THE ROLES OF AFFECT AND SUSTAINABILITY EDUCATION IN INCREASING PRO-ENVIRONMENTAL BEHAVIOUR IN A BOTANICAL GARDEN

by

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Abstract

Generating behaviour change for transformation toward sustainability is a significant challenge of our time. In order to reach local and global sustainability goals, behaviour change at a large scale is not only necessary but crucial. A key question is how to promote pro-environmental behaviour. Multiple factors have been found to influence pro-environmental behaviour, including affect, environmental concerns, and environmental education. To date, the relationship between these factors is still unclear. In this thesis, I conducted a field experiment at University of British Columbia Botanical Garden to determine how a sustainability education program and affect influence pro-environmental behaviour. Of particular interest is the arousal dimension of affect, the state of being physiologically alert and attentive. In the experiment, participants were randomly assigned to spend time in the garden (ground walk condition), spend time in the garden and receive sustainability education (ground walk + education condition), go on a tree-top canopy walk (arousal condition), go on a tree-top canopy walk and receive sustainability education (arousal + education condition), or a control condition where they did not go on any walk or receive education. In the education condition, participants received verbal and interactive education from instructors on the Sustainable Development Goals. I measured participants' arousal level as well as positive and negative affect at the end of the experiment. In addition, I also measured pro-environmental behaviour, which included donations, signing up to receive newsletters from UBC Botanical Garden, signing up to receive volunteering opportunities from the Garden, and signing four petitions. I found that participants in the canopy walk conditions reported higher levels of arousal than the ground walk conditions, but they did not perform more pro-environmental behaviours. The results indicated no significant effect of either arousal or education on pro-environmental behaviour. The study contributes to the currently limited experimental evidence to understand affect, education, and pro-environmental behaviours, and highlights the complicated relationship between these factors. It calls for further research to better understand how we can leverage affective experiences and design education programs to foster pro-environmental behaviour.

Lay Summary

Human behaviour has had destructive impacts on the natural environment. We therefore need to change our behaviour to achieve a more sustainable and just world for both humans and nature. Human emotions and knowledge about the environment are related to actions that benefit the environment, or pro-environmental behaviour. In this thesis, I look at the effects of education and emotions on people's pro-environmental behaviour. Contrary to my expectations, I find no significant effect of emotions or education on pro-environmental behaviour. These findings contrast with previous research showing the benefit of heightened emotional responses or education. This study highlights the complicated relationship between human emotions, knowledge, and pro-environmental behaviour. It calls for further research to better understand how the feeling system and the learning system relate to pro-environmental behaviour.

Preface

This thesis is my original, unpublished work. I identified the research problem, created the research program, and designed the survey with guidance from my supervisor, Jiaying Zhao, and Tara Moreau. The educational programming that was delivered to the different experimental conditions during the data collection phase of the study was developed jointly with Tara Moreau and Oliver Lane. I collected the data at UBC Botanical Garden from May – August 2019. I performed the statistical analyses and wrote the thesis with guidance from Jiaying Zhao. The research project conducted for this thesis was approved by UBC Behavioural Research Ethics Board with the certificate #H19-00360.

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List of Abbreviations

ECO	Ecocentrism Scale
IPCC	Intergovernmental Panel on Climate Change
NEP	New Ecological Paradigm
NR	Nature Relatedness
SDG	Sustainable Development Goals
UN	United Nations

Glossary

Affect	In this thesis, affect is used as an umbrella term for emotions that can be distinguished along the dimensions of arousal and valence.
Arousal	A physiological state that involves activation of the sympathetic nervous system, inducing heightened alertness and attentiveness.
Pro-environmental behaviour	Behaviours that will impact the environment in a positive way, or reduce one's negative impact on the environment.
Valence	The dimension of affect that determines the extent of positive or negative feelings.

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Chapter 1: Introduction

Global climate change is one of the most pressing issues facing humanity. The impacts of climate change on human and natural systems are and will be severe, far reaching and potentially irreversible unless urgent action is taken to curb greenhouse gas emissions (IPCC, 2018). The number of people confronted with air pollution, extreme weather events such as hurricanes, heat waves, and water scarcity continues to rise. It has become widely recognized that these problems represent disruptions of the Earth's ecosystem, which are rooted in human behaviour (Gardner & Stern, 2008; Steffen et al., 2015; Steg, Bolderdijk, Keizer, & Perlaviciute, 2014). Although altering, exploiting, and destroying natural resources and environments are activities that have occurred throughout human history, they are now occurring at an unprecedented pace and continue to negatively impact the climate (Clayton et al., 2016). The need to address climate change was unanimously acknowledged by the United Nations member states in 2015 when they adopted Agenda 2030 and 17 Sustainable Development Goals (SDGs). The SDGs are a network of targets for achieving sustainable development for the period of 2015-2030 and aim to promote shared prosperity, social justice, environmental sustainability, global partnerships, and peace (United Nations, 2015). To achieve the SDGs, it is necessary to reduce emissions, make technological advances, and change production and consumption patterns. Thus, Agenda 2030 clearly demonstrates that sustainable development requires behaviour change.

Individual behaviour change is important to bring about the rapid emissions reductions needed to realize Agenda 2030 (Dubois et al., 2019). It is therefore necessary to understand the environmentally significant behaviours, emotions, and motivations that contribute to high-emissions lifestyles, so that they can be leveraged to also find solutions (Clayton et al., 2015). A key question that has received much attention in the last two decades is how to encourage individual pro-environmental behaviours; behaviours that are intended to minimize environmental harm, or improve environmental conditions (Scannell & Gifford, 2010; Semenza et al., 2008; Steg et al., 2014; Stern, 2000). Humans are not external forces that disrupt natural systems, but integral parts of any ecosystem, or 'socio-ecological system' (Ostrom, 2009). Effective mitigation of current environmental problems will require urgent global action and coordinated policy responses. A concentration of power and wealth to a small number of businesses and corporations limits the effect of individual actions (Esty, 2008; Keohane & Victor, 2016). Still, individual behaviours exert a significant impact on our natural environment (Stern, 2000), and small changes conducted by a large number of people can generate large effects (Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009). As human behaviour degrades the environment in many ways (Amel, Manning, Scott, & Koger, 2017), there are many ways in which it can change to improve it.

Psychological research on environmental problems produced important contributions of how to encourage pro-environmental behaviour and improve the human-environment relationship (Bamberg & Möser, 2007; Gifford, 2014; Schneider, Zaval, Weber, & Markowitz, 2017; Steg & Vlek, 2009; Weber, 2016). However, encouraging pro-environmental behaviour change remains challenging (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007; Varotto & Spagnolli, 2017). The most straight-forward explanation has been a lack of knowledge: people know too little to understand the evidence, they are misled by distortions of it, or they do not know the available solutions. However, that the public lacks the information they need has proven a faulty assumption (Kahan et al., 2011), and both personal factors and situational circumstances are powerful determinants of behaviour (Gifford & Nilsson, 2014; Reddy et al., 2017; Tversky & Kahneman, 1974). Too many policy, education, and public engagement campaigns are based on oversimplifications and false assumptions on how people perceive and respond to environmental issues, for instance that informing individuals about climate science is sufficient to alter decision making and behaviour (Clayton et al., 2016; Hanus, Wong-Parodi, Small, & Grossmann, 2018; Swim, Geiger, & Zawadzki, 2014). Psychological research to understand how human behaviour can be changed is thus imperative for advancing progress towards a sustainable future.

This thesis contributes to research on human behaviour change. It is methodologically rooted in behaviour science, cognitive psychology, and environmental psychology to examine how education and emotions can be leveraged to foster individual pro-environmental behaviour. This chapter (Chapter 1) reviews relevant literature in the context of pro-environmental behaviour change, and covers the topics of education and affect. Chapter 2 describes the methodology and answers the research questions formulated in Chapter 1. It reports findings from a field study conducted in University of British Columbia (UBC) Botanical Garden which examined the effects of education and arousal on individuals' actual pro-environmental behaviour. It further discusses the overall results in light of the current literature on pro-environmental behaviour change, and the implications for future research. Chapter 3 provides a summary of the key results and conclusions from the current study.

1.1 Human behaviour and the environment

As human behaviour is at the crux of sustainability problems, it is essential to study and understand mechanisms that hinder or enable pro-environmental behaviour. Interest in behavioural science from community groups, businesses, and policy makers has surged in recent years, and much progress has been made to better understand the relationship between human behaviour and pro-environmental actions (Dietz et al., 2009; Gifford, 2014; Weber, 2015). These findings reveal that human behaviour is determined by both internal, personal forces such as emotions, habits, and values, as well as forces outside the individual such as social norms, culture, politics, and infrastructure (Bamberg & Möser, 2007; Gifford et al., 2011; Osbaldiston & Schott, 2012; Weber, 2016). Human behaviour is inherently multidimensional and social. This highlights that there are no quick solutions that work for all instances and all individuals. Behaviours are uniquely rooted within social, institutional, and cultural contexts, and so are the barriers to behaviour change (Gifford et al., 2011). This makes the objective of changing behaviour extremely difficult.

Three general reasons have been put forward for why human behaviour is fundamental to environmental challenges (e.g., Clayton et al., 2016; Weber, 2006). Firstly, increasing human population and unsustainable consumption patterns lead to overexploitation of resources and emissions of greenhouse gases (Steffen et al., 2015), resulting in the depletion of natural resources, biodiversity loss, pollution, and climate change. Secondly, human responses are subject to limitations and systematic biases in cognition, which often obstruct opportunities for mitigation and adaptation (Cinner, 2018). Interpretations of climate science and evidence are often skewed according to these biases, personal values, attitudes, and beliefs, as well as to social norms and group polarizations – which could overrule pro-environmental intentions (Gifford, 2011; Steg et al., 2014). Thirdly, human and natural systems are inextricably linked. A positive relationship exists between a personal connection with the natural world and well-being (Wolsko & Lindberg, 2013). Yet wellbeing is increasingly affected by climate change: from sea level rise, forced displacement, floods, and extreme weather events to drought, soil degradation, and social unrest, there are both acute and long-term effects that produce distinct vulnerabilities and impacts for people all over the world (Patz, Frumkin, Holloway, Vimont, & Haines, 2014).

Historically, doing what has always been done has made life more predictable, efficient, and has often been considered the safest option of action (Marshall, 2015; Weber, 2016). However, in the case of climate change, inaction and business as usual responses are the most dangerous options. Continued greenhouse gas emissions will lead to a global environment with more frequent crises such as droughts, floods, extreme weather events as well as social and economic consequences (IPCC, 2018; Steffen et al., 2015). This will seriously challenge humans' current way of life. Humans not only influence the state of their environment, but are also influenced by it. As such, human behaviour is causing environmental crises, and is thereby also a part of the solution.

1.1.1 Why aren't we changing our behaviour already?

People often want to act in pro-environmental ways (Whitmarsh, O'Neill, & Lorenzoni, 2013), however their priorities, habits, and time constraints might clash with this objective. For instance, instead of taking public transit or biking to work it might be faster to drive; when buying food it is easier to throw the remains in the landfill-stream rather than identify the correct composting and recycling streams; and a desire to visit relatives and friends living far away encourages air travel. These types of behaviours depend on more than just knowledge; they are also contingent on time, habits, emotions, and contextual factors (Gifford, 2014; Steg & Vlek, 2009). Thus, there is a gap between pro-environmental knowledge and attitudes on the one side, and contradictory actions on the other. Although individuals report high environmental knowledge and favourable attitudes, they do not necessarily act on these attitudes in context (Kollmuss & Agyeman, 2002). Research demonstrates that attempts to encourage pro-environmental behaviour through awareness campaigns, education, financial incentives, and regulation can be ineffective (Abrahamse & Steg, 2013; Cinner, 2018; Reddy et al., 2017), and sometimes even backfire (Gneezy, Meier, & Rey-Biel, 2011; Stibe & Cugelman, 2016). Insights from the psychological and behavioural sciences on how to bring about behaviour change is therefore essential.

1.1.2 The information deficit model

The standard, neoclassical economic model of human behaviour considers human decision making the result of rational, individualistic utility maximization (Welsch & Kühling, 2009). This rational choice approach assumes that humans are accurately informed about the costs and benefits of their choices, they are aware of constraints in order to maximize utility of their actions, and they act independent of others' behaviour (van den Bergh, Ferrer-i-Carbonell, & Munda, 2000). Information-based strategies for behaviour change similarly assume that with the correct knowledge, people will act according to their goals and interests (Schultz, 2002). As such, the assumption goes that education can increase individuals' understanding, awareness, and concerns, and thereby lead to behaviour change (Otto & Pensini, 2017). Multiple studies report that providing environmental information results in higher willingness to participate in environmental actions (Abrahamse, Steg, Vlek, & Rothengatter, 2005; Lim-Wavde, Kauffamn, & Dawson, 2017; Obery & Bangert, 2017; Stofer et al., 2019). However, in assuming that more information alone will result in behaviour change, this approach oversimplifies the foundations of human behaviour (Kollmuss & Agyeman, 2002). Information-based approaches could work if knowledge is the only missing variable, but this is rarely the case.

1.1.3 Bounded rationality

The rational choice approach to behaviour has long been criticized for neglecting the complexity of human behaviour, and in particular the limitations to people's cognitive capacity (Kahneman, 2003; Welsch & Kühling, 2009). As a response, the 'bounded rationality' model (Simon, 1972) states that people desire to preserve cognitive effort, and therefore do not strive to maximize utility in all cases. Instead, due to limited brain capacity people adjust their cognitive effort to the importance of a decision (Welsch & Kühling, 2009). Decisions are thus based upon the amount of information available, limitations to cognitive capacity, and time constraints (Kahneman, 2003). Choices are thereby adjusted when people become dissatisfied with their outcomes, and rational, utility-maximizing decision-making only occurs when important decisions are made.

