in any attempt to change.

Gamification helped with behaviour change through affecting a wider range of potential motivators than more traditional interventions. The most important factor to evoke emotions, and thereby motivation, in individuals was visualised and personalised feedback, which improved how meaningful one’s own actions were being perceived as. Furthermore, gamification engaged

participants longer through social incentives, novelty, and instant gratification, thereby increasing the chance that new behaviours became habitual.

This paramount importance of *habit* was marked by its inclusion as a direct influence on observed behaviour in the theory of behavioural choice. The other two most important additions to the model were *Sense of one's own actions are meaningful and not in isolation* as an influence on one's attitude towards a behaviour, and *Perception of what constitutes 'normal life'* as an influence on one's intention to engage in the behaviour.

Limitations. The participant sample, consisting of the same individuals as in study 1, shared the same issues: predominantly female, young, and WEIRD (Western, educated, industrialised, rich, and democratic) individuals (Rad et al., 2018). The predominance of female, young users might have influenced the findings because previous research has shown that women are more influenced by the social aspects and ease of use of gamification, and younger users show a stronger novelty effect (Koivisto & Hamari, 2014).

This novelty effect could have been another limitation of this study because the timeframe was only a month. Perceived usefulness and enjoyment of gamification decreases the longer the individual uses it (Koivisto & Hamari, 2014). However, even after a year of use, gamified conditions show improved behaviours when compared to pre-intervention levels (Hamari, 2017). The average timeframe to establish a new habit is two months but can be as short as 18 days (Lally, van Jaarsveld, Potts, & Wardle, 2010). Taking into account this variability and the gamified condition having been the one participants remained most engaged with at the end of the month, the 30-day-duration appears sufficient for the purposes of this study.

Implications. Several aspects are prominent as important additions to the theoretical framework of gamification.

The lack of difference or change in intrinsic motivation towards sustainability, both between conditions and across time, aligns with other research into gamification. This indicates that intrinsic motivation is not affected by gamification and is not one of the psychological mechanisms through which gamification influences behaviour (Mekler, Brühlmann, Tuch, & Opwis, 2017).

More important than intrinsic motivation is emotion-inspiring visual and personal feedback. The importance of the emotional reaction can be traced to the cognitive aspect of emotion and the interaction between emotion, cognition, and behaviour (Heft, 2012; Kals & Müller, 2012). The feedback elicits an emotional reaction which is compared to the ideal state of a rational decision based upon the feedback, in turn eliciting either approach or avoidance emotions (Swim, Markowitz, & Bloodhart, 2012). These emotions are stronger with gamification because the message is more personalised. Personal connection to the environment shapes behaviour and emotion (Kals & Müller, 2012) and emotional appeals are more effective in eliciting sustainable behaviours (Gifford & Sussman, 2012).

However, an emotional response alone is not sufficient. The other important component is the perception of one's actions having meaning. One aspect in which this is visible is the marked difference in which features of the gamified app were used and what was motivating to individuals. This aligns with another study's finding that the interpretation of a game element differs on what meaning is ascribed to it, which in turn influences which achievement needs are met (Cruz, Hanus, & Fox, 2017). The aforementioned emotional response to the feedback further

increases the perception of meaning, because emotion is used to evaluate the cognitive understanding of the world presented in the information (Lazzaro, 2012).

Another way in which this process of creating meaning is supported by gamification is through social incentives (Sailer et al., 2017). Gamification, especially implemented through mobile devices, is capable of utilising the growing sense of ubiquitous and pervasive networking in which smart devices are perceived as part of the individual and social interaction is constant (Susani, 2012). By linking the user into a network of others who also engage in sustainable behaviours, gamification reduces the sense of isolated and thereby meaningless action the participants in this study felt, as well as utilising social comparison (compare oneself to others) (Cruz et al., 2017), social proof (increased likelihood of engaging in behaviours others are seen to engage in), and social validation, which is the perception of behaviours being desirable because others are seen engaging in them (Hamari, 2017).

These social incentives, combined with novelty and instant gratification, capture the individual's attention for longer than other forms of intervention. Combining this with the findings from study 1 shows that this increase in time spent with the intervention drives several effects of gamification, most importantly, the potential increase of new behaviours becoming habitual. The importance of this habit formation was highlighted through the longitudinal design showing the primacy of habit over other influencing factors for determining whether sustainable behaviours are attempted.

Habit is a well-known predictor of behaviour, both through automaticity and through influencing intentions on how to act in a new situation (Ouellette & Wood, 1998). Environmental cues, according to behavioural momentum theory even when unrelated to the behaviour (Nevin & Shahan, 2011), play a large part in triggering habits (Orbell & Verplanken, 2010). Participants

reported that merely seeing the app icon on their phone reminded them of new behaviours, improving habit formation. However, this slight positive influence notwithstanding, the main issue appears to be that environmental intentions have little effect on actual environmental behaviour (more on this in study three).

Similar to the way in which habit has been added to the theory of planned behaviour (de Bruijn, Kremers, Singh, van den Putte, & van Mechelen, 2009) I propose the addition of habit to the theory of behavioural choice. I further venture that one underlying psychological mechanism accounting for gamification's effects on behaviour change is its ability to aid habit formation.

The perception of what constitutes 'normal life' is an important factor in determining whether pre-existing habits are exchanged for more sustainable ones. Many participants perceived sustainability as contrary to life in our society, but at the same time the majority recycled at least some of their waste. The *default effect* likely influences this perception of normalcy. One theme that emerged in the data was the effect of effort. Choosing the default option in a society, in this case the perceived majority's non-action on climate change-relevant behaviours, decreases effort in making the decision which behaviour to engage in, allows the participants to infer that the majority endorses a lack of action, and through previously having made the default decision endows it with a reference effect for what the correct decision is (Dinner, Johnson, Goldstein, & Liu, 2011). Being unsustainable thereby becomes the societal and personal normal.

This default choice of the unsustainable behaviour leads to a further deterioration of the participants' perception of how important environmental attitude and values are to them. The diaries revealed clear instances of cognitive dissonance, wherein participants would alter their attitudes about certain behaviours to preserve their positive self-image. Conversely, the more

sustainable behaviours they performed, the more they reported how important sustainability was to them. Shifting their attitude in both cases was easier than shifting the behaviour (Gifford, 2011), but once behaviours began to be more habitual they elicit greater environmental attitudes.

In sum, this study advanced the understanding of the conceptualisation of day-to-day sustainability. For a sustainable behaviour to be attempted in the first place, it must be perceived as meaningful, achievable without large effort, and, at least until it has become habitual, as emotionally and socially motivating. Gamification can aid in helping individuals engage in more sustainable behaviours by increasing the meaning of one's sustainable actions through emotion-inspiring feedback and social mechanisms, and through prolonging the time an individual persists in engaging with the behaviours, thereby increasing chances of the behaviour becoming habitual, in turn making it appear less effortful.

Future research. To account for the potential effects of a younger, primarily female sample a replication study with a representative population sample, preferably a non-WEIRD population, should be performed to validate this study's findings. Furthermore, the timeframe should be extended to two months or more rather than one month, in order to be able to estimate habit formation better, based on the average time for behaviour change (Lally et al., 2010).

Given the paramount importance of habit, further exploration of gamification's ability to influence behaviour change through habit formation would be fruitful. Possible mechanisms might include (Lally & Gardner, 2013): reduced effort for prospective memory tasks (remembering new behaviours), as seen by participants being reminded by merely seeing the app's icon on their phones. This could be enhanced with an interactive action plan set in the app, which would improve implementation intentions, best influenced with strict if-then rules and coping planning on how to overcome problems. Gamification, through its ability to keep

participants engaged longer, promotes continued repetition, thereby supporting the development of automaticity. This automaticity is supported by several means which align well with gamification features: *rewards* through points and instant gratification, *consistency* through personalised feedback, *automaticity of intention on complex behaviours* through social comparison, and *cues* through visual reminders and social aspects.

Another aspect that merits further research is whether gamification, through social comparison to other users, could help shift perception of sustainable behaviours towards being ‘the default or normal’. If so, it might be able to increase even sustainable behaviour the individuals do not benefit from directly, analogous to how altruistic behaviour increases when it is the default option (Everett, Caviola, Kahane, Savulescu, & Faber, 2015).

Further removed from gamification but of importance to the testing of the added aspect of ‘habit and routine’ to the theory of behavioural choice would be quantitative investigation into the role of habit on (sustainable) behaviours. In addition to the three measures of habit reviewed by Verplanken and Aarts (1999), self-reported behaviour frequency, self-reported habit-strength, and measuring the response-frequency between a situational cue and an associated behaviour, habit may be measurable by how often a new behaviour is forgotten. Participants repeatedly reported that they forgot to bring their re-useable shopping-bag or mug, equipping them with a daily diary app that they press every time they encounter an instance when their habitual behaviour kept them from implementing the new behaviour may be a way to measure habit strength and show its importance in influencing individuals’ daily behaviours.

Study 3

The first two studies sought to improve general understanding of the influence of gamification on sustainable cognition, attitudes, and behaviours. Study 3 focused on the two aspects I am personally most interested in: the role of emotional engagement and storytelling. These two aspects taken together can be seen as a form of perspective taking. Apart from personal interest, the choice of this focus is based on previous research findings indicating that gamification shows most long-term influence on behaviour change through the use of emotion and narrative (Paredes, Tewari, & Canny, 2013).

This effect can be facilitated through virtual reality (Ahn et al., 2016) and audio tapes combined with pictures (Pahl & Bauer, 2013). Immersion and perspective taking respectively influenced the effectiveness of these approaches. This study set out to test if augmented reality could achieve similar effects on perspective taking and, through that, behaviour change as the two other approaches. Augmented reality could provide an easy and cost-effective way to integrate an emotional narrative into already wide-spread applications (e.g., Google Street View), thereby reaching a large number of individuals and hopefully influencing their behaviour. In addition to augmented reality, use of a text-only version of the same story was tested to ensure that the added cost and effort of programming an augmented reality application would be worthwhile, or whether emotion and narrative drive the effects rather than the medium.

Hypotheses

H1: The augmented reality tour will lead to perspective taking

H2: Greater levels of place attachment lead to more perspective taking

H3: Greater levels of perspective taking increase concern about climate change

H4: Greater levels of perspective taking decrease spatial/temporal discounting

H5: Greater levels of perspective taking increase the intention to act more sustainable

H6: Greater levels of perspective taking increase sustainable behaviour

Method

Participants. As with the previous two studies, the participants were recruited through the psychology department's research system. Altogether 225 participants completed the study (*average age* = 22, *range* = 17 - 54, *SD* = 3.74; woman = 181, men = 42, other = 2). The sample mostly consisted of Canadians (*n* = 188) with 16.4% of participants choosing a country different than Canada as their home country.

As with study 1, the sample size was determined based on a power analysis, this time to satisfy the following requirements with four conditions: effect size = .25, significance level = .05, power = .80.

Conditions. All conditions involved perspective taking. However, the way in which it was facilitated differed.

The participants in the control condition took a virtual tour of the University of Victoria campus consisting of pictures and panorama shots overlaid with a video of a student talking about the building shown. While this was related to the university, the presentation was focused on the present rather than providing any form of assistance for the task of taking the perspective of one's own future self.

The information-only condition provided the participants with a short bullet point-style list of likely changes they will experience within the next thirty years caused by climate change without any emotional value attached to it (APPENDIX B1).

The vignette condition conveyed the same information as the information-only condition but did so in the form of a short story from the perspective of the participant's future self

(APPENDIX B2). Combining the information with a storytelling approach was meant to simplify perspective taking through making the information more emotionally accessible and engaging.

The augmented reality condition added to this storytelling approach via visual cues in the form of mock flyers from the year 2048 (APPENDIX B3), and also included a roleplaying aspect to the tour taken around the Cornett building to view the flyers to help with perspective taking through a more experiential approach than a mere story.

The future scenario presented in the information-only, vignette, and augmented reality conditions was based on a review of government reports, environmental agencies' models, and research to construct the most realistic prediction of the future (Greenaway, 2014; Murdock, Sobie, & Aubie Vines, 2017; PCIC, 2013; Yañez-Arenas, Townsend Peterson, Rodríguez-Medina, & Barve, 2016).

Procedure. After having signed up, participants were randomly assigned to one of the four conditions and informed how to access what they required. The augmented-reality tour required them to come to the laboratory; the other three conditions were online-only. The tour was kept short to balance the time spent on task in all four conditions, so that each required approximately thirty minutes for completion.

Once in the office in groups of two or three, the participants received a short introduction to what augmented reality is, how it will be used in this experiment, and then an explanation of the roleplay scenario they would be going through. The scenario was as follows: the participants are back on a visit on campus thirty years in the future. While they explore their old psychology department, they happen to run into the researcher, who then tours them around the building,

talking about the normal day-to-day at the university in the year 2048, and points out the augmented reality flyers while acting as if they are for real events.

Depending on how much the participants engaged with the roleplay and flyers, the tour took about ten to fifteen minutes, after which they were brought back to the office, completed the survey, and were debriefed.

Scales. Two questions of the survey were qualitative, one asking the participants about what they imagine would be on their mind as they leave the campus in 2048, the other asking them for three ways in which they believe climate change would affect their life in the year 2048.