This line of research has given rise to a two-system view of thinking, which distinguishes intuitive thinking from reasoned thinking (Kahneman & Frederick, 2002). Emerging from work in cognitive psychology and behavioural decision making, it postulates that there are two discrete ways in which the human brain processes information: "System 1," a rapid, automatic decision-making and judgement process that is based on heuristics and biases; and "System 2," which involves deliberate and conscious reflection, and represents a slower but more accurate decision-making process (Kahneman, 2003). People primarily employ System 1, which works well for most aspects of daily life. It utilizes past personal experiences, associations, and emotional reactions to interpret information and come up with appropriate behavioural responses. Yet, this rapid decision-making causes behaviour to be irrational in systematic ways. Shortcomings such as the optimism bias (irrational beliefs in preferential outcomes despite evidence of the contrary), loss aversion (preference of avoiding losses that to acquire gains of equal value), resistance to changes to the status quo (preference to keep things the way they have always been), confirmation bias (seeking out information that supports already established beliefs), and insensitivity to threats that are distant in time and space, are prominent features of behaviour (Kahneman, 2003). These biases further contribute to an underestimation of climate related risks, which are slow, remote, abstract, and temporally distant (Weber, 2015).

To summarize, limitations in time, interest, and cognitive capacity makes human decision making susceptible to fatigue and errors of judgement. System 1 and System 2 developed to make humans responsive and adaptive to their environment. The brain is still wired to the environment of those humans who lived thousands of years ago, and is dominated by emotional responses, shortcuts in decision making, and is responsive to storytelling (Marshall, 2015). Today's environment, defined by industrial and technological advances, urbanization, and globalization, does not resemble that of even a few decades ago, let alone that of thousands of years ago. The world is more complex than ever, with a constant flow of stimuli, information, and choice options. Triggering sustainability changes requires changes in public values, attitudes, perceptions, and behaviours, and the right conditions for these changes to happen. Education is one of the most employed behaviour change strategies (Abrahamse, 2019). Education has potential to empower individuals with knowledge (Abrahamse, Steg, Vlek, & Rothengatter, 2007; Otto & Pensini, 2017), reshape worldviews (Cortese, 2003; Kioupi & Voulvoulis, 2019), and has traditionally been considered an important behaviour change method.

1.2 Education

Behaviour change models often focus on developing knowledge through education. The underlying assumption is that having the relevant knowledge will result in pro-environmental behaviour (Duerden & Witt, 2010; Gifford & Nilsson, 2014; Morris et al., 2019). Increasing public engagement and actions for sustainability remain a main challenge for governments, institutions, and organisations (Gifford, 2011). Simultaneously, individual behaviours are important for addressing environmental problems, and work seeking to promote pro-environmental behaviour demonstrates that individuals' level of understanding of climate change matters (Obery & Bangert, 2017; Wolf & Moser, 2011). Knowledge can play a key role in supporting pro-environmental behaviour (Cortese, 2003; Levine & Strube, 2012). Lack of knowledge is seen as a main barrier for pro-environmental action, such as in the cases of energy use, consumption, and recycling (Gardner & Stern, 2008; Lorenzoni et al., 2007; Varotto & Spagnolli, 2017). Education interventions are commonly employed behaviour change strategies as they are scalable, easy to implement, and potentially far reaching (Abrahamse, 2019). In the late 1990s, the Dutch government launched an information campaign about climate change which was diffused through mass media, emphasising scientific information and what individuals could do. A study evaluating the effects of the campaign found that it had a small effect on the public's environmental knowledge, and no effect on willingness to perform pro-environmental behaviour (Staats, Wit, & Midden, 1996). Only people indicating they were already highly motivated and invested in environmental issues demonstrated higher intention to perform pro-environmental behaviours following the campaign (Staats et al., 1996). Other studies also support the notion that the provision of information by itself has limited efficacy of changing behaviour (Abrahamse et al., 2005; Amel et al., 2017; Duerden & Witt, 2010). In general, education can increase environmental knowledge (Osbaldiston & Schott, 2012), but does not change behaviour. It is therefore necessary to examine how education can be combined with other intervention strategies to increase its efficacy.

1.2.1 Education and nature

Learning in natural environments may increase pro-environmental attitudes and behaviour. Multiple studies demonstrate that exposure to natural environments yields benefits on cognition, well-being, and pro-environmental behavior (Chawla, 2015; Wolsko & Lindberg, 2013; Zelenski, Dopko, & Capaldi, 2015). There is consensus from a range of academic fields, including the natural sciences, psychology, sociology, and geography that human connection with nature is a major determinant of people's environmental concern, ecological worldview, and pro-environmental behaviour (Karjalainen, Sarjala, & Raitio, 2010; Kingsley, Townsend, Henderson-Wilson, & Bolam, 2013; Otto & Pensini, 2017; Walker, Holling, Carpenter, & Kinzig, 2004; Wolsko & Lindberg, 2013). Moreover, a personal connection with nature is associated with environmental concern, attitudes, and behaviours (Dunlap, Van Liere, Mertig, & Jones, 2000; Nisbet, Zelinski, & Murphy, 2009), which in turn are some of the main correlates with pro-environmental behaviour (Bamberg & Möser, 2007). In addition, exposure to natural environments correlates with a range of other benefits, including memory and cognition (Barton & Pretty, 2010; Bratman, Daily, Levy, & Gross, 2015), reduced stress and fatigue (Bratman et al., 2015; Shanahan et al., 2016), and well-being (Chawla, 2015). As the modern world and lifestyle become increasingly urbanized, there is growing emphasis on the need to reconnect with the natural world (Grund & Brock, 2019; Obery & Bangert, 2017). In a recent meta-analysis, Whitburn, Linklater, and Abrahamse (2019) demonstrated a moderate, positive, and ubiquitous relationship between the human-nature connection and pro-environmental behaviour. This suggests that a strong relationship with nature is beneficial for pro-environmental behaviour. It is therefore important to further strengthen humans' connection to nature to facilitate pro-environmental behaviour (Whitburn et al., 2019). Providing education in natural environments can also be a way to contextualize knowledge, and reduce the compartmentalization that often occurs between knowledge and practice in traditional education settings. Duerden and Witt (2010) examined the effects of indirect, theoretical experience and direct experience with nature on environmental knowledge, attitudes, and behaviour. The study revealed that levels of knowledge increased similarly in both the indirect and direct experience types, however the association between knowledge and behaviour was stronger in the direct experience with nature (Duerden & Witt, 2010). Taken together, these findings indicate that education can provide knowledge, and that direct experiences can enable knowledge to become a stronger motivating force for behaviour.

1.2.2 Education and botanical gardens

The majority of the human population lives in cities, and 80% of the global population is projected to live in cities by the end of this century (United Nations, 2016). The urban lifestyle is largely removed from the natural world and thereby hinders human-nature relationships. It therefore is essential to find ways to build and reinforce these connections. There are over 3300 botanical gardens around the world which receive over 300 million visitors per year (Dodd & Jones, 2010). Botanical gardens are museums of both common and rare living plants, which serve as centres of conservation, display, research, and public outreach. At the same time, botanical gardens are often situated in population centres and are well positioned to reconnect urban dwellers with the natural world, thus motivating pro-environmental actions.

The global network of botanical gardens with their local expertise and skills have potential to serve as unique outdoor areas for sustainability education. A recent study conducted with five botanical gardens in the United Kingdom found a positive relationship between ecological knowledge and environmental attitudes in visitors to botanical gardens. Visitors displayed stronger environmental attitudes after spending time in a garden (Williams, Jones, Gibbons, & Clubbe, 2015). Furthermore, education in a natural setting has positive impact on children's environmental knowledge, attitudes, and behaviour (Chawla, 2015), and proximity to a natural area increases children's knowledge of and connection with nature (Sampaio, De La Fuente, Albuquerque, Souto, & Schiel, 2018).

The study conducted for this thesis took place at UBC Botanical Garden. The Garden has an established Sustainable Communities Field School (FS) program that aims to engage employees of local businesses and organisations in sustainability topics including biodiversity conservation, food choices, water conservation, and waste. This study was designed to evaluate if delivering education programming to visitors on the Greenheart TreeWalk, a 300-metres long and 25 metres high suspension bridge canopy walkway, increased the frequency of participants' pro-environmental behaviours. This work builds on results from Zelenika, Moreau, Lane, and Zhao

(2018), who found that educating people in the FS encouraged intentions to engage in pro-environmental actions. Participants in the FS self-reported that they were more likely to engage in pro-environmental behaviours, and they signed more petitions than garden visitors who did not experience the FS (Zelenika et al., 2018). However, education only increased certain behaviors, such as doing less laundry and doing full loads of laundry, and the effect was not observed for behaviors that require more effort, such as installing low-flush toilets (Zelenika et al., 2018). Thus, further study is required to examine the potential impacts of educational interventions on people's pro-environmental actions, and the effects of providing education in natural environments on these actions.

1.2.3 Education and the SDGs

Expanding on the Millennium Development Goals, the SDGs (Figure 1.1) were formally adopted by all 193 United Nations member states in 2015. The SDGs are a roadmap for the global community to achieve sustainable development, aiming to end extreme poverty, protecting the planet, and ensuring prosperity and peace for all by 2030 (United Nations, 2015). The 17 SDGs require all nations to take action. The SDGs can be a way to localize action, compare progress, and highlight the need and scope of a community's necessary pro-environmental actions. The SDG framework further emphasizes that sustainable development is not uniquely about the environment, but also about aspects such as poverty alleviation, gender equality, accessible education, and strong partnerships.

Figure 1.1. The SDG logo, including the icons of the 17 Goals and the colour wheel. Adopted from United Nations, (2015).

Overall, education does not seem to be enough to produce pro-environmental behaviour change. Despite over 30 years of educational campaigns to raise public awareness and increase action regarding environmental issues, the general public still confuses environmental issues, in particular climate change, ozone layer depletion, air pollution, and weather (Wolf & Moser, 2011). Additionally, individuals tend to overestimate their expertise (Scharrer, Rupieper, Stadtler, & Bromme, 2017), feel overwhelmed in the face of global challenges like climate change (Ordner, 2017; Stofer et al., 2019), and do not know how their behaviour can be modified (Lorenzoni et al., 2007). To stimulate action, it is necessary to define actionable and achievable calls to action that will lead a specific group of people to do something they have not done before

(Christiano & Neimand, 2017). In terms of knowledge, a meta-analysis of 46 research studies examining factors influencing pro-environmental behaviour found that knowledge is an important factor governing behaviour, but that it is modified by other factors, including problem awareness, internal attributions, and emotions (Bamberg & Möser, 2007). As education aims to modify knowledge and behaviour, recent findings suggest that the effect of education on behaviour is largely mediated by emotions (Carmi, Arnon, & Orion, 2015; Otto & Pensini, 2017). This notion highlights an affective component of pro-environmental behaviour, consistent with a two-system view of behaviour. Whereas System 2 is involved in deliberation, reasoning, and analysis, people often make decisions based on System 1 which relies on a subset of information that is made salient by the decision context. As contextual features of a decision often induce emotion, people frequently rely on those emotional responses more heavily than on other information (Schwarz & Clore, 1983, 2003; Slovic, Finucane, Peters, & MacGregor, 2002). Affect is one particular aspect of emotion that has received empirical attention, and the following section reviews the literature on affect and pro-environmental behaviour.

1.3 Affect

Emotions and behaviour might not immediately seem related. However, emotions can serve as an important route to action. Baumeister et al. (2007, p. 168) postulate that "all psychological processes, and certainly emotion, exist in part to influence behavior." All humans share the necessity of continually having to monitor and evaluate features of their surroundings. When it comes to factors that influence this evaluation and subsequent behaviour, a growing body of research highlights the central role of affect (Clore, Gasper, & Garvin, 2001; Peters & Slovic, 2000; Schwarz & Clore, 1983, 2003; Sinclair et al., 1994; Slovic et al., 2002, 2004, 2005;

Storbeck & Clore, 2008; Winkielman, Knutson, Paulus, & Trujillo, 2007). Affect is an emotional experience that is comprised of two dimensions: arousal, a physiological activation ranging from high to low; and valence, the experience of positive or negative feelings (Baumeister et al., 2007). In terms of how affect impacts behaviour, the affect-as-information model posits that arousing reactions provide bodily and experiential information about importance and urgency, whereas valence signals the positive or negative value of whatever is encountered (Clore & Storbeck, 2006).

As such, when encountering an object, event, or situation, people implicitly ask themselves "how strongly do I feel about it?" (Schwarz & Clore, 1983; Storbeck & Clore, 2008). Affective reactions thus serve to signal overall importance, where a strong arousal response would signal high importance and vice versa, and value, where high valence would signal positivity and vice versa, of a given object, judgement, or event (LeBlanc, McConnell, & Monteiro, 2015; Zadra & Clore, 2011). The goal of the affect-as-information hypothesis is to understand the transformative power of affect on cognition and behaviour (Storbeck & Clore, 2008). Research has shown that subtle activation of negative affect such as self-accountability can be effective in encouraging people to act pro-environmentally (Meng & Trudel, 2017; Peloza, White, & Shang, 2013), whereas strong negative affective states can be counter effective (Kollmuss & Agyeman, 2002). Affect also influences attention (Zadra & Clore, 2011), attitudes (Fazio & Powell, 1997), judgement (Schwarz & Clore, 1983), health behaviours such as vaccination, smoking, and exercise (for a review, see Kiviniemi et al., 2018), and memory and learning (Storbeck & Clore, 2005). Affective information thus guides cognitive processing and the formation of long-term memory, and serves as a foundation for judgements and behaviour.

1.3.1 Arousal

A main affective response is arousal, the state of being physiologically alert and attentive (Storbeck & Clore, 2008). Arousal is an activation of the sympathetic nervous system, involving bodily responses such as increased heart rate, focused attention, changed breathing pattern, and sweating. Arousing information is incorporated into the consideration of one's environment and surroundings, and influences judgement and processing by expressing information about urgency and importance about a stimulus (Zadra & Clore, 2011). Aroused individuals rate themselves as more amused by cartoons than non-aroused individuals (Martin, Harlow, & Strack, 1992), and aroused individuals judge positive ads as more positive and negative ones as more negative (Gorn, Pham, & Sin, 2001). Brain activation patterns also suggest that arousal signals the importance of stimuli (Cunningham, Van Bavel, & Johnsen, 2008). Arousal is further associated with enhanced memory retention (Kensinger & Corkin, 2004; Sharot & Phelps, 2004), and positive arousal, but not negative arousal, enhances preferences for giving and increases donations (Genevsky et al., 2013).

These effects appear to result from misattribution of arousal (Bamberg & Möser, 2007; Storbeck & Clore, 2008). In order for the arousal response to signal urgency about a stimulus, it must be attributed to, or considered to be caused by it. However, the physiological effects of arousal are reactions that can easily be attributed to a range of experiences and reactions. If the person does not question where the feeling is coming from, and the true source of arousal is not apparent, she risks to misattribute the judgement to whatever is the focal point of her attention (Schwarz & Clore, 2003). Sinclair et al. (1994) found that participants who had just been exercising, and therefore had an obvious explanation for their arousal, were not influenced by emotionally primed content when self-rating their current emotional state. However, participants who exercised and self-rated after a time delay, thereby having no obvious explanation for their arousal, showed more extreme and prime-consistent self-ratings (Sinclair et al., 1994). Arousal can be misattributed to one's natural response to a stimulus in the surrounding environment, and thereby become a source of bias in subsequent decision-making and behaviour (Loersch & Payne, 2011).

One classic study especially illustrates the roles arousal and causal attributions play in guiding behaviour. Dutton and Aron (1974) placed an attractive female experimenter at the end of a suspension bridge which extended over a deep ravine. The unstable bridge was 150 metres long, about three feet wide, and crossing it induced an emotionally arousing state. After male participants crossed the bridge, they met the female experimenter, who invited them to answer a survey. The female would then debrief them about the experiment, and in the process gave the participants her telephone number. The results showed that in comparison with control participants who had crossed a non-arousing bridge, the high-arousal participants were more likely to contact the female experimenter (50% in the high-arousal condition vs. 12.5% in the low-arousal condition). The researchers explained the results in terms of misattribution of arousal, in that the male participants in the high-arousal condition thought their increased heart rate, sweaty palms, and changed breathing were responses to the attractive female, when they were in fact caused by the unstable suspension bridge (Dutton & Aron, 1974).

Subsequent research further demonstrates the role of arousal in decision making and behaviour (Kiviniemi et al., 2018; Sinclair et al., 1994; Storbeck & Clore, 2008), and supports the affect-as-information model. Arousal can intensify reactions, amplify accessible judgements, and influence behaviour. There is however a gap in the literature regarding the effect of arousal while learning, and in particular about sustainability. No study found to date addressed the possibility that experiencing arousal while learning about sustainability could elicit an enhanced sense of urgency and encourage pro-environmental actions to a higher extent than simply learning without the simultaneous affective experience. This research aims to further investigate the potential of arousal to encourage pro-environmental behaviour.

1.3.2 Valence

Similarly to arousal, valence needs to be experienced as a reaction to an event, situation, or object of judgement in order to influence behaviour (Storbeck & Clore, 2008). Valenced stimuli attract attention (LeBlanc et al., 2015) and are processed differently depending on whether they are positively or negatively valenced (Marx, Marshall, & Castro, 2008). Positive feelings broaden attention, improve integration of information, and increase recall of peripheral details of events (Fredrickson & Branigan, 2005; Gasper & Clore, 2002). Schneider et al. (2017) found that anticipating positive future emotional state from a pro-environmental action just prior to making an environmental decision, as opposed to anticipating negative emotions from inaction, lead to higher intentions to perform pro-environmental behaviours. Negative valence narrows attention, and negatively valenced stimuli are more elaborated in memory and therefore better recalled (Marx et al., 2008). Fredrickson and Branigan (2005) found that negative valence activates thought-action repertoires and spur behaviours. Koenig-Lewis, Palmer, Dermody and Urbye

(2014) found that both positive emotions (e.g., optimistic, happy, proud) and negative emotions (e.g., nervous, worry) predicted intentions to purchase organic beverage containers. This body of research shows the ubiquitous nature of valence and its influence on stimuli processing, although it is not clear how it influences subsequent behaviour.

1.4 Connectedness to nature and pro-environmental behaviour

People tend to differ in the extent to which they feel emotionally connected to and part of the natural world (Ives et al., 2018; Schultz, 2002). Spending time in nature and strong subjective attachment to the natural world is associated with sustainable attitudes (Gifford, 2014). Feelings of connectedness to nature and sensations that humans are damaging the natural world have been related to pro-environmental constructs such as self-reported environmentalism, environmental concern, and pro-environmental behaviors (Dunlap et al., 2000; Gosling & Williams, 2010; Nisbet, Zelenski, & Murphy, 2009; Schultz et al., 2004). Furthermore, a disconnect from the natural world may contribute to environmentally destructive behaviors including pollution and energy consumption (Schultz et al., 2004).

As concerns about environmental issues and the extent to which an individual believes they are part of nature can be associated with pro-environmental behavior, the study conducted for this thesis included the following three measures of environmental attitudes and concern as control measures.

1. Ecocentrism Scale: Ecocentric views maintain that nature deserves moral considerations due to its intrinsic value, and the ecocentrism construct as measured by the Ecocentrism

Scale captures these moral considerations of whether nature is valuable for its own sake (Thompson & Barton, 1994);

2. The New Ecological Paradigm: This measure is commonly used to evaluate pro-environmental attitudes and captures environmental concern, including individuals' beliefs about humans as separate from or as an integral part of the natural world (Dunlap et al., 2000);
3. Nature Relatedness: The construct of nature relatedness (NR) as measured by the Nature Relatedness scale captures individual differences in how people view their relationship with the natural world (Nisbet et al., 2009). Individuals with high NR are typically happier and demonstrate higher levels of environmental concern that individuals with low NR scores (Nisbet & Zelenski, 2013).

1.5 Research Question and Hypotheses

There is a clear need to develop behaviour change interventions tailored to how people feel, learn, and process information. The literature on affect suggests that people make decisions by implicitly asking themselves, "how strongly do I feel about it?" Arousing stimuli can activate attention, influence judgements, and provide feedback about the urgency or importance of current situations, information, and thoughts. Previous research has not examined the role of arousal, and in particular misattribution of arousal on pro-environmental behaviour. Furthermore, the literature on education shows its potential for influencing behaviour. However, it is unclear whether arousal can assign more urgency to educational interventions and thereby foster pro-environmental behaviour. The purpose of this thesis is to address these gaps and examine whether arousal and education can increase individual pro-environmental actions. This work is the first to examine, to the best of my knowledge, the effects of arousal and education on pro-environmental behaviour. It draws on theoretical indications that experiences which combine environmental education and increased arousal can produce misattribution effects, and in turn higher pro-environmental behaviour. Moreover, this misattribution would manifest as higher environmental concern. Examining this chain of effects will increase the understanding of how to design interventions to engage individuals in pro-environmental behaviours. The following research question addressed this purpose:

What are the roles of arousal and SDG education in increasing individual pro-environmental actions?

Specifically, the thesis tested the following three hypotheses:

1. There will be a main effect of arousal; participants in TreeWalk conditions will be more likely to display pro-environmental behaviour.
2. There will be a main effect of education; participants in education conditions will be more likely to display pro-environmental behaviour.
3. There will be an interaction between arousal and education; those in the high arousal condition and receiving education will display higher levels of pro-environmental behaviour.

Chapter 2 describes the experiment designed to test the research question and affiliated hypotheses. It examines whether an education program delivered in a botanical garden produces increased pro-environmental behaviour. The study contributes to the literature on affect, education, and pro-environmental behaviour by examining whether arousal combined with sustainability education experiences can produce pro-environmental behaviour change in visitors to a botanical garden. The reviewed literature acknowledged the importance of intention and knowledge as an initial step toward behaviour, and past studies relating to affect, education, and pro-environmental behaviour have mostly focused on willingness to act, intentions, and self-reports (Koenig-Lewis et al., 2014; Scannell & Gifford, 2010; Zelenika et al., 2018) rather than observations of actual behavior change (although there are some exceptions, e.g. Obery & Bangert, 2017; Rees et al., 2015). However, Ajzen (1987) already demonstrated that intention only accounted for approximately 30% of the variance in behaviour, which was confirmed by a meta-analysis showing that 27% of the variance in behaviour could be explained by intentions (Armitage & Conner, 2001). As willingness to perform behaviours and behavioural intentions do not necessarily correspond to behaviour change (Russell, Young, Unsworth, & Robinson, 2017), the current study captured actual pro-environmental behaviours.

Chapter 2: Body of Thesis

2.1 Methods

2.1.1 Participants

A total of 423 participants (180 male, 232 female, 4 other, mean age = 42.62 years, *SD* = 17.68) were recruited at UBC Botanical Garden. All adult, English speaking visitors were invited to participate upon their arrival to take part in a 1-hour study examining the impact of garden visits on people's pro-environmental behavior. They were informed that their data would be anonymized and confidential. In compensation for their participation they were offered $10, a free Garden entry and a free TreeWalk entry (combined value of which was $20). Participation in the study was voluntary and participants could withdraw at any time. Participants were randomly assigned to a condition. If participants were allocated to a non-TreeWalk condition they received a voucher so that they could complete it without additional costs in their own time. A power analysis was conducted prior to data collection to determine the sample size using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007). The purpose of the power analysis is to determine the appropriate sample size necessary to detect the effect of the experimental treatment (e.g., arousal or education) based on the alpha level (.05), statistical power, and effect size (Faul et al., 2007). The power analysis was based on a previous study conducted in UBC Botanical Garden by Zelenika et al. (2018). It indicated that at least 65 subjects in each condition would be required for appropriate statistical power. The current study therefore recruited garden visitors until all conditions had minimum 65 participants, and subsequently recruited more participants to certain conditions in order to obtain approximately equal sample sizes. The study was preregistered on Open Science Framework and is available at: osf.io/mucp7.

2.1.2 Experimental Design

We conducted a 2 (education vs. no education) x 2 (high arousal vs. low arousal) between-subjects field experiment with a control group, to examine the effects of education and arousal on garden visitors' pro-environmental behaviour. The independent variables, dependent variables, and covariates are summarized in Table 2.1. Arousal was induced by taking participants on the Greenheart TreeWalk in UBC Botanical Garden, a 300-metres long canopy walkway consisting of wobbly suspension bridges elevated approximately 25 metres up in the air (Figure 2.1). Education was manipulated by delivering education material which was developed jointly with UBC Botanical Garden Field School. The material consisted of five short, interactive lessons that were grounded in the SDGs; one introduction to the SDGs; and one lesson each about SDG 15 – Life on Land, SDG 12 – Responsible Consumption and Production, SDG 11 – Sustainable Cities and Communities, and SDG 13 – Climate Action. The education introduced the participants to the specific SDG and its targets, why it is important, and what participants could do to contribute to it (see Appendix A for full education script).

Table 2.1. Overview of experimental variables and covariates included in the study. *: University of British Columbia Botanical Garden.

<table>
<tr><td colspan="2">Experimental variables</td></tr>
<tr><td>Conditions
• TreeWalk + education
• TreeWalk
• Ground walk + education
• Ground walk
• Control</td><td>Dependent variables
• Donate to BG*
• Sign up to BG newsletter
• Sign up to volunteer opportunities from BG
• Sign petitions</td></tr>
<tr><td colspan="2">Covariates</td></tr>
<tr><td>Arousal and valence
Environmental scales
• Ecocentrism
• Environmental concern
• Nature relatedness</td><td>Demographics
• Age
• Gender
• Financial status
• Political orientation
• Group size</td></tr>
</table>

Figure 2.1. Photo of the Greenheart TreeWalk. Photo courtesy of UBC Botanical Garden.

2.1.3 Survey design

The survey aimed to evaluate the impact of the different experimental conditions on participants' actual pro-environmental behaviour, and their environmental attitudes. The survey included four main components which are described below. The full survey can be found in Appendix B.

2.1.3.1 Affect

The Affect Grid (Figure 2.2) was used to capture participants' level of affect (Russell, Weiss, & Mendelsohn, 1989). The Affect Grid is a commonly used scale designed as a quick means of assessing affect along the dimensions of valence (pleasure – displeasure) and arousal (arousal – sleepiness) (e.g., Colomo-Palacios, Casado-Lumbreras, Soto-Acosta, & García-Crespo, 2011; Deaver, Miltenberger, Smyth, Meidinger, & Crosby, 2003; Gasper & Hackenbracht, 2015). Participants were asked to place one 'x' in one square to indicate how they were feeling at the moment.

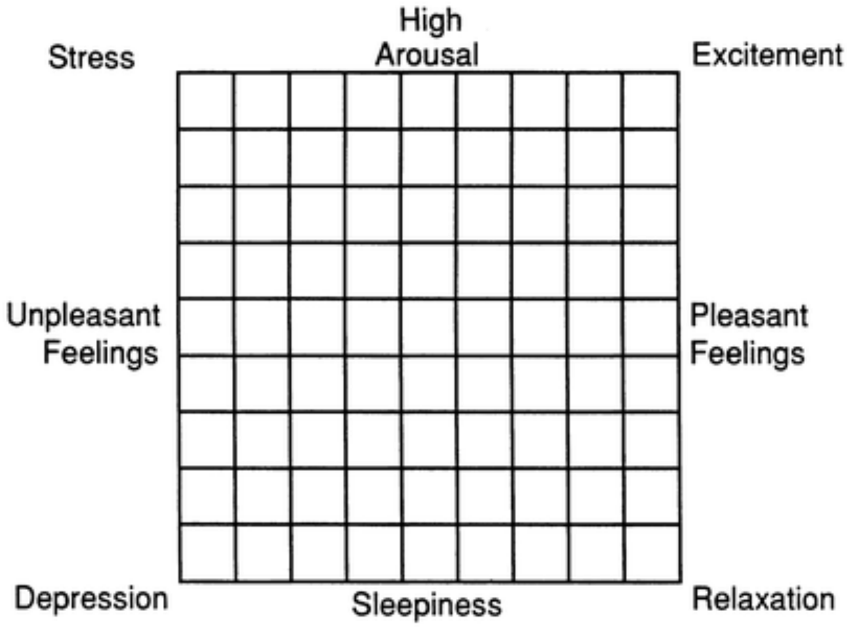


Figure 2.2. The Affect Grid. The participants mark their current emotional state on a two-dimensional 9x9 grid where arousal forms the vertical axis and valence forms the horizontal axis. Adapted from Russell et al. (1989).