The other measures consisted of a place attachment scale (Scannell & Gifford, 2013), the dragons of inaction psychological barriers (DIPB) scale (Lacroix et al., 2019), Leiserowitz' (2006) measure of climate change risk perception, and a perspective-taking measure adapted from a study on episodic future thinking (P.-S. Lee et al., 2018).

The place attachment scale was measured on a seven-point Likert scale (strongly disagree to strongly agree), and featured twenty questions pertaining to the participants' feelings and thoughts about Victoria (the city in which the study was conducted). After reverse scoring appropriate items, answers were averaged for an overall place attachment score.

Psychological barriers towards sustainable behaviour, referred to as dragons of inaction in the text and tables, were measured by way of twenty four questions about different aspects potentially impeding sustainable behaviours (seven-point Likert scale from 'strongly agree' to 'strongly disagree'). Scores across questions were combined, after reverse scoring one item, and averaged to represent an overall compound score.

The climate change risk perception scale consisted of three question groups, one about how concerned the participant is about global warming (0 – 100 from 'not concerned' to 'very

concerned’), one about how likely deteriorating standard of living, water shortages, and increased disease rates are to occur within the next 50 years because of global warming both on a global and personal level (seven-point Likert scale from ‘very unlikely’ to ‘very likely’), and how serious a threat global warming is to non-human nature, globally, Canada, British Columbia, and Victoria (five-point Likert scale from ‘no threat’ to ‘most serious threat’). Originally meant to be broken into personal and global perception of risk after standardization of all items, factor analysis did not show a clean break into two aspects. Therefore, the zscores for the entire scale were averaged to represent one overall score of climate change risk perception.

To measure perspective taking, the participants answered five questions on a seven point scale from ‘strongly agree’ to ‘strongly disagree’. The questions pertained to the aspects of ‘personal sense of having taken the perspective’, how vivid, concrete, emotional, and connected the perspective taking felt. Aspects were combined and averaged for a general perspective taking score, however, individual ratings were retained for some analysis and in those cases represent single-item scales for these aspects.

In addition to these scales, behavioural intent was measured on a 0 – 100 sliding single-item scale (‘very unlikely’ to ‘very likely’) in response to the following question: “Studies show that an effective way to save energy is to only turn on the heat when the room temperature is lower than 20 degrees Celsius. Are you willing to leave the heat turned off until it's colder than 20 degrees Celsius in your room?”

Because reliance on self-report data is problematic for sustainability behaviours (Kormos & Gifford, 2014), the survey offered the participants the following real-world opportunity to become involved in environmental action: “The UVic chapter of the Surfrider Foundation is organizing monthly beach cleanups on Vancouver Island. If you would like to learn how you can

be a part of these, please put your email in here.” Having provided an email or not was dummy coded as 0 (no environmental action) and 1 (environmental action taken).

Results

Descriptive statistics. As a first step scales were checked for reliability.

Table 15. Cronbach’s alpha scores for all multi-item scales for study 3

Scale	<i>Mean</i>	<i>SD</i>	<i>Cronbach’s α</i>
Place attachment	13.64	19.85	.93
Perspective taking	.78	5.98	.82
Dragons of inaction	-26.70	15.09	.88
Climate change risk perception	-.02	7.94	.88

In addition to the composite scores from the different scales, the subcategories of perspective taking are presented because different aspects turned out to be independently relevant from ‘future-self perspective taking.’

Table 16. Descriptive statistics for study 3

	<i>Min</i>	<i>Max</i>	<i>Mean</i>	<i>SD</i>	<i>Skewness</i>		<i>Kurtosis</i>	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Subjective perspective taking	-3.00	3.00	0.24	1.54	-0.45	0.16	-0.83	0.32
Vivid perspective taking	-3.00	3.00	-0.08	1.54	-0.20	0.16	-0.93	0.32
Concrete perspective taking	-3.00	3.00	-0.12	1.65	-0.04	0.16	-1.14	0.32
Emotional perspective taking	-3.00	3.00	0.75	1.56	-0.67	0.16	-0.23	0.32
Connectedness to future self	-3.00	3.00	-0.03	1.56	0.02	0.16	-0.82	0.32
Behavioural intent	0.00	100.00	85.46	21.12	-1.97	0.16	4.02	0.32
Behaviour	0.00	1.00	0.41	0.49	0.37	0.16	-1.88	0.32
Dragons of inaction	-2.81	1.81	-1.27	0.72	0.43	0.16	0.98	0.32
Place attachment	-2.90	2.90	0.68	0.99	-0.53	0.16	0.40	0.32
Climate change risk perception	-2.73	1.32	-.01	.66	-.87	0.16	1.28	0.32
Future-self perspective taking	-2.80	3.00	0.16	1.20	-0.22	0.16	-0.38	0.32

Overall, examination of Q-Q plots indicated satisfactory, if not perfect, normal distribution. However, behavioural intent deviated in that it showed less variation. Fewer participants than expected for a normal distribution indicated low or high scores, and more participants indicated slightly above midrange scores, skewing the mean towards positive answers. This flatter bell curve is similar enough to a normal distribution to assume that it would not pose substantial, statistical problems based on the number of participants (more than twenty per condition).

The other non-normal distributed variable was climate change risk perception, lacking participants with low scores. Participants in this study were predominantly female and younger, both of which are demographic characteristics linked to higher belief in climate change (Weber,

2016). This highlights the need to be cautious about the generalisability of the findings but does not invalidate them.

Quantitative analysis. Correlational and MANOVA analysis showed significant condition-effects on both average future-self perspective taking and subcategories thereof. Dummy-coded analysis to distinguish which condition led to the effects revealed that the relation between overall perspective taking and the AR condition did not hold up to statistical tests. However, the AR-condition was linked to how much the participants themselves believed they took the perspective of their own future self, whereas the vignette-condition is linked to how vivid the perspective taking was. These two conditions were statistically different from both the information-only and the control condition.

Because the shared underlying aspect between the AR-condition and the vignette-condition was *storytelling*, they were combined into a *storytelling*-condition and compared to the combination of the information-only and the control-group, because neither of these conditions employed storytelling. In summary, the original four conditions of AR, vignette, information-only, and control, were split into the storytelling condition (AR and vignette) and no-storytelling condition (information-only and control). Another MANOVA was conducted to check if this recombination changes condition-effects.

Table 17. Correlations of storytelling conditions and DVs

	Story-telling	Place attachment	Dragons of inaction	Risk perception	Perspective taking	Subjective PT	Vivid PT	Concrete PT	Emotional PT	Connected PT	Behavior intent	Behavior
Story-telling	1	.01	.15*	-.15*	-.18**	-.24**	-.19**	-.18**	-.03	-.06	-.07	-.18**
Place Attachment	.01	1	-.09	.08	.07	.06	.07	.01	.01	.15*	.05	.14*
Dragons of inaction	.15*	-.09	1	-.37**	-.11	-.15*	-.01	-.04	-.08	-.11	-.16*	-.21**
Risk Perception	-.15*	.08	-.37**	1	.21**	.14*	.12	.21**	.24**	.11	.11	.15*
Perspective Taking (PT)	-.18**	.07	-.11	.21**	1	.73**	.79**	.79**	.72**	.78**	.18**	.21**
Subjective PT	-.24**	.06	-.15*	.14*	.72**	1	.56**	.48**	.31**	.42**	.16*	.15*
Vivid PT	-.19**	.07	-.01	0.12	.79**	.56**	1	.57**	.42**	.49**	.13	.11
Concrete PT	-.18**	.01	-.04	.21**	.79**	.48**	.57**	1	.44**	.49**	.19**	.03
Emotional PT	-.03	0.01	-.08	.24**	.72**	.31**	.42**	.44**	1	.59**	.15*	.22**
Connected PT	-.06	.15*	-.11	.11	.78**	.42**	.49**	.49**	.59**	1	0.07	.31**
Behavior Intent	-.07	.05	-.16*	.11	.18**	.16*	.13	.16**	.15*	.07	1	.11
Behavior	-.18**	.14*	-.21**	.15*	.21**	.15*	.11	.03	.22**	.31**	.09	1

* $p < .05$ ** $p < .01$ level

Storytelling: 1 = Yes, 2 = No

Table 18. MANOVA and ANOVA tests by original conditions compared to by storytelling conditions

Multivariate Test	Original Conditions (<i>df</i> = 3)					Storytelling conditions (<i>df</i> = 1)			
	<i>F</i>	<i>df</i>	<i>Wilk's A</i>	<i>Sig.</i>		<i>F</i>	<i>df</i>	<i>Wilk's A</i>	<i>Sig.</i>
	2.67	(27, 620)	.73	<.001		.87	(9, 214)	.87	<.001
Univariate Tests	Type III Sum of Squares	Mean Square	<i>F</i>	<i>Sig.</i>		Type III Sum of Squares	Mean Square	<i>F</i>	<i>Sig.</i>
Behavioural intent	4580.51	1526.84	3.54	.02		488.53	488.53	1.10	.30
Behaviour	1.92	.64	2.69	.05		1.71	1.71	7.22	.01
Dragons of inaction	8.72	2.91	6.01	<.01		2.56	2.56	5.06	.03
Climate change risk perception	2.72	.91	2.11	.11		2.06	2.06	4.79	.03
Future-self perspective taking	11.37	3.79	2.71	.05		10.60	10.60	7.63	.01
Subjective perspective taking	42.77	14.26	6.47	<.001		30.44	30.44	13.60	<.001
Vivid perspective taking	23.23	7.74	3.37	.02		18.82	18.82	8.18	<.01
Concrete perspective taking	20.01	6.67	2.50	.06		19.43	19.43	7.35	.01
Emotional perspective taking	1.67	.56	.23	.88		.47	.47	.19	.66
Connectedness to future self	3.57	1.19	.49	.69		1.78	1.78	.73	.39
Conditions	AR, Vignette, Information-only, Control					Storytelling, No-storytelling			

The shift towards the conditions differentiating between storytelling or not, rather than specific modes of storytelling led to all aspects of perspective taking, apart from emotional perspective taking and a feeling of connectedness with one's future self, showing condition effects. In other words, storytelling affected participants' own perception of having taken their own future perspective, how vivid their perspective taking was, how concrete they could envision the future, and their overall perspective taking. Hypothesis 1, which stated that augmented reality would lead to perspective taking, thereby was partially confirmed. However, the use of storytelling in presenting the future was more important than the medium of augmented reality.

A regression analysis confirmed the causal relation between storytelling and perspective taking. In accordance with recommendations to avoid inflated R² values, biased regression coefficients, and issues in case of collinearity, the regression was performed via entry, not stepwise (Babyak, 2004; Judd et al., 2011; Tibshirani, 1996).

Table 19. Regression model for future-self perspective taking

	Unstandardized Coefficients		Standardized Coefficients	<i>Sig.</i>
	<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	
(Constant)	.69	.31		.24
Place Attachment	.06	.08	.05	.47
Storytelling	-.38	.16	-.16	.02
Climate Change Risk Perception	.33	.13	.18	.01
Dragons of Inaction	-.01	.12	-.01	.91
Model Summary	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Sig.</i>
	.27	.07	.06	<.01

The same regression failed to confirm the second hypothesis that place attachment would lead to more perspective taking. The power of this inference was limited, however, because several participants contacted the researcher after the survey to apologize because they believed they might have filled out the place attachment scale incorrectly because it differed from the others in which direction the Likert scale was indicating stronger agreement.

Concerning the third hypothesis, that greater levels of perspective taking lead to increased concern about climate change, the regression revealed that only one aspect of perspective taking had an effect on concern: how strong participants reacted emotionally to what they envisioned occurring in their own future.

Table 20. Regression model for climate change risk perception

	Unstandardized Coefficients		Standardized Coefficients	<i>Sig.</i>
	<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	
(Constant)	-.09	.05		.11
Took Perspective	.03	.04	.07	.38
Vivid	-.02	.04	-.04	.62
Concrete	.05	.03	.13	.14
Emotional	.11	.04	.25	<.01
Connected	-.05	.04	-.11	.23
Model Summary	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Sig.</i>
	.28	.08	.06	<.01

This was a partial confirmation of the hypothesis, although not a strong predictor.

The fourth hypothesis, that perspective taking decreases spatial/temporal discounting, was indicated to have some merit by the correlation between future-self perspective taking and climate change risk perception ($r = .21, p < .001$). Regression on the ‘dragon of inaction’-item:

“These problems are so far in the future, so there is no need to act.” showed that increases in future-self perspective taking decreased the perception of temporal distance but should be regarded with caution because it was a single item scale.

Table 21. Regression model for temporal discounting

	Unstandardized Coefficients		Standardized Coefficients	<i>Sig.</i>
	<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	
(Constant)	1.77	.07		< .001
Future Self Perspective Taking	-.11	.06	-.13	.05

Model Summary	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Sig.</i>
	.13	.02	.01	.05

The qualitative analysis also revealed that participants in storytelling conditions, especially the vignette condition, were more likely to relate the future to their own circumstances in the present and to mention that they should act now. Taking the quantitative and qualitative results together, indication existed that temporal discounting is reduced through perspective taking. However, the data were not conclusive enough to make statements about spatial discounting.

Concerning hypothesis five, that perspective taking increases the intention to act sustainably, the regression for behavioural intent shows one perspective taking aspect asserting influence: how emotional the perspective taking was.