2.1.3.2 Environmental attitudes

Participants' environmental attitudes and concerns were assessed using three well-established and frequently used environmental scales (Table 2.1); the four-item Eco-Centrism (ECO) scale (e.g., "to what extent do you agree with the statement, "Nature is valuable for its own sake'") (Thompson & Barton, 1994); the Shortened Revised New Ecological Paradigm (NEP) scale (Dunlap et al., 2000) which has four items (e.g., "Humans are severely abusing the environment"); and the Shortened Nature Relatedness Scale (NR), which has six items and describes individual levels of connectedness with the natural world (e.g., "I take notice of wildlife wherever I am") (Nisbet & Zelenski, 2013). Participants answered each statement (14 in total) on an 11-point Likert scale, indicating to what extent they agreed (10) or disagreed (0) with each statement. One of the ECO items was reverse coded ("The so-called 'ecological crisis' facing humankind is greatly exaggerated").

2.1.3.3 Pro-environmental behaviours

Four pro-environmental behaviours were included in the survey (Table 2.1). The following three questions captured participants' donations, newsletter signups, and volunteer signups:

1. As a thank you for your participation in this study, you will receive $10. Would you like to donate some or all of this to the UBC Botanical Garden? This is completely voluntary. If you would like to donate, please write down the amount. If not, please leave it blank and move onto the next question.
2. Would you like to sign up to receive a monthly newsletter from UBC Botanical Garden? If yes, please provide your email below. Sign-up is completely voluntary and you can unsubscribe at any time. If not, please leave it blank and move onto the next question.
3. Would you like to sign up to receive information about volunteer opportunities from UBC Botanical Garden? If yes, please provide your email below. Sign-up is completely voluntary and non-committing, and you can unsubscribe at any time. If not, please leave it blank and move onto the next question.

Participants were then presented with four petitions that were available to sign: two that related to the environment (biodiversity and forest conservation), whereas two related to social justice (poverty and income inequalities) (see Appendix B). The social justice petitions were included as control measures, as previous experiences in the Garden suggested that participants would sign any petition they were presented with. The current study wanted to control for this tendency as it was specifically interested in pro-environmental behaviour, and therefore environmental petitions.

2.1.3.4 Demographics

Past research indicates a relationship between demographics such as age, gender, political orientation, and financial status, and pro-environmental behaviour (Williams et al., 2015). We therefore collected information on these variables in order to control for them in our analysis.

2.1.4 Procedure

Participants were recruited at the beginning of their visit to the Garden. As visitors often came in groups and were unwilling to separate, groups of visitors up to five were accepted, in which case all were allocated to the same condition and went through the treatment together. The participants were asked to fill out the surveys individually. The group size was recorded as a covariate to be examined in statistical analysis. Figure 2.3 shows the study area. Once participants signed the consent form they walked with an experimenter for approximately 10 minutes to the TreeWalk area of the Garden (from location A to location B on Figure 2.3), where they received their condition-specific treatment. A complete transcript of the procedure in each treatment can be found in Appendix A. In the TreeWalk with education condition, participants were guided through the TreeWalk and received education based on the SDGs at five of eight platforms. In the TreeWalk condition (no education), participants were simply guided through, without any encouraged communication from the experimenter. In both conditions the participants completed the survey upon exiting the TreeWalk. In the ground walk with education condition, participants were guided along a path that started by the entrance to the TreeWalk and looped below the TreeWalk, finishing at the same location as the exit of the TreeWalk. Participants received identical information about sustainable development below five of eight platforms. For the ground walk (no education) condition, participants walked on the same path below the TreeWalk, however they did not receive the education. They were led by the experimenter but not engaged in any conversation. In both ground walk conditions, participants completed the survey in the same location as the other conditions, near the exit of the TreeWalk. Participants in the control condition were walked to the area of the Garden where the survey was administered (marked 'C' on Figure 2.3), and were immediately asked to fill out the survey. For all conditions, upon completion of the survey the participants were debriefed (both verbally and in writing), paid for their participation ($10), and thanked for their participation. The methods and research procedure were approved by UBC Behavioural Research Ethics Board (Ethics ID: H19-00360).

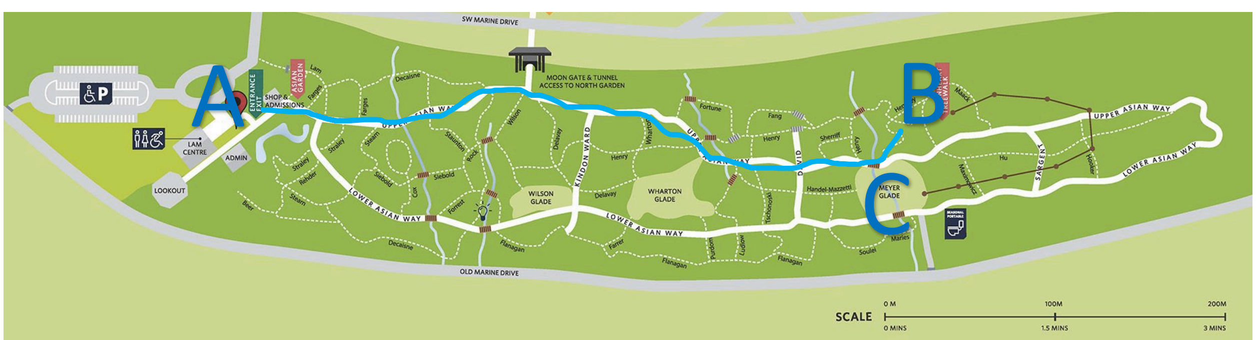


Figure 2.3 Map of UBC Botanical Garden with letters highlighting the recruitment area (A), path taken down to treatment area (blue line), the treatment area (B), and survey area (C).

2.1.5 Data Analysis

Due to missing data, 4 participants were excluded from analysis. The total sample size was N = 419. To assess the effects of arousal and education on participants' pro-environmental behaviour, we first conducted a manipulation check of arousal, thereafter t tests on each independent variable to examine any differences between the control group and the treatment groups. We thereafter conducted a two-way ANOVA for each independent variable to examine the statistical differences between the treatment conditions. We then applied Bonferroni corrections to all significant p values to correct for multiple comparisons. For the petition signing, an ANOVA was performed to assess whether participants differed in the number of environmental petitions vs. social petitions signed across conditions. No significant effect of arousal ($F(1, 295) = .49$, $p = .48$), education ($F(1, 295) = 1.99$, $p = .16$), or interaction effect ($F(1, 295) = .07$, $p = .79$) was uncovered. The petitions were therefore combined into one score (e.g., if a participant signed both environmental petitions and both social petitions, the petition score would be 4) to simplify analysis.

After the pre-registered analyses described above were performed, we conducted an exploratory analysis including regressions and correlations to further examine the data. An ANOVA was performed on the covariate measures valence and the three environmental scales. Moreover, a composite behaviour score was calculated to examine differences between the number of pro-environmental behaviours performed in each condition. The regression analysis is reported in Appendix C, and the correlations are reported in Appendix D. All data were analysed in R.

2.2 Results

The following analyses were performed, as stated in the preregistration.

2.2.1 Manipulation check: arousal

The descriptive statistics of participants' arousal scores are summarized in Figure 2.4. The treatment groups ($M = 5.61$, $SD = 2.05$) reported significantly higher levels of arousal than the control condition ($M = 4.87$, $SD = 1.81$), $t(141.86) = 3.27$, $p = .001$. A two-way ANOVA examining differences between the treatment groups revealed a significant difference from arousal ($F(1, 291) = 33.5$, $p > .001$, $\eta_p^2 = .1$), but no difference from education, ($F(1, 291) = 1.45$, $p = .23$, $\eta_p^2 = .005$). No significant interaction effect was uncovered ($F(1, 291) = 0.00$, $p = .98$, $\eta_p^2 = .00$).

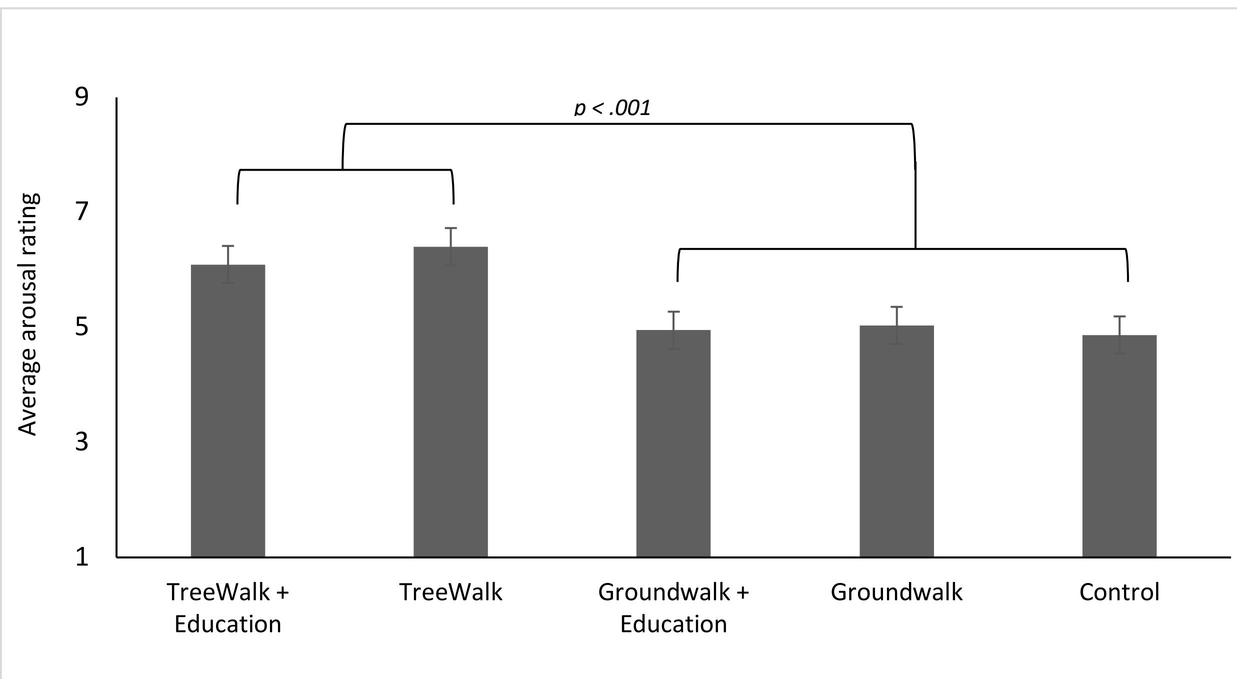


Figure 2.4. Bar graph representing mean arousal scores for the different treatment conditions and control group. A statistically significant main effect of arousal was uncovered at the .001 level. Error bars represent the standard error mean.

2.2.2 Donation

The descriptive statistics of participants' donation scores are summarized in Figure 2.5. The treatment groups (M = 7.88, SD = 3.97) showed no significant difference in donation from the control condition (M = 8.32, SD = 3.93), $t(160.47) = -1.29$, $p = .20$. A two-way ANOVA was performed to examine any differences between the treatment conditions, which reported no main effect of arousal ($F(1, 292) = 0.54$, $p = .46$, $\eta_p^2 = .002$) or education ($F(1, 292) = 1.58$, $p = .21$, $\eta_p^2 = .005$). No significant interaction effect was uncovered ($F(1, 292) = 3.74$, $p = .05$, $\eta_p^2 = .013$).

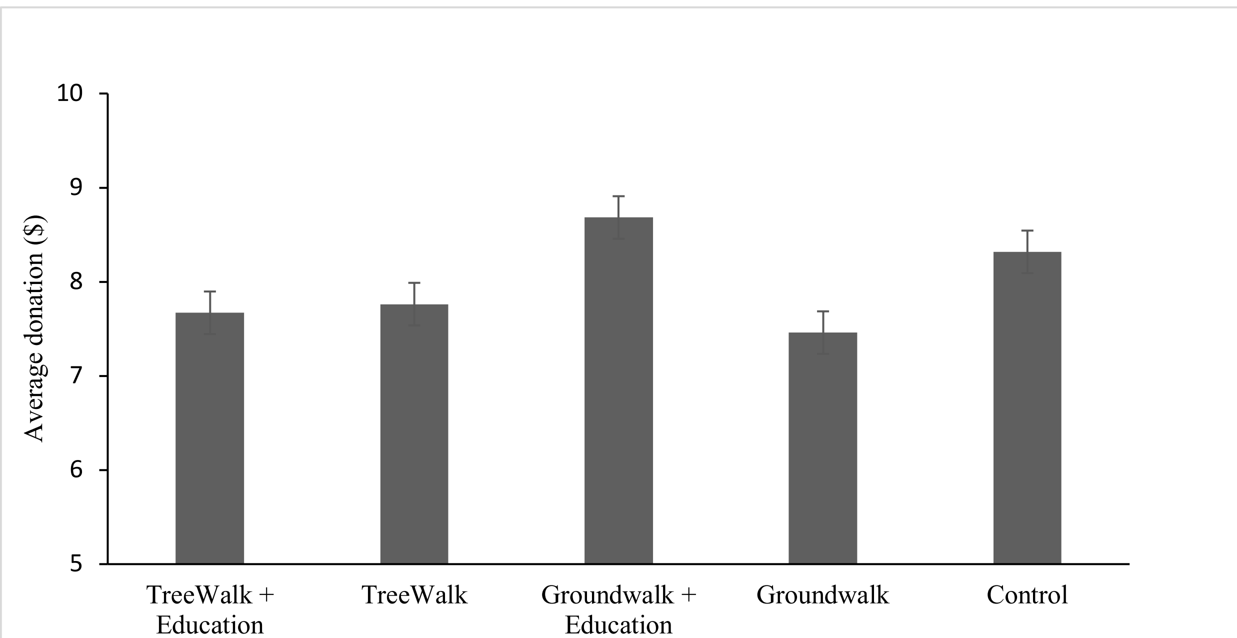


Figure 2.5. Bar graph representing mean donation scores for the different treatment conditions and control group. There was no statistically significant main effects of either arousal or education at the .05 level. Error bars represent the standard error mean.

2.2.3 Petitions

The descriptive statistics of participants' petition signing scores are reported in Figure 2.6. The treatment groups (M = 2.46, SD = 1.75) reported significantly higher levels of petition signing than the control condition (M = 1.95, SD = 1.73), $t(131.18) = 2.42$, $p = .02$. A subsequent ANOVA revealed no main effect of arousal ($F(1, 292) = 0.28$, $p = .60$, $\eta_p^2 = .001$) or education ($F(1, 292) = 0.64$, $p = .42$, $\eta_p^2 = .002$), and no interaction effect was uncovered ($F(1, 292) = 2.44$, $p = .11$, $\eta_p^2 = .008$). We further tested whether the conditions differed in the types of petitions that were signed; environmental or social petitions. The ANOVA revealed no main effect of education ($F(1, 292) = 1.99$, $p = .16$, $\eta_p^2 = .007$) or arousal ($F(1, 292) = 0.49$, $p = .48$, $\eta_p^2 = .002$), and no statistically significant interaction effect ($F(1, 292) = 0.28$, $p = .60$, $\eta_p^2 = .001$) was uncovered.

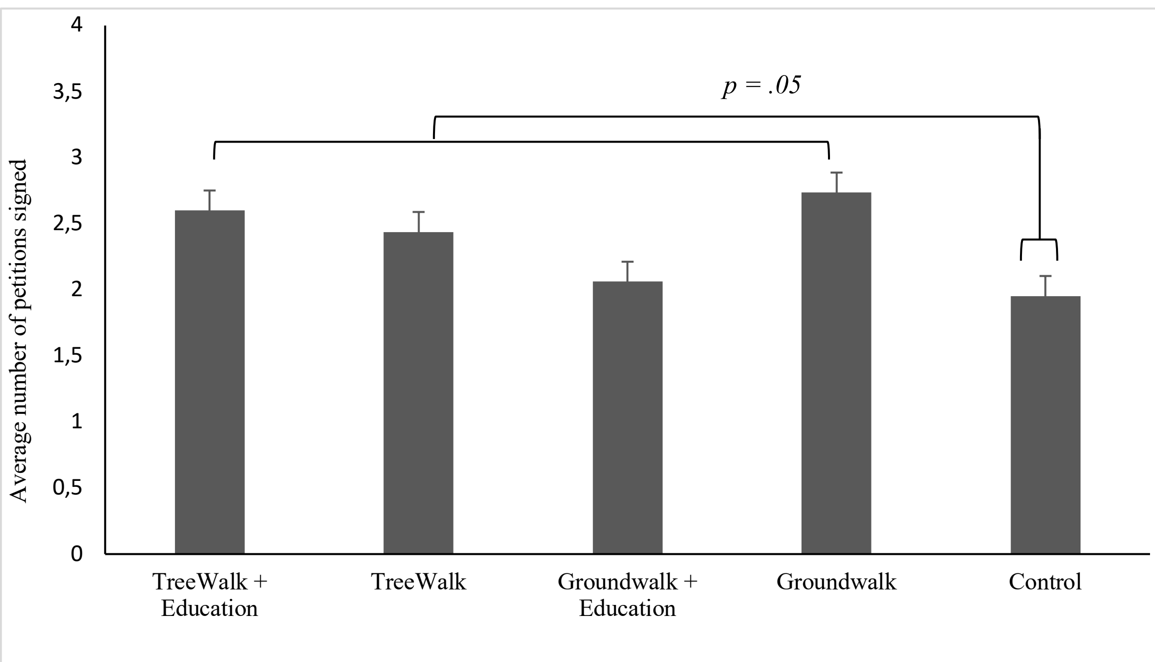


Figure 2.6. Bar graph representing mean petition signing scores for the different treatment conditions and control group. No statistically significant main effects of arousal or education was uncovered at the .05 level. Error bars represent the standard error mean.

2.2.4 Newsletter and volunteer signups

The measures of newsletter and volunteer sign-ups were added into a composite measure in order to create a continuous measure and simplify analysis (Figure 2.7). The treatment groups (M = .41, SD = .64) showed no significant difference in volunteering and newsletter signup from the control condition (M = .47, SD = .7), $t(131.19) = -0.69$, $p = .49$. The two-way ANOVA uncovered no main effect of arousal ($F(1, 292) = 0.05$, $p = .83$, $\eta_p^2 = .000$) or education ($F(1, 292) = 0.08$, $p = .78$, $\eta_p^2 = .000$). Similarly, no statistically significant interaction effect ($F(1, 292) = 0.28$, $p = .60$, $\eta_p^2 = .001$) was uncovered.

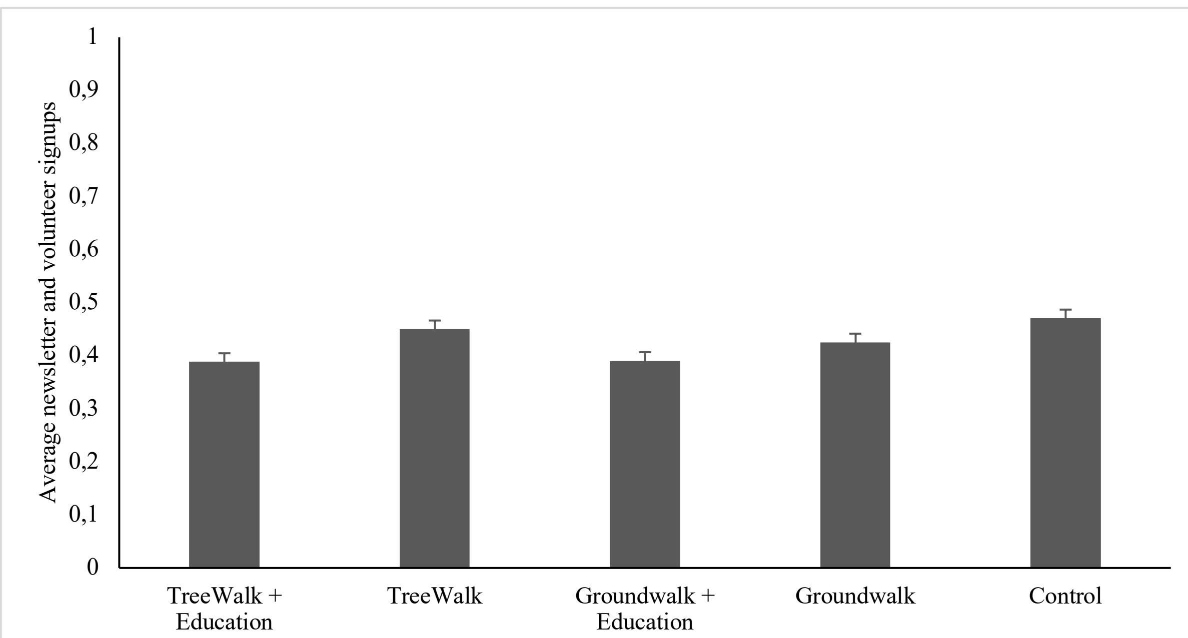


Figure 2.7. Bar graph representing mean newsletter and volunteer signup scores for the different treatment conditions and control group. No statistically significant main effects of arousal or education was uncovered at the .05 level. Error bars represent the standard error mean.

2.2.5 Exploratory analyses

We conducted the following exploratory analyses to gain further insight into the data.

2.2.5.1 Valence

A *t* test did not reveal a significant difference in the level of valence between the treatment groups ($M = 7.9$, $SD = 1.22$) and the control condition ($M = 8.06$, $SD = 0.95$), $t(160.47) = -1.29$, $p = .20$. Furthermore, a two-way ANOVA revealed no significant effect of arousal ($F(1, 291) = 2.73$, $p = .1$, $\eta_p^2 = .009$) or education ($F(1, 291) = 1.97$, $p = .16$, $\eta_p^2 = .007$). No significant interaction effect was uncovered ($F(1, 291) = 0.11$, $p = .73$, $\eta_p^2 = .00$).

2.2.5.2 Environmental scales

Descriptive statistics for the environmental scales are summarized in Figure 2.8. The ECO score of the treatment groups ($M = 9.09$, $SD = 1.02$) was not significantly different from that of the control condition ($M = 9.05$, $SD = 1.02$), $t(129.61) = 0.30$, $p = .77$. In examining the differences between the treatment groups, the two-way ANOVA uncovered no main effect of arousal ($F(1, 295) = 0.008$, $p = .93$, $\eta_p^2 = .000$) or education ($F(1, 295) = 0.04$, $p = .84$, $\eta_p^2 = .000$). Similarly, there was no statistically significant interaction effect ($F(1, 295) = 0.34$, $p = .56$, $\eta_p^2 = .001$).

The NEP score did not significantly differ between the treatment groups ($M = 8.38$, $SD = 1.42$) and the control condition ($M = 8.48$, $SD = 1.21$), $t(148.93) = -0.67$, $p = .51$. To examine the differences between the treatment groups, the two-way ANOVA uncovered no main effect of arousal ($F(1, 295) = 0.04$, $p = .82$, $\eta_p^2 = .000$) or education ($F(1, 295) = 0.85$, $p = .36$, $\eta_p^2 = .002$).

Similarly, there was no statistically significant interaction effect ($F(1, 295) = 2.35$, $p = .25$, $\eta_p^2 = .004$).

For the NR scale, the treatment groups ($M = 7.49$, $SD = 1.64$) did not significantly differ from the control condition ($M = 7.49$, $SD = 1.63$), $t(130.48) = 0.02$, $p = .99$. The two-way ANOVA uncovered no main effect of arousal ($F(1, 295) = 0.01$, $p = .91$, $\eta_p^2 = .000$) or education ($F(1, 295) = 0.39$, $p = .53$, $\eta_p^2 = .001$). No statistically significant interaction effect was uncovered ($F(1, 295) = 4.97$, $p = .03$, $\eta_p^2 = .014$) after applying Bonferroni corrections.

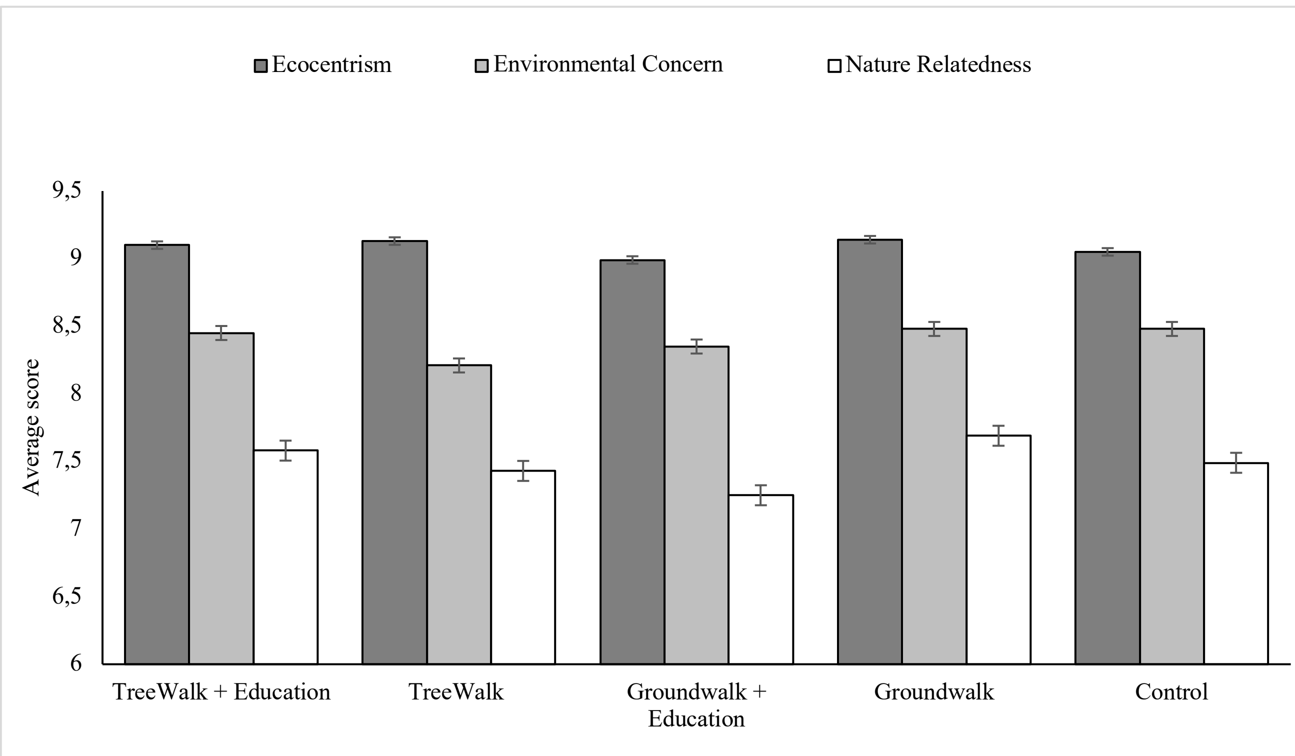


Figure 2.8. Bar graph representing mean scores for the three constructs of ecocentrism, environmental concern, and nature relatedness for the different treatment conditions and control group. No statistically significant main effects of arousal or education was uncovered at the .05 level. The interaction effect for NR was non-significant after correcting for multiple comparisons. Error bars represent the standard error mean.