Table 22. Regression model for behavioural intent

	Unstandardized Coefficients		Standardized Coefficients	<i>Sig.</i>
	<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	
(Constant)	.27	.19		<.00
Place Attachment	.04	.03	.07	.75
Storytelling	-.18	.07	-.18	.55
Climate Change Risk Perception	.08	.05	.13	.84
Dragons of Inaction	-.06	.05	-.09	.03
Took Perspective	.01	.03	.03	.44
Vivid	-.01	.03	-.04	.81
Concrete	-.07	.03	-.22	.13
Emotional	.03	.03	.09	.04
Connectedness	.10	.03	.32	.07
Model Summary	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Sig.</i>
	.29	.08	.04	.03

Table 23. Regression model for behaviour

	Unstandardized Coefficients		Standardized Coefficients	<i>Sig.</i>
	<i>B</i>	<i>Std. Error</i>	<i>Beta</i>	
(Constant)	.43	.18		.16
Place Attachment	.04	.03	.07	.25
Storytelling	-.17	.07	-.17	.01
Climate Change Risk Perception	.05	.05	.06	.37
Dragons of Inaction	-.07	.05	-.11	.15
Took Perspective	.01	.03	.04	.66
Vivid	-.01	.03	-.03	.72
Concrete	-.07	.03	.22	< .01
Emotional	.03	.03	.11	.22
Connectedness	.01	.03	.31	< .001
Behavioural Intent	.01	.01	.04	.51
Model Summary	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Sig.</i>
	.43	.18	.14	< .001

For hypothesis six (increased future-self perspective taking increases sustainable behaviour) two of the subcategories were important to increased sustainable behaviour: how concrete the events were that participants envisioned their own future self to experience, and how connected they felt to their own future self. This confirmed hypothesis six and shed light on the specific qualities perspective taking must fulfill to influence sustainable behaviour.

Both for H5 and H6 the regressions with the compound variable 'Future-Self Perspective Taking' were inferior to the presented regressions (H5: $R^2 = .08$, *ns* and H6: $R^2 = .08$, $p = .001$). All regression models had VIF scores below two and therefore show no signs of problematic multicollinearity between the factors.

The analyses above revealed some additional findings unrelated to the hypotheses. Being in a storytelling condition in contrast to a non-storytelling condition increased sustainable behaviour directly, whereas one's intention to act sustainable had no effect on actual behaviour. Perceiving fewer barriers towards sustainability, shown through the dragons of inaction scale, increased the intent to act sustainably. Additionally increased climate change risk perception led to increased future-self perspective taking.

Qualitative analysis. Two of the questions in the survey were qualitative. They followed after the place attachment scale but before any questions about climate change to avoid priming participants.

General thoughts question. The first question asked the participants to list three thoughts they would have while leaving campus after their stay in 2048.

The responses to the question showed a trend between conditions where fewer participants mentioned environmental or nature related thoughts the less involved the condition was. Of the approximately 56 participants in each condition, 47 in the AR condition, 43 in the

vignette condition, 28 in the information-only condition, and 22 in the control condition mentioned the environment, nature, or climate change at all.

The type of mentions also varied between conditions, however, some themes existed across conditions:

The link between the increased coffee prices and climate change-induced production difficulties was the least understood of all the climate change effects in the study. This occurred even though the link was explicitly mentioned in the information-only condition. Generally, the agricultural effects seemed the least expected and understood.

Some participants across conditions mentioned concern about the situation in Victoria and wondered where they might be able to move to avoid the effects of climate change, demonstrating a lack of understanding of the global nature of climate change.

Not a single participant was aware that Victoria already has drought conditions today during the summer. This lack of awareness about the current situation led to several of them questioning the likelihood of drought in the 2048 scenario.

Only a small number related the 2048 situation to themselves in 2018. Personal experience with relevant situations helped these participants see the connection. For example, one participant had been homeless for a time and worried about how bad the conditions for homeless persons would be with the drought, another participant recalled arguing with their father, who denied climate change existed.

Apart from the expected emotional responses to the increase in coffee price, which was mentioned most often, and to the rattlesnakes and sharks, some participants appeared to also engage in emotional self-regulation. Several different strategies were used, for example, “only one of many possible futures,” “it only appears a stark contrast because of the direct comparison,

by 2048 I'll be used to it," "it's different but no worse," and a small number of participants stated that the future changes seemed positive.

In addition to these trends across conditions, some condition-specific observations were made:

In the AR condition, a number of participants thought that climate change would have improved by 2048. Most mentions of the environment or nature were climate change-focused but this was also the condition with the most participants hoping for techno salvation from the issues of climate change.

In the vignette condition, more participants than in the other conditions commented on the need to do something right now. However, one participant also mentioned the feeling of powerlessness, that even if they altered their behaviour, too many others would not, rendering their efforts meaningless. This was also the only condition in which participants commented on the increased restrictiveness experienced through the visibility of water use advisories and regulations of outdoor activities.

With the information-only condition, the emotional effect of the experience began to decrease. The coffee price and rattlesnake continued to evoke strong responses, but the mentions of the environment or nature decreased markedly and also began to shift to more aesthetic aspects.

In the control condition, essentially all mentions of nature or the environment were about beauty or personal enjoyment, for example, liking the nature integration in the campus. This may have been a by-product of this condition including a virtual tour of the campus that mentioned the University of Victoria's sustainability goals. In contrast to that, several participants worried that no trees would be left on campus. Technological advances were mentioned more in this

condition as well, renewable energy, zero waste, and carbon neutrality were named, among others.

Climate change effects. The second qualitative question asked the participants to list three consequences of climate change that would have a personal effect on them.

Based on the flyers presented in the AR condition, which also informed the vignette and the information presented in the information-only condition, the responses were investigated for the presence of the following seven themes: restrictions on outdoor use, (summer) heat, forest fires and smoke, changing natural environment, drought and water issues, animal migration, and food availability.

The conditions differed markedly in how often the themes were mentioned, speaking to the vividness of the AR condition with 146 theme mentions. In the vignette condition the themes were mentioned 119 times, compared to 105 in the information-only condition. As can be expected from the control condition with its complete lack of priming for any sustainability concerns, the mention of themes was drastically reduced with only 58.

The AR-condition was the only condition in which heat was not the most mentioned theme, rather *forest fires and smoke* (32) was the theme that captured participants most; followed by *drought and water issues* (27), with *heat* a close third (26). Interestingly, the strong reaction in the general thoughts on the price of coffee and the rattlesnakes notwithstanding, the themes of *animal migration* (13) and *food availability* (11) were the two least mentioned themes.

Animal migration specifically seemed not to be on participants' minds with the vignette-condition having had 5, and the information-only condition having had 6 mentions. As low as this might be, all of these primed conditions had at least some mentions of it, whereas the control

condition did not have a single mention of the theme, indicating that the thirteen mentions in the AR-condition were a marked increase of awareness of the issue.

The theme of *food availability* may have revealed a lack of understanding of the effects of climate change on agriculture. The strong reactions to the increased price of coffee notwithstanding, most conditions showed comparatively low amounts of mentions for the theme of *food availability*. The exception to this was the information-only condition, which was the only condition in which climate change affecting agricultural production of certain foods was stated. In this condition, *food availability* was the second most-mentioned theme (23).

Heat was the most-mentioned theme across the vignette, information-only, and control condition. This was not surprising when one takes the close association of global warming with climate change into account; however, the control condition revealed that this association might begin to change. As the only condition not primed with a specific mention of summer heat it had participants mention *increases in extreme weather* more often (15) than mere *heat* (13). *Extreme weather* was also mentioned in the vignette condition (12) and the information-only condition (5), but not in the AR-condition.

This pattern also held for *sea level rise*, which was a theme that was not addressed in the information relayed to the participants. Nonetheless, it was mentioned across conditions, but least in the AR-condition. One possible explanation could be that the AR-condition focused participants' attention more on the specifically-addressed effects of climate change rather than their general knowledge of it. This could be problematic if it decreased awareness of issues unmentioned in the specific intervention, but could also be beneficial if it made hitherto unfamiliar issues seem more relevant. This appears to have been the case for the theme of *drought and water issues*, which was the second-most mentioned theme in the AR-condition (27)

and the vignette condition (27) but the second least-mentioned theme in the information-only (7) and control condition (6).

Some non-provided themes were mentioned across conditions (health, cost of living, air quality); however, some trends and differences existed between conditions in the way they were mentioned. Despite the aforementioned potential overreliance on the themes presented, participants in the AR condition generated more different themes than participants in other conditions. Many of them showed a pattern towards being based more in personal experiences, maybe indicating that the AR-condition led to a more personal perspective-taking approach.

The vignette condition was the only condition in which several participants mentioned sadness about a loss of beauty or greenery, and especially that they disliked that their children would not have the same childhood experiences with nature as they themselves did. Both the information-only condition (10) and control condition (12) mentioned emotional effects of climate change for various reasons, with guilt, anger, and frustration being more common in the information-only condition, and bad moods because of heat and loss of nature more common in the control-condition.

Lastly, participants in the information-only condition mentioned economical change specifically, whereas participants in the control condition were the only ones repeatedly mentioning changes to transportation e.g., that they must buy an electric vehicle or not be able to drive a car otherwise. The control condition also stood out in that the climate change effects mentioned were much vaguer and general than in the other conditions, giving the impression that participants were repeating statements read in the media rather than thinking from the perspective of their future selves.

Discussion

Summary. This study investigated the effects of various forms of presenting climate change information: through an interactive augmented-reality tour, a short story, or a list of bullet-point facts. The form of presentation was hypothesised to affect climate change risk perception, amount of future-self perspective taking, intent to act sustainable, and actual sustainable behaviour. Place attachment was expected to moderate the effects.

Contrary to the hypothesis, storytelling rather than the use of augmented reality had the largest influence on future-self perspective taking. Perspective taking influenced climate change risk perception if the future envisioned caused an emotional reaction. This increase in risk perception, combined with lowered scores for the specific dragons of inaction item and qualitative results, in turn, indicated that future-self perspective taking decreased temporal discounting. An emotional reaction to taking one's future-self's perspective increased intention to act sustainably; however, actual sustainable behaviour was influenced primarily by how concrete the events envisioned were and how connected the person felt to the envisioned future.

Place attachment had no significant effect. This, however, was potentially caused by inconsistency in how the place attachment scale was filled out by participants and should not be seen as conclusive. In addition to the hypothesized effects, storytelling had a direct effect on sustainable behaviour, whereas behavioural intention did not. Perception of fewer barriers increased intent, but not actual behaviour. Climate change risk perception improved future-self perspective taking.

Conceptualisation and understanding of climate change showed a general lack of awareness of climate change affecting food production and availability. Some participants thought moving away from climate change effects was possible and awareness of already

existing and likely future conditions in Victoria was low. Current experiences with climate change improved chances of relating the future scenario back to the present, although strong negative emotions could lead to self-regulation strategies including denial of the severity of the future situation, reliance on techno salvation, and declaring any actions they could do now as meaningless. Unless primed with any mention of climate change, participants focused on aesthetics and personal enjoyment of the environment in their vision of the future.

Storytelling led to significantly more mentions of specific scenarios when asking participants how they would be personally affected by climate change. Heat, forest fires and smoke, and water issues were the issues most capturing participants attention, whereas awareness of and focus on animal migration, and food availability were low. Explicit description of food availability being connected to climate change buffered against this lack of awareness. Although heat remained a major part of the conceptualisation of climate change, participants showed an increase in awareness that extreme weather would also become more prevalent. Irrespective of condition, participants expected climate change to affect their health, cost of living, and air quality.

Limitations. As in study 1 and 2, the participants were WEIRD (Rad et al., 2018), predominantly female (80%), and young with an average age of 22. Again, this led to difficulties in generalising the findings to other populations. The gender imbalance, especially, could be a potential issue because perspective taking constitutes a sub-construct of empathy, which has often been reported to be greater in women (Toussaint & Webb, 2005). However, closer inspection of the issue reveals that the empathic differences, most importantly here differences in perspective taking capability, between men and women are based in self-report data and vanish when neuro-scientific and behavioural scales are used (Derntl et al., 2010).

The augmented reality setup used in this study was comparatively basic, consisting of simple 2D flyers superimposed onto walls and tag-boards around the psychology department familiar to the participants. In a study using virtual reality, immersion in the scenario was an important factor for improving the participants' sense of interconnectedness with nature and thereby perception of the imminence of environmental risks (Ahn et al., 2016). Extrapolating from this, a more interactive and thereby immersive form of augmented reality would likely have shown different and greater effects.

To partially offset the simplistic augmented reality implementation, it was intermixed with a roleplaying approach to the augmented reality tour. Although this improved the immersion, it changed the experience. An unguided augmented reality tour, incorporating the roleplaying into the app directly for better gamification, would lead to more augmented-reality specific findings. However, because the storytelling aspect appeared to be more important than the specific tool used to deliver the story, the importance of the finding that augmented reality can be used for conveying a story outweighs the details of the technology used.

Another potential setup factor is that merely a future scenario was presented, without offering any solutions to the issues evident in it. Presenting a fear-inducing message without also presenting an attainable way to avoid the event increases the likelihood of denying the possibility and severity of the event and decreases chances of behaviour change (Aronson, 1997; Devos-Comby & Salovey, 2002). Therefore, it is possible that this study induced less environmental behaviour than a study which presented easy steps to be more sustainable now in addition to the future scenario would have.