2.2.5.3 Behaviour score

The treatment groups (*M* = 3.71, *SD* = 2) did not significantly differ from the control condition (*M* = 3.27, *SD* = 2.03) in the number of pro-environmental behaviours performed, $t(129.01) = 1.79$, $p = .08$. The two-way ANOVA uncovered no main effect of arousal ($F(1, 295) = 0.04$, $p = .84$, $\eta_p^2 = .000$) or education ($F(1, 295) = 0.25$, $p = .62$, $\eta_p^2 = .001$). Furthermore, no statistically significant interaction effect ($F(1, 295) = 1.43$, $p = .23$, $\eta_p^2 = .004$) was detected.

2.3 Discussion

The goal of the current study was to examine the roles of arousal and education in motivating pro-environmental behaviour by visitors to a botanical garden. Participants were recruited at the start of their visit to the garden and randomly allocated to one of four experimental conditions that manipulated arousal and education, or one control group in which they only answered a survey. The survey contained four pro-environmental behaviours: donation, signing up to receive newsletters, signing up to receive volunteer opportunities, and signing petitions. In general, the results indicated few differences in the pro-environmental behaviours across conditions. There was a marginal interaction effect where education increased donations in the ground walk conditions but not in the TreeWalk conditions, and participants in the treatment conditions signed more petitions than those in the control condition. These findings highlight the complicated relationship between education, affective states such as arousal, and pro-environmental behaviour. Herein, I discuss the results as they relate to the study's hypotheses; 1) arousal would have a main effect on pro-environmental behaviour; 2) education would have a main effect on pro-environmental behaviour; and 3) there would be an interaction effect between arousal and education.

2.3.1 Hypothesis 1: main effect of arousal

Despite reporting significantly higher levels of arousal, participants in the TreeWalk conditions did not engage in more, or less, pro-environmental actions than participants in the ground walk conditions. The first hypothesis was thereby not supported. A possible explanation stems from participants' attribution of arousal: there were no differences across any of the conditions in ecocentrism, environmental concern, or nature relatedness (Figure 2.8), despite higher levels of arousal among participants in the TreeWalk conditions (Figure 2.4). This suggests that the participants on the TreeWalk did not misattribute their arousal to environmental concern. The arousal response can affect judgement of a particular stimulus as long as it is attributed to that stimulus, and influence subsequent behaviour (Sinclair et al., 1994; Storbeck & Clore, 2008). In line with the affect-as-information hypothesis, participants' attribution of arousal to the TreeWalk itself suggests that they would prescribe increased importance to the TreeWalk and not to other stimuli. It is therefore unlikely that they would experience urgency in regards to performing pro-environmental behaviour. It should also be noted that the current study measured participants' pro-environmental behaviour immediately after inducing arousal. Some researchers have found an effect of arousal on memory after two days (Sharot & Phelps, 2004), and it is possible that arousal has a delayed influence on pro-environmental behaviour.

Another explanation for the lack of a main effect of arousal is the type of arousal that the participants experienced. Participants reported high arousal and high valence in the TreeWalk conditions, which suggests that they were predominantly experiencing positive affect. Peters and Slovic (2000) claim that negative affect is a more powerful stimulant for action. Negative emotions including fear and worry motivate people to avoid the source of danger or to change their surroundings to reduce the feeling of risk, and negative stimuli are better recalled (Marx et al., 2008). People often associate sustainability and pro-environmental behaviour with negativity or uncertainty, and the affective system is more efficient than the analytical system when it comes to making decisions under uncertainty (Peters & Slovic, 2000; Slovic et al., 2005; Weber, 2006). Negative valence could thereby produce more efficient processing and subsequent action. In contrast, others have found that negative affect in relation to environmental issues can lead to personal distancing, create a sense of helplessness, and inhibit action (Kollmuss & Agyeman, 2002). Russell et al. (2017) found that participants induced with negative affect in relation to food waste reported higher behavioural intention to reduce their food waste compared to participants induced with neutral or positive affect. However, when observing actual behaviour, negative affect corresponded with higher amounts of food waste (Russell et al., 2017). As such, negative affect can backfire for certain behaviours. Given the relationship between affect and behaviour, it is encouraging that the TreeWalk impacted participants' arousal in the current study. Yet, it is currently not clear how it can best be utilized to increase pro-environmental behaviour.

2.3.2 Hypothesis 2: main effect of education

Contrary to initial expectations, the current study did not detect a main effect of education on pro-environmental behaviour. Participants who received education did not perform more pro-environmental behaviours than those in non-education conditions. The education was grounded in the SDGs and highlighted how participants could contribute to sustainability in their communities as well as to the global sustainability goals. It is possible that the participants' knowledge of sustainability increased, as the current study did not measure knowledge, but that it did not translate into the behaviours that were included in the current study. These results correspond with previous findings suggesting that education does not necessarily result in pro-environmental actions (Abrahamse et al., 2005; Osbaldiston & Schott, 2012). Furthermore, they expand on findings from Zelenika et al. (2018) who found that an education program in a botanical garden increased participants' willingness to act pro-environmentally. As the current study observed actual behaviour, it supports the notion that willingness and behavioural intentions do not necessarily translate into actual behaviour (Armitage & Conner, 2001; Russell et al., 2017). Overall, the current results suggested that education was not effective for changing behaviour. However, they do not exclude the possibility that the efficacy of educational interventions can be enhanced by combining them with other approaches, such as targeting affective responses, message framing, or applying social norms (Abrahamse, 2019; Reddy et al., 2017).

It should also be noted that the results revealed opposing trends for the behaviours performed in the ground walk + education condition. This condition had the highest average donation score, and the lowest average number of petitions signed. Different sets of behaviours have been related to different sets of determinants, so the motivations to donate are likely not the same as the ones to sign petitions (Bamberg & Möser, 2007; Stern, 2000; Welsch & Kühling, 2009). There might be a trade-off in engaging in several pro-environmental behaviours (Steg & Vlek, 2009), which is important to note for educators, interventionists, and policy makers when having a desired outcome in mind.

2.3.3 Hypothesis 3: interaction effect

Overall, the general lack of interaction effects in the current study was contrary to initial belief, and surprising considering the vast literature demonstrating connections between arousal, education, and behaviour (Dutton & Aron, 1974; Gifford & Nilsson, 2014; Kollmuss & Agyeman, 2002; Storbeck & Clore, 2008; Zadra & Clore, 2011). The current study drew on theoretical indications that environmental education combined with increased arousal would produce misattribution effects. The misattribution effect would manifest as higher environmental concern, and in turn result in higher pro-environmental behaviour. However, the results showed no significant interaction effects, and high levels of ecocentrism, environmental concern, and nature relatedness across all conditions (Figure 2.8). This indicated that no misattribution of arousal to environmental concern occurred for the participants, which could explain the lack of experimental effects (Storbeck & Clore, 2008). A possible explanation is that the participants were visiting the garden in their free time and presumably above average interested in botany, nature, and conservation. Their high levels of environmental concern and connection to nature made them a biased sample, and could prevent the manipulation of arousal and education from producing a misattribution effect. Higher environmental concern and stronger connectedness with the natural world can increase pro-environmental behaviours (Whitburn et al., 2019), so efforts to understand how outdoors experiences can produce misattribution effects should be increased. Future research should examine negative arousal. Exposing participants to negative content could increase arousal in a negative way (Peters & Slovic, 2000), which may produce misattribution more effectively and in turn increase environmental concern pro-environmental behaviours.

2.3.4 Exploratory analyses

The exploratory analyses examined the differences in pro-environmental behaviour by valence as well as environmental concerns and attitudes, and whether there were differences in the amount of behaviours displayed in each condition. The results revealed a ceiling effect of valence across all conditions; all participants reported high levels of positive feelings. The clustering of scores towards the high end of the scale across all conditions suggested that the experimental treatment did not influence the participants' responses. According to the affect-as-information hypothesis, whereas arousal signals importance, valence directs attention and signals information about what to learn (Storbeck & Clore, 2008). As the participants were visiting the garden in their free time, it is possible that they were experiencing these high levels of pleasant feelings because they were spending time outdoors in nature. Therefore, they were not affected by the manipulation of arousal or education. Although exposure to natural environments is related to pro-environmental behaviour (Zelenski et al., 2015), the current study's sample included people with a pre-established interest in gardens and other natural environments. This likely caused bias and resulted in a non-representative sample. It is therefore not certain if the current intervention could influence pro-environmental behaviour in the general population.

There were no differences across conditions in the total number of pro-environmental behaviours performed. However, the data suggested some trade-offs between different behaviours, and all behaviours required some form of effort or self-sacrifice, either of money (donations), time and effort (volunteering), or giving up personal information (signing petitions). The effect of these differentiated demands was partially reflected in the study: irrespective of condition, most participants donated, and many signed petitions. Conversely, few participants signed up to receive newsletters and volunteer opportunities. This floor effect signaled that the treatment did not influence participants' behaviour; volunteering might be too effortful to be impacted by the current manipulations, or that the ask was too large. Other behaviours that incorporate or result in personal rewards, such as conserving water or energy which result in lower costs, could yield different results (Carmi et al., 2015). Moreover, as the study was conducted in the summertime there were many tourists among the participants, who could be less inclined to support projects at UBC Botanical Garden or petitions which concern Canada.

Ultimately, this raises the question of which domains of pro-environmental behaviour (e.g., donations, signing petitions, volunteering) could be most influenced with which intervention (e.g., affective, educational). As some treatments have stronger influence under some conditions than others (Byerly et al., 2018; Stern, 2000), it is important to examine how high-impact behaviours can be motivated. Although education had limited impact on the pro-environmental behaviours in the current study, it might influence other drivers of behaviours, such as knowledge, values, or beliefs (Gifford & Nilsson, 2014; Otto & Pensini, 2017). Evidence suggests that positive environmental attitudes and values are associated with low-impact behaviours, whereas high-impact behaviours are primarily explained by contextual factors and typically more difficult to change (Gifford, 2011; Zelenika et al., 2018). It is possible that frameworks such as the affect-as-information model and the misattribution effect cannot sufficiently capture and predict phenomena and behaviours that are more gracefully captured by other models or theories (Winkielman et al., 2007).

It is widely established that people process information and make decisions according to two distinct systems: both analytical and instinctive processes influence behaviour (Bamberg & Möser, 2007; Kahneman, 2003; Slovic et al., 2007). Interventions that are designed to evoke personal experiences, highlight relevant information, and elicit affective responses can lead to more public attention to and engagement with sustainability topics (Marx et al., 2008). Some scholars suggest that there is an 'emotional deficit' in current communication. In the context of journalism, people who were exposed to emotional content and personalized stories have shown greater knowledge gain than those exposed to hard-fact versions of the same stories (Bas & Grabe, 2015). Affective content and cues can influence thoughts, judgements, and behaviour, and it is becoming increasingly recognized that education can influence and drive pro-environmental behaviour if it elicits an affective response that is internalized (Carmi et al., 2015). In the current study, the lack of heightened environmental concern suggested that arousal was not internalized or attributed to the environment, and not translated into pro-environmental behaviour. It is also possible that education and arousal were influencing some other intrinsic motivation, and had an indirect effect on behaviour (Kollmuss & Agyeman, 2002; Otto & Pensini, 2017). No single theory or approach can sufficiently explain the variation in human experience and connection with sustainability, nor behaviours in response to it (Wolf & Moser, 2011). Interventions will require multiple strategies and will be dependent on context (Amel et al., 2017). As such, further research that assesses actual behavioural outcomes will be necessary in order to understand how behaviour can be changed.

2.3.5 Limitations

There were multiple limitations to the current study. While it employed random allocation of participants to the different conditions and measured actual behaviour, it recruited people who were voluntarily visiting a botanical garden in their spare time, and who presumably hold above average interests in plants, nature and conservation. As having a connection to nature is associated with environmental attitudes, concern, and behaviour (Whitburn et al., 2019), the biased sample limits the generalizability of the current results to the general public. It could further explain the ceiling effect of environmental attitudes. Furthermore, it was not possible to control the group sizes in the treatment conditions: some arrived as singles, others as pairs, threes, or fours. Previous studies suggest that people vary in decision-making depending on whether other people are present (Peloza et al., 2013; Steg et al., 2016). It is also possible that arousal is experienced differently in the presence of others. Future studies can standardise the size of the treatment groups, or include it as an independent variable. Another limitation to the current study was the measurement of pro-environmental behaviours immediately following the intervention. It is unclear what, if any, long-term implications exist of arousal or education on pro-environmental behaviour.

2.3.6 Future avenues

Based on the findings as well as the limitations from the present study there are multiple avenues for future research. In terms of SDG education, more research is needed to identify which SDGs and messaging can be leveraged to motivate specific pro-environmental behaviours. It is also necessary to examine the different methodologies, vocabulary, and assumptions underlying the SDGs in order to develop effective education programmes and delivery practices. Moreover, further research is needed to identify specific individual and collective behaviours that contribute to advancing the SDGs; which behavior change strategies are effective for localized actions; and how they can be implemented. Another avenue for further study relates to the effect of the current intervention in a non-natural environment. To get a better understanding of causality, studies should look into the effects of arousal and education without the simultaneous nature exposure. This could help assess whether arousal can break down the compartmentalization that occurs between education and behaviour (Duerden & Witt, 2010). The effect of education and information provision can be further improved by combining it with other strategies, such as tailoring information or message framing. People respond differently to the same message depending on prior values, attitudes, and beliefs (Clayton et al., 2015). Combining education with tailored messaging to people's existing beliefs is an avenue to pursue. In addition, although the current study included a manipulation check for arousal, it did not include one for education. It is therefore uncertain whether education had an effect. Future studies can include a manipulation check for education, for instance by including a questionnaire of the education material and comparing the results of participants in the education conditions to those the non-education conditions.

Further studies can also produce more narratives and story-based educational material. Research indicates that people are more responsive, can imagine the effects of climate change to a greater extent, and exert more pro-environmental behaviour in response to story-based rather than fact-based narratives (Marx et al., 2008; Morris et al., 2019). Narratives can influence individual behaviours as well as preference for public policy and community engagement. Finally, and although challenging to implement, future studies should adopt longitudinal approaches to examine any potential long-term effects of arousal on behaviour. Overall, it is important to continue to strive for effective behaviour change interventions, as they are critical tools to counter environmental problems and produce a shift towards pro-environmental behaviour.

Chapter 3: Conclusion

Current environmental issues are rooted in human behaviour. Therefore, it is vital to understand factors that influence behaviour, and how to leverage them to turn the tides from environmentally destructive practices to pro-environmental behaviours. This thesis set out to examine the roles of arousal and education in motivating pro-environmental behaviour in visitors to a botanical garden. Specifically, it manipulated participants' level of arousal (high vs. low) and whether or not participants received SDG education, and assessed differences in four pro-environmental behaviours; donation, signing up to receive newsletters from UBC Botanical Garden, signing up to receive volunteer opportunities from the Garden, and signing petitions. Overall, the results revealed that experiencing arousal or receiving SDG education had limited impact on participants' pro-environmental behaviour; the only observed effect was that participants in the treatment conditions signed more petitions on average than participants in the control condition.

The theoretical background of the current study demonstrated a potential for affective states such as arousal and educational programming to impact participants' pro-environmental actions, but that further study was necessary to understand the mechanisms by which these operate. People use affective states to guide their judgements and behaviour. A main way in which affective states influence behaviour is by misattribution. The literature demonstrated multiple behavioural effects based on misattribution of arousal. However, the current study revealed limited behavioural differences between conditions, despite discrepant levels of arousal. Participants' environmental concern and ecocentrism were similar across all conditions, which suggested that participants did not misattribute the arousal they experienced on the TreeWalk to the sustainability education. This could explain the lack of differences in pro-environmental behaviour between conditions.

The current study did not explore the effect of the SDG education on learning, or whether different group sizes impacted participants' learning, attitudes, and pro-environmental behaviours. There could be social desirability effects associated with the grouped structure of the study. In addition, it would be useful to examine the potential long-term effects of arousal and the educational intervention, and how they impact samples that are more representative of the general public. These shortcomings provide avenues for future research, and highlight that further study is required to understand how arousal and education experiences can be leveraged to motivate pro-environmental behaviour.

Pro-environmental behaviour is a function of the interaction between a person and her environment, and behavioural motivations and barriers are as complex as her environment. Traditionally, the study of affect and the study of education have been distinct, and their joint effect on pro-environmental behaviour has not been explored in the literature. Increasingly, relevant aspects of cognition, knowledge, and affect, and their influence on pro-environmental behaviour are considered as highly interactive. The two systems of thinking that dominate decision making and behaviour – System 1 and System 2 – are not mutually exclusive, but operate in parallel and feed into one another. In addition, there are cognitive biases associated with each system, including the confirmation bias and the optimism bias, that can prevent behaviour change. These must together with affect, education, and pro-environmental behaviour be considered as interactive processes, and therefore studied collectively.

Consistent with the 2030 Agenda for Sustainable Development, addressing sustainability challenges requires the public to change their behaviour, and the right conditions for these changes to happen. Going forward, researchers, policy makers, and intervention planners must keep human behaviour in mind as policies, plans, and programs are designed. In attempting to motivate pro-environmental behaviour it is thus important to use a well-equipped toolbox which includes affective and cognitive approaches, behavioural science, environmental science, and social science approaches to foster enduring pro-environmental behaviour.

References

Abrahamse, W. (2019). *Encouraging pro-environmental behaviour: What works, what doesn't, and why*. Academic Press.

Abrahamse, W., & Steg, L. (2013). Social influence approaches to encourage resource conservation: A meta-analysis. *Global Environmental Change*, *23*(6), 1773–1785.

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2005). A review of intervention studies aimed at household energy conservation. *Journal of Environmental Psychology*, *25*(3), 273–291.

Abrahamse, W., Steg, L., Vlek, C., & Rothengatter, T. (2007). The effect of tailored information, goal setting, and tailored feedback on household energy use, energy-related behaviors, and behavioral antecedents. *Journal of Environmental Psychology*, *27*(4), 265–276.

Ajzen, I. (1987). Attitudes, traits, and actions: Dispositional prediction of behavior in personality and social psychology. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (Vol. 20, pp. 1–63). Elsevier.

Amel, E., Manning, C., Scott, B., & Koger, S. (2017). Beyond the roots of human inaction: Fostering collective effort toward ecosystem conservation. *Science*, *356*(6335), 275–279.

Armitage, C. J., & Conner, M. (2001). Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology*, *40*(4), 471–499.

Bamberg, S., & Möser, G. (2007). Twenty years after Hines, Hungerford, and Tomera: A new meta-analysis of psycho-social determinants of pro-environmental behaviour. *Journal of Environmental Psychology*, *27*(1), 14–25.

Barton, J., & Pretty, J. (2010). What is the best dose of nature and green exercise for improving mental health? A multi-study analysis. *Environmental Science & Technology*, *44*(10), 3947–3955.

Bas, O., & Grabe, M. E. (2015). Emotion-provoking personalization of news: Informing citizens and closing the knowledge gap? *Communication Research*, *42*(2), 159–185.

Baumeister, R. F., Vohs, K. D., DeWall, N. C., & Zhang, L. (2007). How emotion shapes behavior: Feedback, anticipation, and reflection, rather than direct causation. *Personality and Social Psychology Review*, *11*(2), 167–203.

Bratman, G. N., Daily, G. C., Levy, B. J., & Gross, J. J. (2015). The benefits of nature experience: Improved affect and cognition. *Landscape and Urban Planning*, *138*, 41–50.

Byerly, H., Balmford, A., Ferraro, P. J., Hammond Wagner, C., Palchak, E., Polasky, S., Ricketts, T. H., Schwartz, A. J., & Fisher, B. (2018). Nudging pro-environmental behavior: Evidence and opportunities. *Frontiers in Ecology and the Environment*, *16*(3), 159–168.

Carmi, N., Arnon, S., & Orion, N. (2015). Transforming environmental knowledge into behavior: The mediating role of environmental emotions. *The Journal of Environmental Education*, *46*(3), 183–201.

Chawla, L. (2015). Benefits of nature contact for children. *Journal of Planning Literature*, *30*(4), 433–452.

Christiano, A., & Neimand, A. (2017). Stop raising awareness already. *Stanford Social Innovation Review*, *15*(2), 34–41.

Cinner, J. (2018). How behavioral science can help conservation. *Science*, *362*(6417), 889–890.

Clayton, S., Devine-Wright, P., Stern, P. C., Whitmarsh, L., Carrico, A., Steg, L., Swim, J., & Bonnes, M. (2015). Psychological research and global climate change. *Nature Climate Change*, *5*(7), 640–646.

Clayton, S., Devine-Wright, P., Swim, J., Bonnes, M., Steg, L., Whitmarsh, L., & Carrico, A. (2016). Expanding the role for psychology in addressing environmental challenges. *American Psychologist*, *71*(3), 199–215.

Clore, G. L., Gasper, K., & Garvin, E. (2001). Affect as information. In *Handbook of affect and social cognition* (pp. 121–144). Lawrence Erlbaum Associates.

Clore, G. L., & Storbeck, J. (2006). Affect as information about liking, efficacy, and importance. In *Hearts and minds: Affective influences on social cognition and behaviour*. Psychology Press.

Colomo-Palacios, R., Casado-Lumbreras, C., Soto-Acosta, P., & García-Crespo, Á. (2011). Using the affect grid to measure emotions in software requirements engineering. *Journal of Universal Computer Science*, *17*(9), 1281–1298.

Cortese, A. D. (2003). The critical role of higher education in creating a sustainable future. *Planning for Higher Education*, *31*(3), 15–22.

Cunningham, W. A., Van Bavel, J. J., & Johnsen, I. R. (2008). Affective flexibility: Evaluative processing goals shape amygdala activity. *Psychological Science*, *19*(2), 152–160.

Deaver, C. M., Miltenberger, R. G., Smyth, J., Meidinger, A., & Crosby, R. (2003). An evaluation of affect and binge eating. *Behavior Modification*, *27*(4), 578–599.

Dietz, T., Gardner, G. T., Gilligan, J., Stern, P. C., & Vandenbergh, M. P. (2009). Household actions can provide a behavioral wedge to rapidly reduce US carbon emissions. *Proceedings of the National Academy of Sciences*, *106*(44), 18452–18456.

Dodd, J., & Jones, C. (2010). *Redefining the role of botanic gardens: Towards a new social purpose*. Research Centre for Museums and Galleries (RCMG) Leicester. https://www.bgci.org/files/Worldwide/Education/Social_inclusion/social%20inclusion%20report.pdf

Dubois, G., Sovacool, B., Aall, C., Nilsson, M., Barbier, C., Herrmann, A., Bruyère, S., Andersson, C., Skold, B., Nadaud, F., Dorner, F., Moberg, K. R., Ceron, J. P., Fischer, H., Amelung, D., Baltruszewicz, M., Fischer, J., Benevise, F., Louis, V. R., & Sauerborn, R. (2019). It starts at home? Climate policies targeting household consumption and behavioral decisions are key to low-carbon futures. *Energy Research & Social Science*, *52*, 144–158.

Duerden, M. D., & Witt, P. A. (2010). The impact of direct and indirect experiences on the development of environmental knowledge, attitudes, and behavior. *Journal of Environmental Psychology*, *30*(4), 379–392.

Dunlap, R. E., Van Liere, K. D., Mertig, A. G., & Jones, R. E. (2000). New trends in measuring environmental attitudes: Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues*, *56*(3), 425–442.

Dutton, D. G., & Aron, A. P. (1974). Some evidence for heightened sexual attraction under conditions of high anxiety. *Journal of Personality and Social Psychology*, *30*(4), 510.

Esty, D. C. (2008). Rethinking global environmental governance to deal with climate change: The multiple logics of global collective action. *American Economic Review*, *98*(2), 116–121.

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191.

Fazio, R. H., & Powell, M. C. (1997). On the value of knowing one's likes and dislikes: Attitude accessibility, stress, and health in college. *Psychological Science*, *8*(6), 430–436.

Fredrickson, B. L., & Branigan, C. (2005). Positive emotions broaden the scope of attention and thought-action repertoires. *Cognition & Emotion*, *19*(3), 313–332.

Gardner, G. T., & Stern, P. C. (2008). The short list: The most effective actions U.S. households can take to curb climate change. *Environment: Science and Policy for Sustainable Development*, *50*(5), 12–25.

Gasper, K., & Clore, G. L. (2002). Attending to the big picture: Mood and global versus local processing of visual information. *Psychological Science*, *13*(1), 34–40.

Gasper, K., & Hackenbracht, J. (2015). Too busy to feel neutral: Reducing cognitive resources attenuates neutral affective states. *Motivation and Emotion*, *39*(3), 458–466.

Genevsky, A., Västfjäll, D., Slovic, P., & Knutson, B. (2013). Neural underpinnings of the identifiable victim effect: Affect shifts preferences for giving. *The Journal of Neuroscience*, *33*(43), 17188–17196.

Gifford, R. (2011). The dragons of inaction: Psychological barriers that limit climate change mitigation and adaptation. *American Psychologist*, *66*(4), 290–302.

Gifford, R. (2014). Environmental psychology matters. *Annual Review of Psychology*, *65*(1), 541–579.

Gifford, R., Kormos, C., & McIntyre, A. (2011). Behavioral dimensions of climate change: Drivers, responses, barriers, and interventions. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(6), 801–827.

Gifford, R., & Nilsson, A. (2014). Personal and social factors that influence pro-environmental concern and behaviour: A review. *International Journal of Psychology*, *49*(3), 141–157.

Gneezy, U., Meier, S., & Rey-Biel, P. (2011). When and why incentives (don't) work to modify behavior. *Journal of Economic Perspectives*, *25*(4), 191–210.

Gorn, G., Pham, M. T., & Sin, L. Y. (2001). When arousal influences ad evaluation and valence does not (and vice versa). *Journal of Consumer Psychology*, *11*(1), 43–55.

Gosling, E., & Williams, K. J. (2010). Connectedness to nature, place attachment and conservation behaviour: Testing connectedness theory among farmers. *Journal of Environmental Psychology*, *30*(3), 298–304.

Grund, J., & Brock, A. (2019). Why we should empty pandora's box to create a sustainable future: Hope, sustainability and its implications for education. *Sustainability*, *11*(3), 893.

Hanus, N., Wong-Parodi, G., Small, M. J., & Grossmann, I. (2018). The role of psychology and social influences in energy efficiency adoption. *Energy Efficiency*, *11*(2), 371–391.

Intergovernmental Panel on Climate Change. (2018). *Global warming of 1.5 °C: An IPCC special report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.* https://www.ipcc.ch/sr15/

Ives, C. D., Abson, D. J., von Wehrden, H., Dorninger, C., Klaniecki, K., & Fischer, J. (2018). Reconnecting with nature for sustainability. *Sustainability Science*, *13*(5), 1389–1397.

Kahan, D. M., Wittlin, M., Peters, E., Slovic, P., Ouellette, L. L., Braman, D., & Mandel, G. N. (2011). The tragedy of the risk-perception commons: Culture conflict, rationality conflict, and climate change. *SSRN Electronic Journal*.

Kahneman, D. (2003). A perspective on judgment and choice: Mapping bounded rationality. *American Psychologist*, *58*(9), 697.

Kahneman, D., & Frederick, S. (2002). Representativeness revisited: Attribute substitution in intuitive judgment. In *Heuristics and biases* (pp. 49–81). Cambridge University Press.

Karjalainen, E., Sarjala, T., & Raitio, H. (2010). Promoting human health through forests: Overview and major challenges. *Environmental Health and Preventive Medicine*, *15*(1), 1–8.

Kensinger, E. A., & Corkin, S. (2004). Two routes to emotional memory: Distinct neural processes for valence and arousal. *Proceedings of the National Academy of Sciences*, *101*(9), 3310–3315.