Methodological limitations of this study were the use of single-item scales for temporal distance and aspects of perspective taking, and the likely response issue for the place-attachment

scale. Single-item scales generally were viewed as problematic. However, studies on the subject indicate that reliability and validity do not necessarily differ from multiple-item scales (de Boer et al., 2004; Wanous & Hudy, 2001; Wanous & Reichers, 1996; Yohannes, Dodd, Morris, & Webb, 2011). The potential of a substantial number of participants having filled out the place-attachment scale incorrectly cannot be tested and so any findings about place attachment should be viewed as potentially flawed.

The variable behavioural intention showed a non-normal distribution which may be partially at fault for the lacking relation between sustainable intentions and behaviour. However, this finding should not be dismissed. Not only does it align with other research (Davies, Foxall, & Pallister, 2002) but sustainable intentions not being predictive of behaviour has far reaching theoretical and behaviour intervention design implications. For these reasons it is treated as a valid finding.

Implications. The importance of storytelling rather than the specific medium it is conveyed by aligns with previous research. In the field of health and wellness, dramatic game elements (narration, avatars, metaphors, etc.) have been shown to have the greatest effect on long-term behaviour change (Baranowski, Buday, Thompson, & Baranowski, 2008; Paredes et al., 2013). In the environmental field, audio tapes paired with photos (Pahl & Bauer, 2013) and virtual reality (Ahn et al., 2016) both improved various sustainability-related variables, showing that a wide range of storytelling devices can be effective.

The similarity in effectiveness between a written story and a roleplay-facilitated augmented reality approach brings the primacy of other aspects to the foreground. Perspective taking is the vehicle by which the story affects sustainable behaviours, which aligns with previous research on episodic future thinking (P.-S. Lee et al., 2018). Envisioning concrete

events and feeling connected to one's own future-self had the greatest effect on behaviour, emotional reaction to the perspective taking the greatest effect on behaviour intent. Borrowing concepts from the field of communication research into narrative persuasion and entertainment-education, these findings fit into the framework of the importance of involvement, transportation, and emotion.

Involvement with a specific character is similar to the feeling of connectedness with one's future self and is important for individuals to feel transported by the narrative and therefore emotionally involved, which in turn influences knowledge, attitudes, and behaviour (de Graaf, Hoeken, Sanders, & Beentjes, 2012; Frank, Moran, Patnoe-Woodley, & Murphy, 2011; Murphy, Frank, Chatterjee, & Baezconde-Garbanati, 2013). Reacting emotionally to the presented scenario influenced the participants' behaviour intent and climate change risk perception, which in turn improved perspective taking, indicating a dynamic relation between involvement and emotion. The emotional tone or seriousness of the narrative influences which aspects are most influential. Although the tone of the tour was kept light to invoke an 'everyday'-feeling, the presented information was likely perceived as somber. In contrast to a more comedic presentation, which would benefit from relatability, positive emotions evoked, and entertainment, this somberness likely led to the primacy of transportation and negative emotions evoked (Borum Chattoo & Feldman, 2017).

Another aspect of narrative persuasion which likely played a part in the effect of the intervention is its high external realism, in which the narrative's world appears similar to the real world. The scenario was based on research into the scientifically most likely future of the location the study was conducted at. This localisation to an environment familiar to the participants improved external realism, which influences how much causal statements for events

in the narrative are being accepted as truthful (Dahlstrom, 2015). In turn, this acceptance of the future reality could have increased the emotional effect of perspective taking, which influences the intention to act more sustainably, in order to prevent the seemingly plausible, unwanted future scenario.

The qualitative data point to one potential aspect undermining the external realism of the scenario. Participants appeared to be unaware of the already existing drought conditions in Victoria during the summer months, which decreased the likelihood of the scenario being accepted as truthful or likely to occur. If this breaks the immersion, shown in virtual reality to be an important factor (Ahn et al., 2016), it might indicate one way in which perspective taking is decreased and temporal discounting preserved as the change from seeming abundance to drought would seem to indicate a far future.

An action point emerging from the qualitative data is the lack of awareness around agriculture and food availability being climate change issues. This indicates a need to increase the public discourse around these topics. Evidence for the influence of the public discourse around climate change on public perception comes from the control groups' description of climate change effects which are primarily aligned with popular media coverage when compared to the other conditions. That media coverage and public discourse can change perceptions was exemplified via the increasing awareness of extreme weather, as opposed to merely extreme heat being caused by climate change. Recent findings on the high toll our current agricultural system takes on the environment (Poore & Nemecek, 2018) and a growing database on the need for climate change adaptation to ensure food security ("Climate and agriculture: Models, impacts, and adaptation strategies," 2019) make bringing these issues into the public consciousness paramount.

In sum, this study showed the feasibility of using augmented reality as a tool for influencing intention to act sustainable, environmental behaviours, climate change risk perception, and future-self perspective taking. The findings could be fitted into a narrative persuasion framework, indicating the need to integrate narrative persuasion models into the dramatic-element utilisation in gamification to improve gamification's effectiveness and advance the theoretical underpinnings of gamification. Furthermore, the study highlighted the need for improved communication of local climate change effects already in evidence and their relevance to agriculture and food security.

Future research. To address the limitations of the study further research should be conducted using a more representative sample, more immersive augmented-reality features in isolation rather than intermixed with roleplay, including attainable solutions to the fear-inducing message of climate change in the scenario presented, a simpler-to-use place-attachment scale, and exclusively multiple-item scales.

Concerning theory building and application, the most fruitful approach would be studies focusing on how dramatic elements in gamification influence user's involvement, transportation, and emotion. This would enable theoretical inclusion of narrative persuasion models into the growing body of theoretical underpinnings as to why gamification is effective, and improve gamification's effectiveness itself.

General Discussion

Summary

Across all studies, gamification is linked to the time individuals stayed engaged with a task through social incentives, novelty, and instant gratification. This increase in engagement, in turn, influenced how much they knew about how to be sustainable and how much effort they were willing to invest. The prolonged time spent with an intervention, change to motivation levels, and absolute knowledge and willingness to invest effort after the intervention are related to behaviour change towards more sustainability. In particular, as indicated by the qualitative data, behaviour change was supported through gamification by affecting a wide range of potential motivators. The visual and personalised feedback provided by a gamified app evoked emotions and thereby increased motivation because one's actions were perceived as more meaningful.

One aspect of gamification, dramatic elements, was investigated in more detail as to its ability to influence perspective taking. The specific presentation of the dramatic elements was less important than the use of storytelling in itself. Storytelling that captured the individuals' emotions and helped them to envision concrete events as well as feeling connected to their own future increased risk perception and decreased temporal discounting through perspective taking, and influenced behaviour directly.

In addition to these findings linked to gamification, the studies discovered that sustainability was conceptualised as requiring constant conscious deliberation, complete dedication, and as being in conflict with 'normal life' in a society in which being unsustainable is the default. Habit was the paramount factor in determining which behaviours were performed. Habit furthermore influenced whether a behaviour was perceived as under one's control, oneself

capable of performing it, whether the consequences of it were seen as meaningful, and whether it aligned with one's motivations and 'normal life'. If a new behaviour fit these criteria chances improved for it to become habitual.

Predictions and Results

The original research questions I set out to answer in this dissertation were:

- Can gamification help with sustainability education, attitude change, and behaviour change?
- What part do affect and perspective taking play in the potential effects of gamification?

The first question can be answered with a: yes, with caveats.

Although no direct effect of gamification was observed in my studies I postulate that I do not contradict a growing evidence base in a variety of fields concerning the effectiveness of gamification (Nacke & Deterding, 2017). Likely, my specific study setup revealed the importance of the time a person spends on any form of attempted behaviour change. Knowledge was influenced by this time, which confirms that gamification can help with sustainability education. Environmental concern, which I had chosen as an indicator of one's attitude towards the environment, did not show an effect. However, motivation and effort willing to invest did, which may indicate that gamification has a stronger effect on a person's behavioural activation system rather than behavioural inhibition system (Pickering & Smillie, 2008). In the introduction, I have argued for the need to make sustainability enjoyable rather than force individuals to engage with it out of a sense of moral obligation or fear of the negative consequences; therefore, this finding is promising.

Gamification's ability to affect behaviour change was shown both through the more 'pointsification'-based app and in the form of storytelling in the augmented reality study. This

highlights the breadth of difference in individuals' reasons to (not) behave sustainably.

Gamification has a chance of engaging a variety of individuals because of the inherent higher complexity and interactivity of the medium, with different aspects engaging different kinds of individuals. The interactive aspect offsets the potential information overload (Kimura et al., 2008; Mayer & Moreno, 2003; Scielzo & Greenwood-Ericksen, 2003) caused by the higher complexity. In addition to that, visualisation, the feature most mentioned in regards to the gamified app, and storytelling likely improves behaviour change by framing information in a salient and personalised way (Stern, 1992).

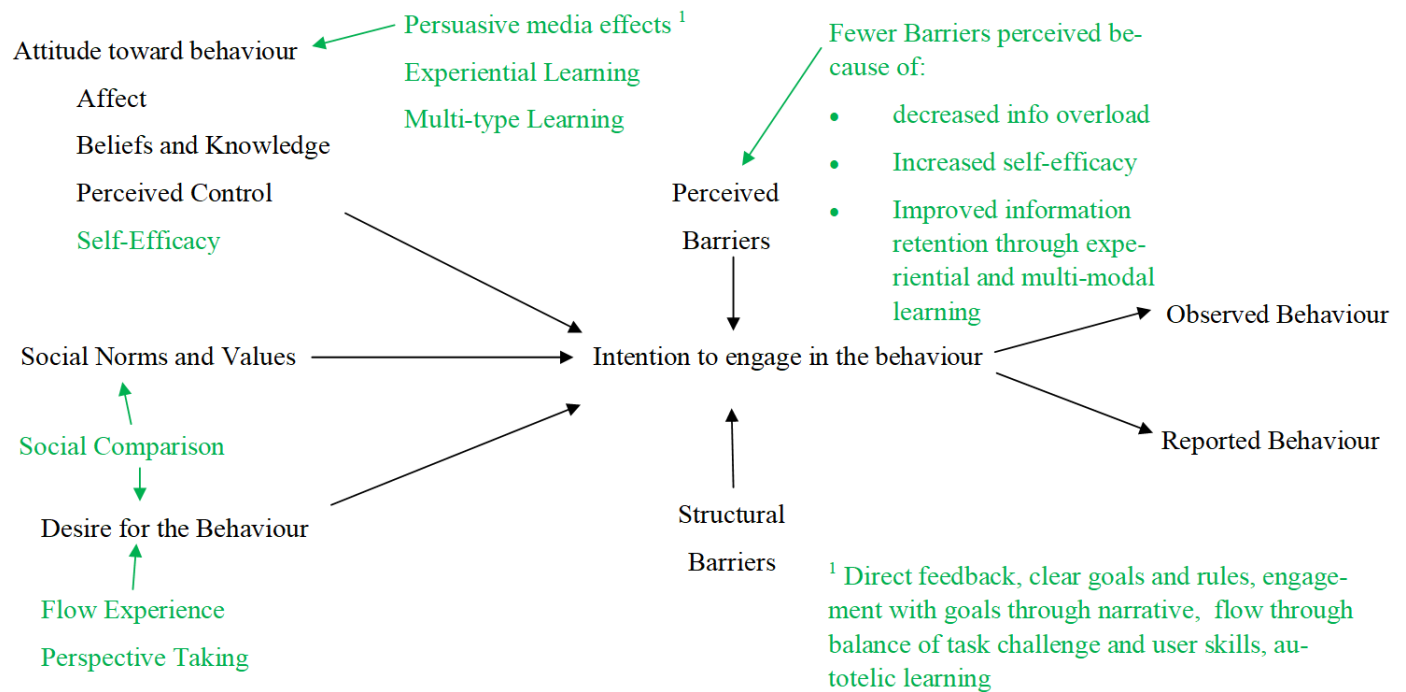
Concerning the second question on how perspective taking and affect play into gamification, the answer provided by this dissertation is only partial. My studies indicate that storytelling influences behaviour and that affect mediates this relation. Only when the storytelling evokes emotions and helps the individual to envision concrete events does it show its full effect.

Storytelling constitutes an important part of games. Ludology, the scientific field of the study of games, conceptualises storytelling as one of the dramatic elements of a game. Dramatic elements immerse the player into the game, endow the interaction with the game with meaning and context (Fullerton, 2008). A large number of gamification attempts undervalue these dramatic elements and rather focus on the easier-to-implement 'pointsification features' (Antin, 2012; Lawley, 2012; Seaborn & Fels, 2015). This tendency has rightfully garnered heavy criticism (Bogost, 2011) and my own findings on the effectiveness of storytelling, and the importance of meaning-making to participants, only further corroborate previous research findings that long-term change requires dramatic elements rather than instant gratification features (Paredes et al., 2013).

New Model

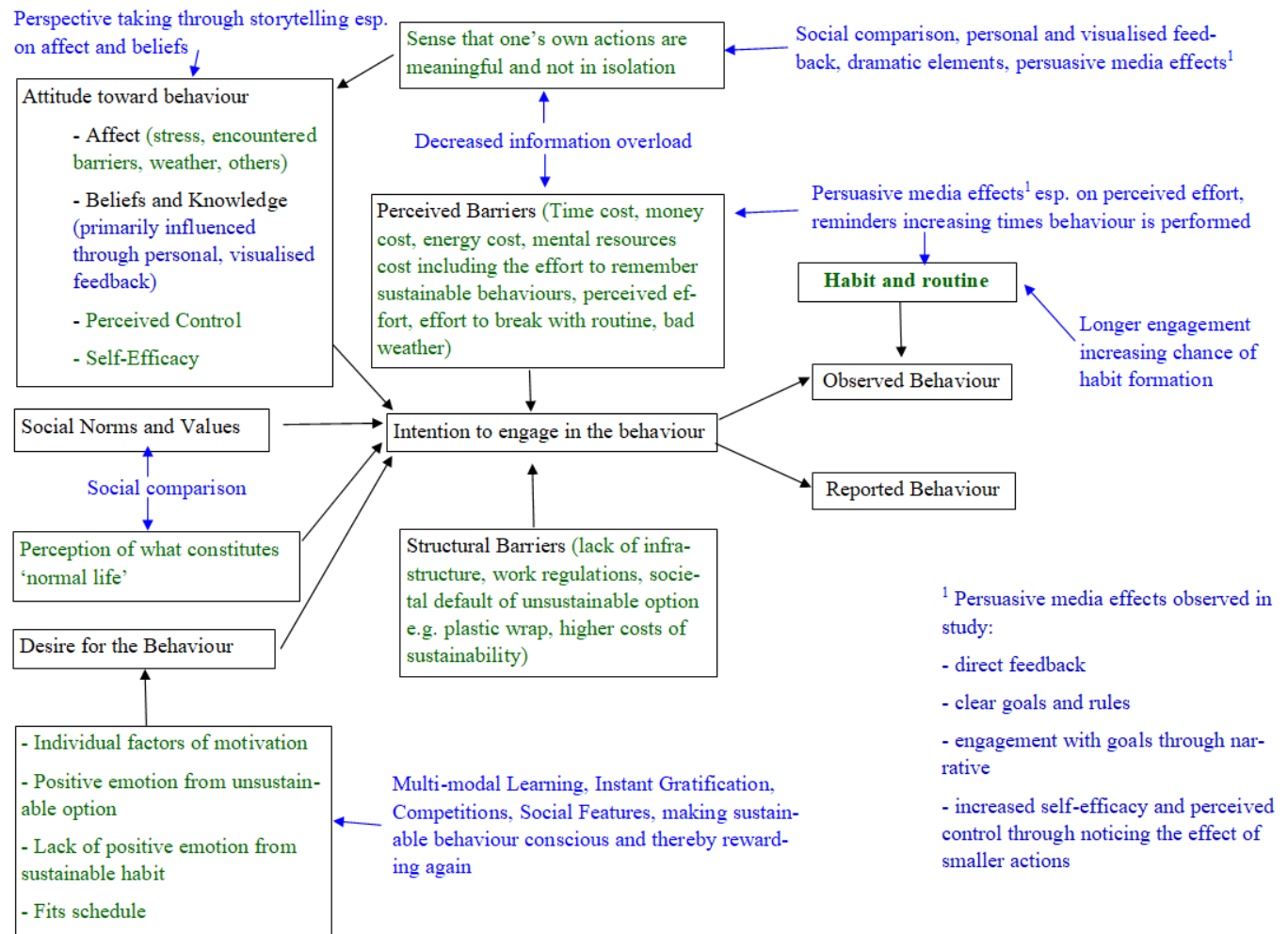
The original model postulated of how gamification acts on the model of behavioural choice is repeated here to highlight the differences between postulation and findings:

Figure 12. Original model of gamification



From this starting point the model of behavioural choice was expanded based on the bottom-up qualitative approach in study 2 (shown in boxes and green). Then the various aspects that were observed of how gamification, both in its more pointsification-based form in study 1 and 2, and more dramatic element-based form in study 3, acts on behavioural choice were added to the model (shown in blue). This led to the much more complex model shown below:

Figure 13. Model of Behavioural Choice for Sustainable Behaviours including ways in which gamification affects it



In the introduction, I postulated that gamification can influence attitudes through a mix of learning and goal-setting strategies in addition to improving the user's self-efficacy, their social norms and values through social comparison within the game, that it will increase the desire for the behaviour through flow experiences and perspective taking, and lower perceived barriers via effective learning and improved self-efficacy.

Before these model postulations can be conclusively answered, more in-depth research into each of the aspects is necessary. However, based on the studies presented here the following observations arise:

Gamification can indeed influence attitudes. In part, this is because the multi-modal learning and goal-setting options lower the perception of how much effort is necessary to engage in sustainable behaviours. Social norms and values are influenced through the social comparison provided by the social features of gamification; however an additional category of ‘normalcy’ carries more individual weight and may be harder to influence. The postulation that flow has an influence on one’s desire for the behaviour cannot be answered as it was not observed in the sample. However, desire itself for a behaviour may not be a large consideration influencing actual behaviour; if anything, a competing desire for the unsustainable behaviour appears to be more influential. Perspective taking appears to be more influential for one’s attitude towards the behaviour rather than one’s desire for the behaviour. Finally, although perceived barriers can be influenced by gamification, the influence on intent to act does not automatically translate to actual changes to behaviour.

More particularly, the effects of gamification, in its most common pointsification form employed in study 1, can be traced to the individual’s level of knowledge and how much effort one is willing to spend on being sustainable. Knowledge is a part of the attitude toward behaviour section of the model and participants explicitly linked knowledge improvements to receiving individualised and visual feedback about their own behaviours. Effort willing to invest can be conceptualised as a part of the perceived barriers section but also as a part of the beliefs subsection of attitude towards behaviour. The potential link between them may be that gamification improves the individual’s sense that their behaviours are meaningful.

This potential link also exists for perspective taking, which shows its effect on beliefs and knowledge in a similar fashion to visualisation, in addition to its influence on affect. However, because perspective taking is facilitated through a narrative, or, in gamification terms, dramatic elements, this effect is likely mediated through the improved sense of meaning to one's actions and does not act in isolation.

Concerning the persuasive media effects which I postulated would be involved in gamification's effect, some changes from the original model were made. The postulated effects were: direct feedback, clear goals and rules, engagement with goals through narrative, flow through balance of task challenge and user skills, and autotelic learning. However, not all of these effects were observed. The data did not show any flow effects directly, although the increase shown in effort willing to invest may indicate a change towards perceived task challenge and confidence in one's own skills to meet it. Autotelic learning, learning for its own sake, also was not observed because the participants showed very little curiosity in general.

Persuasive media effects were originally posited to influence only attitude toward behaviour. However, the data indicate that this influence extends to three additional aspects: sense of meaning and lack of isolation, perceived barriers, and habit and routine.

Sense of meaning and lack of isolation acts as a mediator to the effect on attitude toward behaviour. Beliefs and knowledge, perceived control, and self-efficacy were expected to be influenced by persuasive media effects and indeed show signs of being influenced, most strongly shown by the repeated mention of the importance of personalised and visual feedback. In addition to this direct effect, perceived control and self-efficacy are boosted by way of new awareness about minor behaviours being meaningful and others also acting in similar ways. This counteracts the common conceptualisation of sustainability as a solitary all-or-nothing venture.

Originally the main influence of persuasive media effects on perceived barriers was posited to be decreased information overload, increased self-efficacy, and information retention. With the new model, perceived barriers are more focused on the cost and effort of sustainability, which shifts how persuasive media actually affects perceived barriers. Although decreased information overload still plays a role by way of freeing up mental resources and making participants aware of the misconception that sustainability inherently carries high monetary costs, the main aspect is a decrease in perceived effort. Smaller actions become meaningful, already performed behaviours are recognised as sustainable thereby lowering the perceived bar as to what can be considered sustainable, and receiving direct feedback for one's action helps identify which actions are indeed sustainable. In addition, the reminder of seeing the app notifications (or even just the icon) decrease how much mental resources need to be spent to remember a new behaviour.

Persuasive media effects also influence another new model factor: Habit and routine. The influence comes in the form of clear goals and rules, increased self-efficacy, and perceived control enabling individuals to more easily incorporate new behaviours into their routine. Improved engagement, through narrative persuasion, novelty, and instant gratification, increases chances of a new habit forming. Overall, gamification works on habit and routine by way of prolonged engagement with the behaviour and by being a reminder to more often perform the behaviour. This repetition increases the chance of behaviour change.

Social comparison was originally posited to work on social norms and values. Although this appears to be indeed the case, norms did not show as strong an influence as expected unless the app helped participants remember that they are not the only one caring about the environment when surrounded by a group of people who seem uncaring. This indicates that the more

important influence of social comparison is to establish a sense of meaning and lack of isolation. Community-oriented participants found a drive towards sustainability when they felt that they were part of a bigger movement rather than senselessly fighting against a system alone. This also contributes to reaffirming some participants' sense of some sustainable actions as part of 'normal life'. However, influencing an individual's perception of what constitutes a 'normal life' appears to be more complicated and potentially requires far more involved forms of gamification.

In addition to these community-oriented social aspects, gamification also engages participants who are more influenced by individual factors of motivation. Some persons are motivated by seeing their group be sustainable together, others are fiercely competitive and wait for the gamified app to start a new round of competition between users.

Other gamification aspects also interact with the variety of individual motivations participants showed. The ability to experience the effects of one's own behaviours through the personalised feedback opens up venues of learning about oneself rather than simply accepting knowledge handed to one. For some participants, the instant gratification of the gamified app rewarding any sustainable behaviour reported is important, in effect positively conditioning themselves. Finally, these rewards rekindled enjoyment of performing sustainable behaviours for users who had habituated to being sustainable and no longer gained positive emotions from it, while actively having to fight against the positive emotions still associated with many unsustainable behaviours.

The effect of dramatic elements, or storytelling, should be highlighted as more than merely an important part of the new model. Although it does influence sense of meaning and lack of isolation, as well as attitude toward behaviour, those two factors play into the intention to engage in the behaviour. Study 3 showed that intention does not necessarily directly influence

behaviour. However, storytelling had a direct effect on behaviour and in this capacity, should be investigated as more than a mere subcategory of the model.

Before I elaborate on the implications of these observations, a word about parsimony. One may criticize the model presented above for its complexity, for its apparent lowering of parsimony of the theory of behavioural choice. In accordance with the perspective that theory building in the social sciences should start bottom-up and focus on closeness to the social reality rather than attempt grand generalisability (Merton, 1968), this dissertation focused on building a model by way of sense-making and a focus on meaning, rather than measure (Andersen & Kragh, 2010). As a model, not theory, it aims to represent the reality found in these specific studies, not to be a general explanation of reality.

The current model, as it stands, is based on the theory of behavioural choice. The potential additions to the theory the model suggests are not as wide-reaching as they may appear at first glance. This first bottom-up round of research both confirmed the postulated structure of the theory and opens new venues for testing each addition in an interpolation-based refinement of the theory by testing these additions (Andersen & Kragh, 2010). ‘Perception of ‘normal life’ is currently listed as its own point but may turn out to be merely a subcategory of ‘Attitudes and Beliefs.’ Further research will have to determine if its distinctiveness in this sample holds across others. The same is true for ‘sense of meaning and lack of isolation’. The diversity of motivators and emotional aspects of sustainable and unsustainable behaviours already are meant as sub-categories of ‘Desire for the behaviour’, important to be aware of to design specific interventions but not an integral part of a general theory.

However, ‘habit and routine’ is highly likely to be a fruitful additional aspect to the theory of behavioural choice. Habit has been described as a boundary condition for theories

based on attitude-behaviour connections and rational choices (Verplanken & Aarts, 1999). As argued in the introduction, behaviour is often ruled by bounded-rationality (Simon, 2000) and hedonism (Scarpi, 2012). Although the theory of behavioural choice accounts for hedonism through the aspect of ‘desire for the behaviour’, this aspect plays into ‘intent’, which implies a conscious decision on the behaviour. Habits, by contrast, do not require conscious consideration, freeing up mental resources, allowing for more efficient navigation of routine tasks, and automatic reactions to behavioural cues (Maréchal, 2009). This alone may be perceived as a hedonic advantage of habits over conscious behaviour (as one can relax and not fret over each action) but the required repetition to establish a habit is motivation-driven (Lazaric, 2007) and goals can activate habits (Aarts & Dijksterhuis, 2000).

Much of human behaviour is driven by habits (Maréchal, 2009) and a theory of behaviour should account for this automatism. The theory of behavioural choice accounts for the three fundamental motivations of most behaviour (Gifford & Sussman, 2012): gain, norms, and hedonic through its three antecedents to behavioural intention. As argued above, this neglects the importance of automatic, unthinking, non-intention based influences on behaviour. The inclusion of habit in the theory therefore would not diminish its parsimony but include a necessary aspect.

Implications

By improving the theoretical model of how (sustainable) behaviour is chosen and how gamification acts upon these behavioural choices, this dissertation’s findings have important real-world implications beyond the equally-important increase in academic knowledge. The two major implications concern sustainable behaviour change and gamification’s potential role therein.