Keohane, R. O., & Victor, D. G. (2016). Cooperation and discord in global climate policy. *Nature Climate Change*, *6*(6), 570–575.

Kingsley, J., Townsend, M., Henderson-Wilson, C., & Bolam, B. (2013). Developing an exploratory framework linking australian aboriginal peoples' connection to country and concepts of wellbeing. *International Journal of Environmental Research and Public Health*, *10*(2), 678–698.

Kioupi, V., & Voulvoulis, N. (2019). Education for sustainable development: A systemic framework for connecting the SDGs to educational outcomes. *Sustainability*, *11*(21), 6104.

Kiviniemi, M. T., Ellis, E. M., Hall, M. G., Moss, J. L., Lillie, S. E., Brewer, N. T., & Klein, W. M. P. (2018). Mediation, moderation, and context: Understanding complex relations among cognition, affect, and health behaviour. *Psychology & Health*, *33*(1), 98–116.

Koenig-Lewis, N., Palmer, A., Dermody, J., & Urbye, A. (2014). Consumers' evaluations of ecological packaging – rational and emotional approaches. *Journal of Environmental Psychology*, *37*, 94–105.

Kollmuss, A., & Agyeman, J. (2002). Mind the Gap: Why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental Education Research*, *8*(3), 239–260.

LeBlanc, V. R., McConnell, M. M., & Monteiro, S. D. (2015). Predictable chaos: A review of the effects of emotions on attention, memory and decision making. *Advances in Health Sciences Education*, *20*(1), 265–282.

Levine, D. S., & Strube, M. J. (2012). Environmental attitudes, knowledge, intentions and behaviors among college students. *The Journal of Social Psychology*, *152*(3), 308–326.

Lim-Wavde, K., Kauffman, R. J., & Dawson, G. S. (2017). Household informedness and policy analytics for the collection and recycling of household hazardous waste in California. *Resources, Conservation and Recycling*, *120*, 88–107.

Loersch, C., & Payne, B. K. (2011). The situated inference model: An integrative account of the effects of primes on perception, behavior, and motivation. *Perspectives on Psychological Science*, *6*(3), 234–252.

Lorenzoni, I., Nicholson-Cole, S., & Whitmarsh, L. (2007). Barriers perceived to engaging with climate change among the UK public and their policy implications. *Global Environmental Change*, *17*(3–4), 445–459.

Marshall, G. (2015). *Don't even think about it: Why our brains are wired to ignore climate change*. Bloomsbury Publishing USA.

Martin, L. L., Harlow, T. F., & Strack, F. (1992). The role of bodily sensations in the evaluation of social events. *Personality and Social Psychology Bulletin*, *18*(4), 412–419.

Marx, B. P., Marshall, P. J., & Castro, F. (2008). The moderating effects of stimulus valence and arousal on memory suppression. *Emotion*, *8*(2), 199.

Meng, M. D., & Trudel, R. (2017). Using emoticons to encourage students to recycle. *The Journal of Environmental Education*, *48*(3), 196–204.

Morris, B. S., Chrysochou, P., Christensen, J. D., Orquin, J. L., Barraza, J., Zak, P. J., & Mitkidis, P. (2019). Stories vs. facts: Triggering emotion and action-taking on climate change. *Climatic Change*, *154*(1–2), 19–36.

Nisbet, E. K., & Zelenski, J. M. (2013). The NR-6: A new brief measure of nature relatedness. *Frontiers in Psychology*, *4*, 813.

Nisbet, E. K., Zelenski, J. M., & Murphy, S. A. (2009). The nature relatedness scale: Linking individuals' connection with nature to environmental concern and behavior. *Environment and Behavior*, *41*(5), 715–740.

Obery, A., & Bangert, A. (2017). Exploring the influence of nature relatedness and perceived science knowledge on proenvironmental behavior. *Education Sciences*, *7*(1), 17.

Ordner, J. P. (2017). Community action and climate change. *Nature Climate Change*, *7*(3), 161–163.

Osbaldiston, R., & Schott, J. P. (2012). Environmental sustainability and behavioral science: Meta-analysis of proenvironmental behavior experiments. *Environment and Behavior*, *44*(2), 257–299.

Ostrom, E. (2009). A general framework for analyzing sustainability of social-ecological systems. *Science*, *325*(5939), 419–422.

Otto, S., & Pensini, P. (2017). Nature-based environmental education of children: Environmental knowledge and connectedness to nature, together, are related to ecological behaviour. *Global Environmental Change*, *47*, 88–94.

Patz, J. A., Frumkin, H., Holloway, T., Vimont, D. J., & Haines, A. (2014). Climate change: Challenges and opportunities for global health. *JAMA*, *312*(15), 1565.

Peloza, J., White, K., & Shang, J. (2013). Good and guilt-free: The role of self-accountability in influencing preferences for products with ethical attributes. *Journal of Marketing*, *77*(1), 104–119.

Peters, E., & Slovic, P. (2000). The springs of action: Affective and analytical information processing in choice. *Personality and Social Psychology Bulletin*, *26*(12), 1465–1475.

Reddy, S. M. W., Montambault, J., Masuda, Y. J., Keenan, E., Butler, W., Fisher, J. R. B., Asah, S. T., & Gneezy, A. (2017). Advancing conservation by understanding and influencing human behavior: Human behavior and nature. *Conservation Letters*, *10*(2), 248–256.

Rees, J. H., Klug, S., & Bamberg, S. (2015). Guilty conscience: Motivating pro-environmental behavior by inducing negative moral emotions. *Climatic Change*, *130*(3), 439–452.

Russell, J. A., Weiss, A., & Mendelsohn, G. A. (1989). Affect grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social Psychology*, *57*(3), 493.

Russell, S. V., Young, C. W., Unsworth, K. L., & Robinson, C. (2017). Bringing habits and emotions into food waste behaviour. *Resources, Conservation and Recycling*, *125*, 107–114.

Sampaio, M. B., De La Fuente, M. F., Albuquerque, U. P., da Silva Souto, A., & Schiel, N. (2018). Contact with urban forests greatly enhances children's knowledge of faunal diversity. *Urban Forestry & Urban Greening*, *30*, 56–61.

Scannell, L., & Gifford, R. (2010). The relations between natural and civic place attachment and pro-environmental behavior. *Journal of Environmental Psychology*, *30*(3), 289–297.

Scharrer, L., Rupieper, Y., Stadtler, M., & Bromme, R. (2017). When science becomes too easy: Science popularization inclines laypeople to underrate their dependence on experts. *Public Understanding of Science*, *26*(8), 1003–1018.

Schneider, C. R., Zaval, L., Weber, E. U., & Markowitz, E. M. (2017). The influence of anticipated pride and guilt on pro-environmental decision making. *PLOS ONE*, *12*(11), e0188781.

Schultz, P. W. (2002). Inclusion with nature: The psychology of human-nature relations. In P. Schmuck & W. P. Schultz (Eds.), *Psychology of Sustainable Development* (pp. 61–78). Springer US.

Schultz, P. W., Shriver, C., Tabanico, J. J., & Khazian, A. M. (2004). Implicit connections with nature. *Journal of Environmental Psychology*, *24*(1), 31–42.

Schwarz, N., & Clore, G. L. (1983). Mood, misattribution, and judgments of well-being: Informative and directive functions of affective states. *Journal of Personality and Social Psychology*, *45*(3), 513–523.

Schwarz, N., & Clore, G. L. (2003). Mood as information: 20 years later. *Psychological Inquiry*, *14*(3–4), 296–303.

Semenza, J. C., Hall, D. E., Wilson, D. J., Bontempo, B. D., Sailor, D. J., & George, L. A. (2008). Public perception of climate change. *American Journal of Preventive Medicine*, *35*(5), 479–487.

Shanahan, D. F., Bush, R., Gaston, K. J., Lin, B. B., Dean, J., Barber, E., & Fuller, R. A. (2016). Health benefits from nature experiences depend on dose. *Scientific Reports*, *6*(1), 28551.

Sharot, T., & Phelps, E. A. (2004). How arousal modulates memory: Disentangling the effects of attention and retention. *Cognitive, Affective, & Behavioral Neuroscience*, *4*(3), 294–306.

Simon, H. A. (1972). Theories of bounded rationality. In *Decision and organization* (Vol. 1, pp. 161–176). North-Holland Publishing Company.

Sinclair, R. C., Hoffman, C., Mark, M. M., Martin, L. L., & Pickering, T. L. (1994). Construct accessibility and the misattribution of arousal: Schachter and Singer revisited. *Psychological Science*, *5*(1), 15–19.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. *Risk Analysis*, *24*(2), 311–322.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2007). The affect heuristic. *European Journal of Operational Research*, *177*(3), 1333–1352.

Slovic, P., Finucane, M., Peters, E., & MacGregor, D. G. (2002). Rational actors or rational fools: Implications of the affect heuristic for behavioral economics. *The Journal of Socio-Economics*, *3*(4), 329–342.

Slovic, P., Peters, E., Finucane, M. L., & MacGregor, D. G. (2005). Affect, risk, and decision making. *Health Psychology*, *24*(4, Suppl), S35–S40.

Staats, H. J., Wit, A. P., & Midden, C. Y. H. (1996). Communicating the greenhouse effect to the public: Evaluation of a mass media campaign from a social dilemma perspective. *Journal of Environmental Management*, *46*(2), 189–203.

Steffen, W., Richardson, K., Rockstrom, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., & Sorlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science*, *347*(6223), 1259855.

Steg, L., Bolderdijk, J. W., Keizer, K., & Perlaviciute, G. (2014). An integrated framework for encouraging pro-environmental behaviour: The role of values, situational factors and goals. *Journal of Environmental Psychology*, *38*, 104–115.

Steg, L., Lindenberg, P., & Keizer, K. (2016). Intrinsic motivation, norms and environmental behaviour: The dynamics of overarching goals. *International Review of Environmental and Resource Economics*, *9*(1–2), 179–207.

Steg, L., & Vlek, C. (2009). Encouraging pro-environmental behaviour: An integrative review and research agenda. *Journal of Environmental Psychology*, *29*(3), 309–317.

Stern, P. C. (2000). Toward a coherent theory of environmentally significant behaviour. *Journal of Social Issues*, *56*(3), 407–424.

Stibe, A., & Cugelman, B. (2016). Persuasive backfiring: When behavior change interventions trigger unintended negative outcomes. In A. Meschtscherjakov, B. De Ruyter, V. Fuchsberger, M. Murer, & M. Tscheligi (Eds.), *Persuasive Technology* (Vol. 9638, pp. 65–77). Springer International Publishing.

Stofer, K. A., Lundgren, L., Dunckel, B. A., James, V., Lange, M., & Krieger, J. (2019). Public engagement on climate and health in museums and participatory dialogues may foster behavior change. *The Journal of STEM Outreach*, *2*(1).

Storbeck, J., & Clore, G. L. (2005). With sadness comes accuracy; with happiness, false memory: Mood and the false memory effect. *Psychological Science*, *16*(10), 785–791.

Storbeck, J., & Clore, G. L. (2008). Affective arousal as information: How affective arousal influences judgments, learning, and memory. *Social and Personality Psychology Compass*, *2*(5), 1824–1843.

Swim, J. K., Geiger, N., & Zawadzki, S. J. (2014). Psychology and energy-use reduction policies. *Policy Insights from the Behavioral and Brain Sciences*, *1*(1), 180–188.

Thompson, S. C. G., & Barton, M. A. (1994). Ecocentric and anthropocentric attitudes toward the environment. *Journal of Environmental Psychology*, *14*(2), 149–157.

Tversky, A., & Kahneman, D. (1974). Judgment under uncertainty: Heuristics and biases. *Science*, *185*(4157), 1124–1131.

United Nations. (2015). *Transforming our world: The 2030 agenda for sustainable development.* https://stg-wedocs.unep.org/bitstream/handle/20.500.11822/11125/unep_swio_sm1_inf7_sdg.pdf?sequence=1

United Nations. (2016). *The world's cities in 2016, data booklet (ST/ESA/SER. A/392)*. https://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf

van den Bergh, J. C. J. M., Ferrer-i-Carbonell, A., & Munda, G. (2000). Alternative models of individual behaviour and implications for environmental policy. *Ecological Economics*, *32*(1), 43–61.

Varotto, A., & Spagnolli, A. (2017). Psychological strategies to promote household recycling. A systematic review with meta-analysis of validated field interventions. *Journal of Environmental Psychology*, *51*, 168–188.

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social–ecological systems. *Ecology and Society*, *9*(2), 5.

Weber, E. U. (2006). Experience-based and description-based perceptions of long-term risk: Why global warming does not scare us (yet). *Climatic Change*, *77*(1–2), 103–120.

Weber, E. U. (2015). Climate change demands behavioral change: What are the challenges? *Social Research: An International Quarterly*, *82*(3), 561–580.

Weber, E. U. (2016). What shapes perceptions of climate change? New research since 2010: What shapes perceptions of climate change? *Wiley Interdisciplinary Reviews: Climate Change*, *7*(1), 125–134.

Welsch, H., & Kühling, J. (2009). Determinants of pro-environmental consumption: The role of reference groups and routine behavior. *Ecological Economics*, *69*(1), 166–176.

Whitburn, J., Linklater, W., & Abrahamse, W. (2019). Meta-analysis of human connection to nature and proenvironmental behavior. *Conservation Biology*, *34*(1), 180–193.

Whitmarsh, L., O'Neill, S., & Lorenzoni, I. (2013). Public engagement with climate change: What do we know and where do we go from here? *International Journal of Media & Cultural Politics*, *9*(1), 7–25.

Williams, S. J., Jones, J. P. G., Gibbons, J. M., & Clubbe, C. (2015). Botanic gardens can positively influence visitors' environmental attitudes. *Biodiversity and Conservation*, *24*(7), 1609–1620.

Winkielman, P., Knutson, B., Paulus, M., & Trujillo, J. L. (2007). Affective influence on