Based upon the rich qualitative exploration of the participants' (lack of) behaviour change, specific conditions appear to be needed for the adoption of new sustainable behaviours. These conditions do not vary between individuals who already engage in a large amount of sustainable behaviours and those who consider recycling as the extent of necessary sustainability. To summarize: For a sustainable behaviour to even be attempted, it must be perceived as meaningful, achievable without large effort, and, at least until it has become habitual, as emotionally and socially motivating.

Each of these factors can directly be traced to the model; however, their specific importance is not immediately observable because they only constitute a subset of the higher complexity model. The importance of the perception of meaning, obvious to the individual, in any behaviour they are asked to engage in may appear to be only a small part of the individual's attitude, but throughout the qualitative sections of all three studies, it stood out as a quintessential part of the conceptualisation of sustainability.

The need for the behaviour to be achievable without large effort encapsulates aspects of self-efficacy, the paramount importance of how much effort one is willing to invest, and the influence of 'sustainability fitting into one's schedule' on how desirable the behaviour appears.

The condition of the behaviour being emotionally and socially motivating incorporates both the diversity of motivations persons have for behaving a certain way, which, in these studies specifically encapsulated a need for behaviours not to be done in social isolation versus competitive and hedonistic motivation, and the importance of affective states. The allure of comfortable, enjoyable, and convenient unsustainable behaviours has a high chance to win out over sustainable behaviours perceived as tedious, effortful, and potentially meaningless. Habitual behaviours elicit far less of an emotional response and are less impacted by social comparison in

any specific situation; therefore, the emotional incentive of the unsustainable behaviour loses its effect once sustainable behaviours have become habitual.

This conceptualisation fits well with another psychological model of environmental behaviour-change (Unsworth, Dmitrieva, & Adriasola, 2013). Similar to the model presented above, Unsworth et al. integrated non-cognitive factors into their model of green interventions. Their finding that the sustainable behaviour needs to be perceived as self-concordant and attractive is equivalent to this model's social and emotionally motivating condition. Their 'efficacious' maps onto 'meaningful,' and what appears in my data as 'achievable without large effort' is named in their model as 'close to achieved or completed'. They highlight the importance of environmental behaviours not being in conflict with other goals, which is one of the dragons of inaction, and in another form plays into 'perception of normalcy'.

This obvious overlap of their theory-based model and this dissertation's data-based model bodes well for approaching a workable model of sustainable behaviour and behaviour change. Attaining such a model is important not only for theoretical accuracy but also for practical implications of how to best design behavioural interventions.

Improving gamification's chances of being one such well-designed behavioural intervention is the second major contribution of this dissertation. The finding that gamification engages individuals for longer and thereby increases their knowledge and invested effort, as well as storytelling increasing emotional and concrete perspective taking, all of which increases sustainable behaviour change, implies venues through which gamification can be used for sustainable interventions.

In addition to the advantages of gamification presented in the model, another aspect is noteworthy: the potential to reduce the need for direct human-guided interventions. As

mentioned in the introduction, behavioural conditioning is a successful strategy; however, it requires a large amount of expert involvement (Geller et al., 2016). Some of the pointsification features of gamification allow participants to condition themselves, and combining this with dramatic elements improves the chance of evoking emotion similar to human interaction. This is caused by the human tendency to interact with computer programs, and even more so avatars, as if they were human, thereby investing more emotion (Smith et al., 2012).

Similar to how the behavioural choice model aligns well with a similar model, this dissertation's model of how gamification influences behaviour change can be compared to a framework for serious games' effect on energy literacy (Wood et al., 2014). To remind the reader, in this dissertation gamification and serious games are defined as two points on a scale of playful interventions rather than distinct concepts. The importance of storytelling and thereby dramatic elements indicates that well designed gamified applications are likely to be experienced as (serious) games. Therefore, design principles can and should be compared between gamification and serious games.

The Wood et al. (2014) framework highlights the following four aspects of serious games as paramount for improving a sustainable behaviour, in this case energy savings: 1) the scenario must be applicable to everyday life, 2) goals and feedback must be clear and actionable, 3) social comparison to others and a sense of community, and 4) the game must be personally relevant.

Again, the overlap to this dissertation's model is apparent: The need for the game to be applicable to everyday life maps onto gamification's influence on sense of meaning and perceived barriers. Clear and actionable goals and feedback are equivalent to persuasive media effects, as well as the repeated mention of personalised and visual feedback. The social aspects

are identical down to the importance of not having the impression that one is isolated in their attempt to be sustainable. Finally, personal relevance overlaps with the effects of perspective taking and the diversity of motivations.

At a more detailed level, some of the twenty-one criteria of the framework reveal further overlap. The encouragement of active thinking about energy-saving behaviours is similar to my finding of habitual sustainability lacking emotional rewards but regaining them when made conscious. Communication of information in a personally-relevant way and engaging methods of feedback overlaps with the importance of decreasing information overload and multi-modal learning. The opportunity to test learned behaviours in a failure-tolerant environment (virtual in this case) is one of the cornerstones of improving one's self-efficacy (Bandura, 1977). And finally, prolonged engagement with the game is the same as this model's improved chances of habit-formation through keeping individuals involved with the intervention.

Taking together the fit of this model with both another psychological model of sustainable behaviour choice, and a human-computer interaction framework for serious games, I am confident that research based on these findings will further consolidate a psychological framework of gamification for sustainability.

Future Research

This dissertation is only the first step in establishing a psychological model of gamification. The bottom-up, qualitative approach to matching sustainable behaviours to the theory of behavioural choice uncovered aspects that were previously unaccounted for in the model. Studies focusing on these aspects, rather than their interaction with gamification, are crucial to discovering if the added aspects are an artifact of this specific sample and methodology

or if they enrich the theoretical understanding of how behaviours are performed and practical applications thereof.

Parallel to this theory testing, the way in which gamification interacts with behaviour change requires more in-depth study. This dissertation focused on only two aspects; however research in the field is growing. Goal-setting theory, one of the factors I proposed as a gamification mechanism influencing behaviour, has been confirmed through research conducted after my initial proposal (Landers, Bauer, & Callan, 2017). One game mechanic linked to goal-setting are badges which improve behaviour through setting clear and specific expectations that are higher than those without an anchor point; thereby improving satisfaction and self-efficacy when completed (Hamari, 2017). This demonstrates that psychological theories are gaining traction and the development of an overarching model would be a boon to guide research.

One venue of future theory-driven research could be the integration of narrative persuasion theories into gamification. Storytelling showed promising effects in these studies and it would be fruitful to lean on fields, such as communication, that provide models to fit gamification's dramatic elements into, rather than attempting to view them as unique. Serious game research indicates that dramatic elements are crucial to long-term behaviour change (Baranowski et al., 2008). Therefore, they should be a much larger focus in gamification, rather than the more common pointsification features.

On the smaller scale, the finding that perspective taking influences behaviour although intention to act does not opens up the question about which mechanism underlies the effect of perspective taking. If only perspective taking that is emotionally involved and concrete shows this effect, then a sense of meaning or reality to the perspective taking might be involved. This might play into the model's factor of meaning to one's actions and lack of isolation. Another

possibility may be an influence on perception of ‘normal life’ and the future normal eliciting a negative emotional reaction.

Answering any of these questions would improve chances to influence behaviour towards more sustainable venues in hopes of combating climate change, which remains humanity’s greatest challenge.

Conclusion

The field of gamification research is rapidly becoming more complex and theories are improving (Nacke & Deterding, 2017). This dissertation added to this maturing by exploring gamification, and especially gamification as a sustainable intervention, through the lens of environmental psychology. The findings of gamifications' association with behaviour change, via prolonged engagement with the intervention, through knowledge and a willingness to put effort towards one's sustainable behaviours on the more pointsification side, and its influence by way of storytelling that evokes emotions and helps concrete perspective taking, highlights the versatility of gamification. This versatility is necessary to influence behavioural choice, which's model is growing only more complex, and addressing the newly-added factors of 'sense of meaning to my actions and lack of isolation,' 'perception of normal life,' and maybe most importantly, 'habit and routine'. Although only a small fraction of the model was researched directly, findings are promising that an increased focus on the underlying psychological mechanisms of how gamification acts on behavioural choice and behaviour change can lead to the design of effective interventions. These interventions, in turn, may overcome the shortfalls of other interventions and add another tool to those dearly needed in the effort to mitigate and adapt to climate change.

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APPENDIX A

A1: Descriptive statistics for study 1 at T1

Condition		Behaviour	Know- ledge	Self- Efficacy	Concern	Dragons	Motiva- -tion	Effort- Willing
Sustain- ability @BU	Range	8.00	77.29	100.00	2.27	1.79	81.00	81.00
	Min	1.00	22.71	.00	-.27	-1.46	19.00	19.00
	Max	9.00	100.00	100.00	2.00	.33	100.00	100.00
	Mean	6.33	56.56	59.16	.88	-.65	72.48	69.62
	SD	1.70	17.12	20.03	.50	.41	18.48	16.08
	Kurtosis	.82	-.21	.65	-.41	-.31	.96	1.27
	SE Kurtosis	.66	.66	.65	.65	.65	.65	.65
	Skew- ness	-.82	.41	-.79	.09	.05	-.72	-.56
	SE Skew- ness	.33	.33	.33	.33	.33	.33	.33
	N	51.00	51.00	52.00	52.00	52.00	52.00	52.00
ForGood	Range	7.00	62.57	76.86	1.67	1.71	91.00	80.00
	Min	2.00	23.43	23.14	-.20	-1.58	9.00	20.00
	Max	9.00	86.00	100.00	1.47	.13	100.00	100.00
	Mean	5.76	55.36	61.67	.85	-.67	69.76	66.48
	SD	1.46	14.65	20.68	.38	.31	19.12	16.20
	Kurtosis	.00	-.48	-.45	-.24	1.46	1.28	.38
	SE Kurtosis	.66	.64	.64	.66	.66	.64	.64
	Skew- ness	-.50	.07	.23	-.54	.12	-.89	-.40
	SE Skew- ness	.34	.33	.32	.34	.33	.32	.32
	N	50.00	53.00	54.00	50.00	51.00	54.00	54.00
Green- choices. org	Range	7.00	67.57	75.43	1.60	1.58	85.00	93.00
	Min	2.00	25.00	24.57	-.13	-1.58	15.00	7.00
	Max	9.00	92.57	100.00	1.47	.00	100.00	100.00
	Mean	6.06	56.18	60.76	.89	-.73	67.70	66.17
	SD	1.90	15.73	19.26	.39	.33	18.29	17.07
	Kurtosis	-.58	-.31	-.65	-.11	.20	.35	1.46
	SE Kurtosis	.66	.65	.65	.64	.64	.64	.64
	Skewne ss	-.52	.43	.10	-.61	.12	-.62	-.72
	SE Skewne	.34	.33	.33	.33	.32	.32	.32

	ss							
	N	50.00	52.00	52.00	53.00	54.00	54.00	54.00
Total	Range	8.00	77.29	100.00	2.27	1.92	91.00	93.00
	Minimum	1.00	22.71	.00	-.27	-1.58	9.00	7.00
	Maximum	9.00	100.00	100.00	2.00	.33	100.00	100.00
	Mean	6.05	56.03	60.55	.87	-.69	69.95	67.39
	SD	1.70	15.76	19.90	.43	.35	18.62	16.43
	Kurtosis	-.10	-.30	-.10	-.17	.24	.73	.94
	SE Kurtosis	.39	.39	.38	.39	.38	.38	.38
	Skewness	-.55	.33	-.14	-.22	.12	-.72	-.56
	SE Skewness	.20	.19	.19	.19	.19	.19	.19
	N	151.00	156.00	158.00	155.00	157.00	160.00	160.00

A2: Descriptive statistics for study 1 at T2

Condition		Behaviour	Know- ledge	Self- Efficacy	Concern	Dragons	Motivation	Effort- Willing
Sustain- ability @BU	Range	7.00	69.29	88.57	2.00	2.17	94.00	91.00
	Min	2.00	30.71	11.43	-.27	-1.88	6.00	9.00
	Max	9.00	100.00	100.00	1.73	.29	100.00	100.00
	Mean	6.33	69.36	70.09	.96	-.77	73.58	68.69
	SD	1.26	16.22	19.57	.46	.52	19.29	20.90
	Kurtosis	3.31	-.51	.38	-.44	-.57	1.81	.52
	SE Kurtosis	.66	.66	.67	.67	.66	.65	.65
	Skewness	-1.29	-.33	-.65	-.47	-.04	-1.02	-.92
	SE Skewness	.33	.34	.34	.34	.33	.33	.33
	N	51.00	50.00	49.00	49.00	51.00	52.00	52.00
ForGood	Range	7.00	70.29	85.86	2.13	2.63	70.00	71.00
	Min	2.00	29.71	14.14	-.40	-1.88	30.00	29.00
	Max	9.00	100.00	100.00	1.73	.75	100.00	100.00
	Mean	6.00	63.30	65.92	.85	-.72	71.22	66.00
	SD	1.60	17.94	18.98	.46	.54	17.96	17.94
	Kurtosis	.26	-.90	.15	.19	.67	.30	-.77
	SE Kurtosis	.66	.64	.65	.64	.64	.64	.64
	Skewness	-.87	.17	-.35	-.45	.47	-.86	-.37
	SE Skewness	.34	.33	.33	.32	.33	.32	.32
	N	50.00	53.00	52.00	54.00	53.00	54.00	54.00
Green- choices. org	Range	7.00	76.14	86.57	1.87	1.75	84.00	85.00
	Min	1.00	16.00	13.43	.13	-1.75	16.00	15.00
	Max	8.00	92.14	100.00	2.00	.00	100.00	100.00
	Mean	6.16	66.68	66.92	1.03	-.83	72.57	65.78
	SD	1.49	15.54	17.96	.49	.39	14.38	16.94
	Kurtosis	2.16	.52	.18	-1.04	-.16	3.15	1.16
	SE Kurtosis	.66	.64	.64	.65	.66	.64	.64
	Skewness	-1.45	-.60	-.32	.06	.12	-1.14	-.81
	SE Skewness	.33	.32	.32	.33	.34	.32	.32
	N	51.00	54.00	54.00	52.00	50.00	54.00	54.00
Total	Range	8.00	84.00	88.57	2.40	2.63	94.00	91.00
	Min	1.00	16.00	11.43	-.40	-1.88	6.00	9.00
	Max	9.00	100.00	100.00	2.00	.75	100.00	100.00
	Mean	6.16	66.39	67.59	.94	-.77	72.44	66.80

SD	1.45	16.67	18.78	.47	.49	17.23	18.57
Kurtosis	1.49	-.53	.10	-.36	.27	1.47	.21
SE Kurtosis	.39	.38	.39	.39	.39	.38	.38
Skewness	-1.20	-.22	-.42	-.23	.29	-.97	-.68
SE Skewness	.20	.19	.19	.19	.20	.19	.19
N	152.00	157.00	155.00	155.00	154.00	160.00	160.00

A3: Descriptive statistics for study 1 for change variables

Condition		Behaviour change	Knowledge change	Self-efficacy change	Concern change	Dragons change	Motivation change	Effort willing change
Sustainability @BU	Range	7.00	106.14	133.57	3.33	1.92	155.00	118.00
	Min	-3.00	-39.14	-51.71	-1.53	-1.04	-74.00	-41.00
	Max	4.00	67.00	81.86	1.80	.88	81.00	77.00
	Mean	-.10	12.33	11.34	.07	-.10	1.10	-.92
	SD	1.68	24.21	30.57	.71	.45	26.60	25.75
	Kurtosis	-.38	-.12	-.36	.16	-.45	1.54	.61
	SE Kurtosis	.66	.67	.67	.67	.66	.65	.65
	Skewness	.32	-.03	.23	.08	-.26	.30	.54
	SE Skewness	.34	.34	.34	.34	.33	.33	.33
	N	50.00	49.00	49.00	49.00	51.00	52.00	52.00
ForGood	Range	10.00	96.71	140.57	2.33	2.04	106.00	108.00
	Min	-5.00	-38.71	-68.57	-1.20	-.79	-61.00	-63.00
	Max	5.00	58.00	72.00	1.13	1.25	45.00	45.00
	Mean	.15	8.46	4.26	.02	-.04	1.46	-.48
	SD	2.12	22.54	31.40	.58	.44	24.03	23.70
	Kurtosis	.34	-.18	-.05	-.58	.66	.11	-.15
	SE Kurtosis	.69	.65	.65	.66	.66	.64	.64
	Skewness	-.14	.05	-.32	-.01	.74	-.39	-.20
	SE Skewness	.35	.33	.33	.34	.34	.32	.32
	N	46.00	52.00	52.00	50.00	50.00	54.00	54.00
Green-choices.org	Range	9.00	104.71	90.00	2.60	1.67	107.00	94.00
	Min	-4.00	-45.14	-37.86	-1.27	-.92	-54.00	-47.00
	Max	5.00	59.57	52.14	1.33	.75	53.00	47.00
	Mean	.19	11.20	6.49	.13	-.08	4.87	-.39
	SD	2.28	24.79	23.23	.63	.33	22.25	22.64
	Kurtosis	-.51	-.53	-.69	-.71	.02	.00	-.52
	SE Kurtosis	.67	.65	.65	.66	.66	.64	.64
	Skewness	.20	-.34	.11	-.20	.03	-.05	-.16
	SE Skewness	.34	.33	.33	.33	.34	.32	.32
	N	48.00	52.00	52.00	51.00	50.00	54.00	54.00
Total	Range	10.00	112.14	150.43	3.33	2.29	155.00	140.00
	Min	-5.00	-45.14	-68.57	-1.53	-1.04	-74.00	-63.00
	Max	5.00	67.00	81.86	1.80	1.25	81.00	77.00
	Mean	.08	10.63	7.28	.07	-.07	2.49	-.59

SD	2.02	23.76	28.56	.64	.41	24.24	23.89
Kurtosis	-.11	-.36	-.04	-.26	.32	.67	.01
SE Kurtosis	.40	.39	.39	.39	.39	.38	.38
Skewness	.15	-.11	-.03	-.02	.20	-.04	.10
SE Skewness	.20	.20	.20	.20	.20	.19	.19
N	144.00	153.00	153.00	150.00	151.00	160.00	160.00

A4: Descriptive statistics for self-reported time spent with the intervention in study 1

Condition		Time Spent
Sustainability@BU	Range	92.00
	Minimum	.00
	Maximum	92.00
	Mean	41.67
	SD	25.67
	Kurtosis	-.93
	SE Kurtosis	.65
	Skewness	-.07
	SE Skewness	.33
	N	52.00
ForGood	Range	76.00
	Minimum	.00
	Maximum	76.00
	Mean	32.20
	SD	21.44
	Kurtosis	-.85
	SE Kurtosis	.64
	Skewness	.47
	SE Skewness	.32
	N	54.00
Greenchoices.org	Range	88.00
	Minimum	.00
	Maximum	88.00
	Mean	27.63
	SD	21.46
	Kurtosis	-.16
	SE Kurtosis	.64
	Skewness	.68
	SE Skewness	.32
	N	54.00
Total	Range	92.00
	Minimum	.00
	Maximum	92.00
	Mean	33.74
	SD	23.50
	Kurtosis	-.80
	SE Kurtosis	.38

Skewness	.38
SE Skewness	.19
N	160.00

A5: Measures**Block: Environmental Knowledge**

How much impact on the environment do you think this behaviour category has?

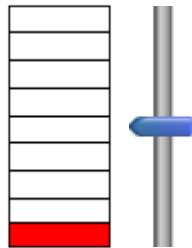
Minimal impact

Very high impact

Energy Use	
Transportation	
Use of Toiletries and Cosmetics	
Waste and Recycling	
Choice of Cleaning Products	
Decision around Clothing	
Food and Drink	

Block: Self-Reported Behaviour

In your own estimation, how often do you engage in environmentally relevant behaviours?



Block: Motivation

Please set the slider freely to wherever you think it best describes how you feel.

Very little

Very high

How motivated are you to live a more sustainable life?	
How much effort are you willing to invest?	

Block: Environmental Concern

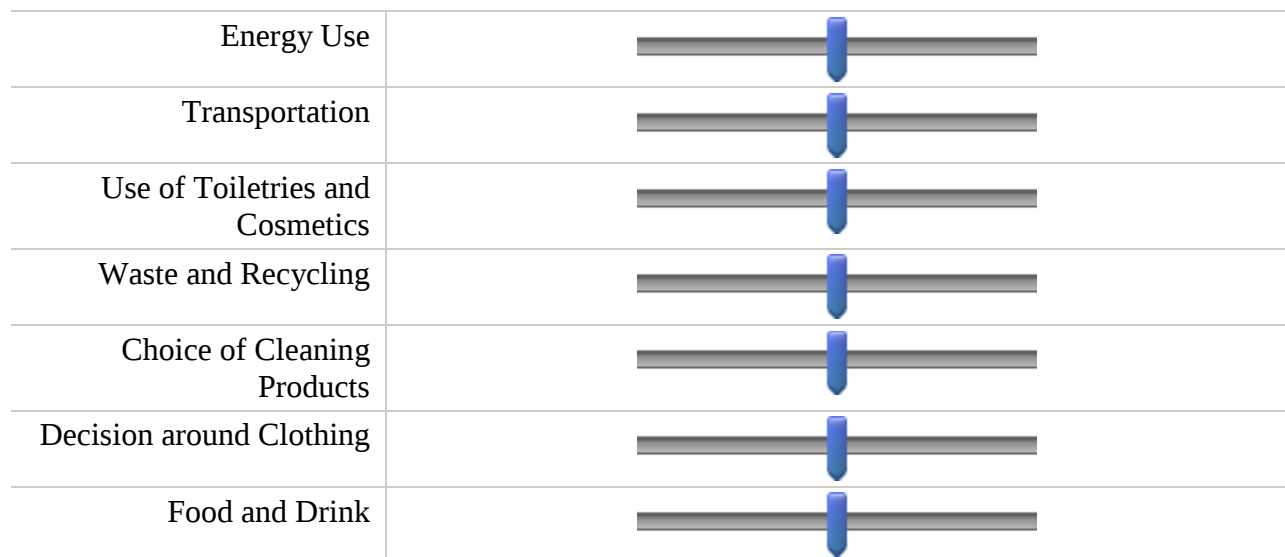
Listed below are statements about the relationship between humans and the environment. For each one, please indicate whether you **STRONGLY DISAGREE**, **MILDLY DISAGREE**, are **UNSURE**, **MILDLY AGREE** or **STRONGLY AGREE** with it:

1. We are approaching the limit of the number of people the earth can support
2. Humans have the right to modify the natural environment to suit their needs
3. When humans interfere with nature it often produces disastrous consequences
4. Human ingenuity will insure that we do NOT make the earth unlivable
5. Humans are severely abusing the environment
6. The earth has plenty of natural resources if we just learn how to develop them
7. Plants and animals have as much right as humans to exist
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations
9. Despite our special abilities humans are still subject to the laws of nature
10. The so-called “ecological crisis” facing humankind has been greatly exaggerated
11. The earth is like a spaceship with very limited room and resources
12. Humans were meant to rule over the rest of nature
13. The balance of nature is very delicate and easily upset
14. Humans will eventually learn enough about how nature works to be able to control it
15. If things continue on their present course, we will soon experience a major ecological catastrophe

Block: Self-Efficacy

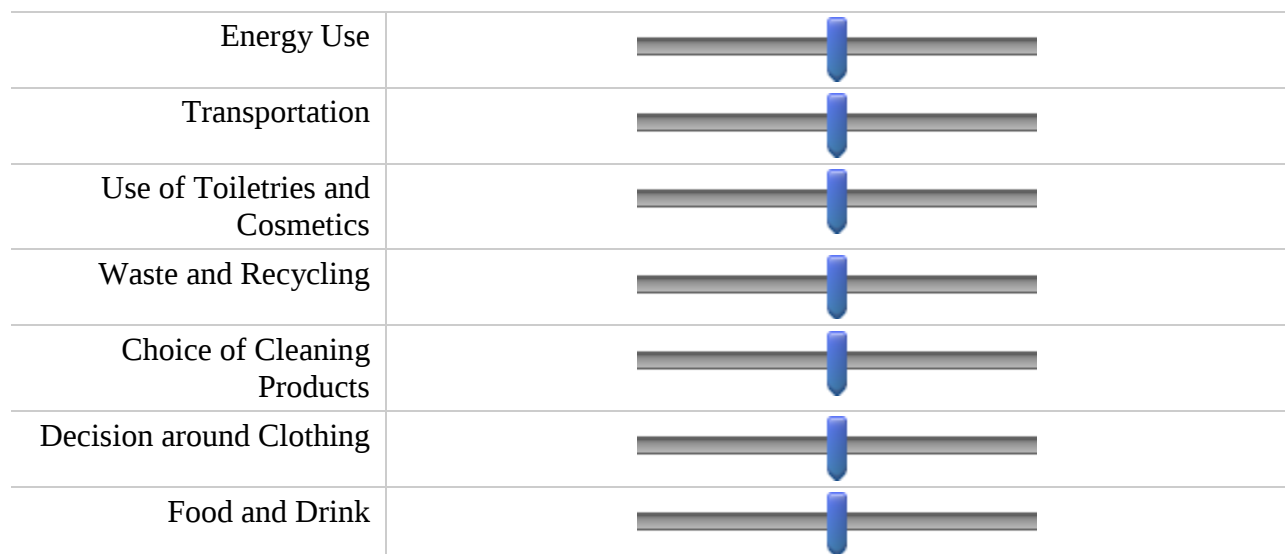
I believe I know how to improve my sustainability in the domain of:

I don't know what to do at all Moderately certain I know what to do Highly certain I know what to do



I believe I can have an impact in the domain of:

My behaviour won't have an impact at all I am certain I make a difference with my behaviour



Block: Barriers

What are the biggest barriers in your life to becoming more sustainable? Please feel free to list both specific behaviour related ones as well as overarching issues. (open ended)

Block: Dragons

These are general statements about making decisions in your own life about environmental sustainability. Please indicate how much you disagree or agree with them. (Strongly disagree, disagree, neither agree nor disagree, agree, strongly agree)

I've already made sacrifices to solve environmental problems, so there is no need for me to do more.

There's a need for change because I believe that a serious environmental problem exists.

I'm worried that my friends would disapprove if I made this change.

It's not fair for me to change when really it's industry that's causing the majority of environmental problems.

The pro-environmental efforts that I currently engage in make further changes unnecessary.

Human are powerless when it comes to saving the earth, so there is no need to change.

Making this change would be criticized by those around me.

There's not much point in me making this change because I feel confident that technological innovators will solve environmental problems.

I'd like to change but I'm not sure where to begin.

My environmental actions already make enough of a difference.

Making this change would interfere too much with my other goals in life.

What happens at the industrial level makes my changing insignificant.

I would be letting certain people down if I made this change.

I haven't changed because I'm afraid this wouldn't work.

I previously have made important effort in this, so there is no need for me to make further changes.

I'm concerned that this change will take up too much of my time.

If I made the necessary change, I would probably be embarrassed when others noticed what I was doing.

The government should make it easier for me to change, if it really has the best interest of the environment in mind.

I don't understand enough of the details about how to make this change.

I can't change because I'm invested in my current lifestyle.

It's the government's responsibility to regulate this change.

There's so much information out there that I am confused about how to make this change.

These issues are important to me but it's too hard to change my habits.

These problems are so far in the future, so there is no need to act.

Block: Time Spent

How much time did you spend interacting with your sustainability resource? (the app or webpage)

Once or twice Several times Several times
weekly daily

Interaction(s) with app/webpage



APPENDIX B

B1: Information-only – prompt

Please imagine yourself back on a visit at the UVic campus in the year 2048.

Here are some scientific predictions of developments you can expect, to help you envision the future:

- Coffee prices are increasing drastically as the coffee plant is becoming more difficult to cultivate
- New species, including rattlesnakes and sharks, migrate north into BC
- The types of food able to be grown in BC changes, introducing more locally-grown fruit
- Summers grow longer, dryer, and hotter
- Public access to beaches and rivers will be restricted periodically because of heat strain
- Forestry is a booming field of employment because of the northward expansion of southern tree species and the need for more management due to increased wildfire risk

Imagine taking a trip around the 2048 campus and what you would be thinking about.

B2: Vignette – Prompt

Please imagine yourself back on a visit at the UVic campus in the year 2048.

You're taking a stroll through the area after you bought your coffee. It's only ten dollars a cup so that students can still afford it. After you took a look at the library exhibit about BC's new wildlife with its stuffed rattlesnake and pictures of sharks taken by UVic students, you brave the 36-degree September heat again.

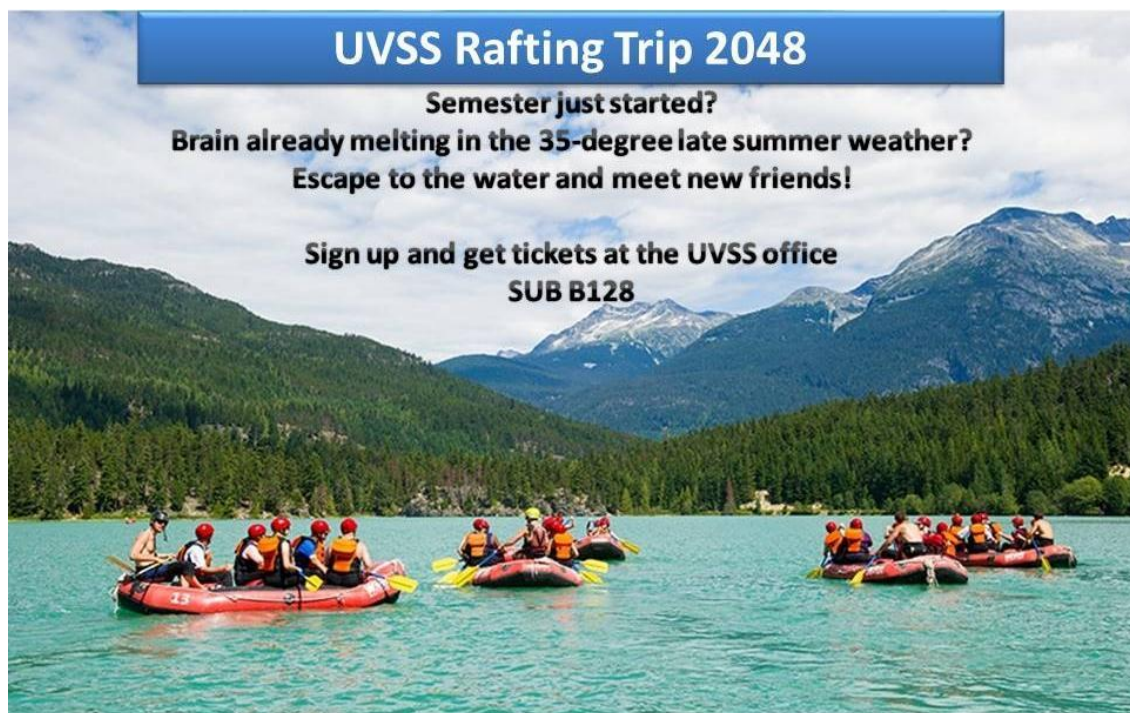
Getting back into an air-conditioned building you find yourself agreeing with the students you overhear saying they look forward to the annual UVSS rafting trip. With this heat, rafting and beaches sound perfect. You spot a flyer for a beach event and are not surprised to see that Eats&Beats in Colwood must move its location because the original beach is closed to the public to protect the fish from added stress.

As you go to refresh yourself at a water fountain, you see the water-restriction notice reminding you that it is the yearly drought period between April and October and giving you some tips on how to reduce your water use while on campus. Now the water footprint charts you saw in the cafeteria make more sense to you. Thinking of the cafeteria makes you realize you should grab some food soon. The locally-grown avocados looked really good.

Checking around your old 2018 department you see one of the info screens switching away from a message about where to check for up-to-date wildfire information to an advertisement of the upcoming coop-career fair for the Forest Sector. The fair advertises the increasing need for sustainable forest managers given the northward expansion of southern tree species.

As you leave after your visit you think about your day on campus.

Please imagine what you would be thinking about.

B3: Augmented reality flyers

Consider a career in Canada's growing Forest Sector!

Looking for work? Exploring career options? Connect with some of BC's largest employers
Interested in grad school? Learn what programs could bring you closer to your dream job

Don't miss the chance to learn about this booming field in BC!
Northward expansion of southern tree species and the increased need for sustainable forest management make forestry a booming field of the future.
Make it your future!

Tuesday, October 2 and Wednesday, October 3, 2048

10 a.m. - 3 p.m.

Michele Pujol Room, Student Union Building



Summer Drought Water Conservation Reminders

Yearly drought months: April to October

Turn off when lathering up: Turn off the faucet when lathering up with soap instead of letting the water run.

Be water-conscious while shopping: Use the water footprint charts available at the food outlets to minimise your daily water consumption. Remember, veggies are good for you and good for water conservation!

Tray-free dining: Just carry your plate! Each tray Food Services doesn't have to wash saves 1-2 liters of water.

Water plants first thing in the morning: Don't waste water on evaporation, that won't make you or your office plant happy.

Report a problem: When on campus, please report all leaks and water waste to Facilities



University
of Victoria



Migrating North: Our New BC Wildlife

The McPherson Library in collaboration with the Biology Department invites you to explore our newest exhibit on Beautiful British Columbia.



The collection highlights UVic student and faculty research on the migration of species once native only to more southerly regions, which now are becoming a common sight in our changing climate.

Exhibit runs throughout the 2048 Fall Semester on the ground floor of the library.

COFFEE

Americano	6.00	6.50	7.00
Blended Coffee	10.00	10.75	11.50
Cappuccino	6.50		
Drip Coffee	5.50	5.75	6.00
Espresso	5.50		
Latte	8.55	9.25	10.00
Mocha	8.75	9.50	10.25

EXTRAS

Flavor	+0.50
Extra Shot	+1.00
Cow or Goat Milk	+0.75

FLAVORS

vanilla, hazelnut, caramel, coconut,
strawberry, raspberry, english, toffee,
cherry, almond, sugar-free vanilla,
sugar-free hazelnut, sugar-free coconut

FOOD

Locally grown avocado	3.50
Hummus Plate	4.50
Apples & PB or Yogurt	2.50
Grilled Cheese, Pickle, & Chips	5.00

Allergen Alert: All cheese soybased

DRINKS

Chai Latte	6.00	6.75	7.50
Hot Chocolate	3.00	3.75	4.50
Mexican Hot Chocolate	4.25	5.00	5.50
Milk/Steamer	3.00	3.50	4.50
Tea	2.50	2.75	3.00
Soda	2.00	2.50	3.00
Italian Soda	2.50	3.00	3.50
Juice	1.50		
Bottled Water	1.00		

B4: Measures**Block: Place Attachment**

The questions that follow assess your feelings and thoughts about Victoria. Please think about and answer each question separately, and as accurately as possible. (strongly disagree, disagree, somewhat disagree, neither agree nor disagree, somewhat agree, agree, strongly agree)

I feel that Victoria is a part of me

Victoria says very little about who I am

I feel that I can really be myself in Victoria

Victoria reflects the type of person I am

I feel relaxed when I'm in Victoria

I feel happiest when I'm in Victoria

Victoria is my favorite place to be

I really miss Victoria when I'm away from it for too long

Victoria is the best place for doing the things that I enjoy most

For doing the things that I enjoy most, no other place can compare to Victoria

Victoria is not a good place to do the things I most like to do

As far as I am concerned, there are better places to be than in Victoria

I feel attached to Victoria

I am proud of Victoria

The spiritual nature of Victoria ties me to this place

I feel a connection to the visual landscape of this area

I feel that this city is my home

My roots are in Victoria

I intend to continue living in Victoria for the next 3 years

I wish to live in Victoria for the rest of my life

Block: Qualitative

After you took the tour of UVic in 2048, what would be on your mind? Please list three things.
(open ended)

Please envision and write down three changes due to climate change in 2048 that you think will have an effect on you personally. (open ended)

Block: Perspective Taking

Please indicate how much you agree with the following statements. (strongly agree, agree, somewhat agree, neither agree nor disagree, somewhat disagree, disagree, strongly disagree)

I could envision how it would be to live in 2048.

I vividly imagined myself in 2048.

I envisioned concrete events when I thought about my day in 2048.

I had an emotional response to the things I envisioned.

I felt connected to my future self.

Start of Block: Leiserowitz Climate Change Risk Perception

Please set the slider to where it best fits for you.

Not Concerned

Very Concerned

How concerned are you about global warming?



How likely do you think that each of the following will occur during the next 50 years *due to global warming*? (very unlikely, unlikely, slightly unlikely, neither unlikely nor likely, slightly likely, likely, very likely)

Worldwide, many people's standard of living will decrease

Worldwide water shortages will occur

Increased rates of serious disease worldwide

My standard of living will decrease

Water shortages will occur where I live

My chance of getting a serious disease will increase

How serious a threat do you believe global warming is to the following:

	No threat	Mild threat	Some threat	Serious threat	Most serious threat
Non-human nature	☐	☐	☐	☐	☐
Globally	☐	☐	☐	☐	☐
Canada	☐	☐	☐	☐	☐
British Columbia	☐	☐	☐	☐	☐
Victoria	☐	☐	☐	☐	☐

Block: Dragons of Inaction

Please think about any behaviour you believe you should do to help the environment but that you currently are not doing, or not doing often enough. With this behaviour in mind please pick how much you agree with each of the following statements. (strongly agree, agree, somewhat agree, neither agree nor disagree, somewhat disagree, disagree, strongly disagree)

1. I've already made sacrifices to solve environmental problems, so there is no need for me to do more.
2. There's a need for change because I believe that a serious environmental problem exists.
3. I'm worried that my friends would disapprove if I made this change.
4. It's not fair for me to change when really it's industry that's causing the majority of environmental problems.
5. The pro-environmental efforts that I currently engage in make further changes unnecessary.
6. Human are powerless when it comes to saving the earth, so there is no need to change.
7. Making this change would be criticized by those around me.
8. There's not much point in me making this change because I feel confident that technological innovators will solve environmental problems.
9. I'd like to change but I'm not sure where to begin.
10. My environmental actions already make enough of a difference.
11. Making this change would interfere too much with my other goals in life.
12. What happens at the industrial level makes my changing insignificant.
13. I would be letting certain people down if I made this change.
14. I previously have made important effort in this, so there is no need for me to make further changes.
15. I'm concerned that this change will take up too much of my time.
16. If I made the necessary change, I would probably be embarrassed when others noticed what I was doing.
17. I don't understand enough of the details about how to make this change.
18. I can't change because I'm invested in my current lifestyle.
19. There's so much information out there that I am confused about how to make this change.
20. These issues are important to me but it's too hard to change my habits.
21. These problems are so far in the future, so there is no need to act.

Block: Behaviours

Studies show that an effective way to save energy is to only turn on the heat when the room temperature is lower than 20 degrees Celsius.

Very Unlikely

Very Likely

Are you willing to leave the heat turned off until it's colder than 20 degrees Celsius in your room?	
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The UVic chapter of the Surfrider Foundation is organizing monthly beach cleanups on Vancouver Island. If you would like to learn how you can be a part of these, please put your email in here: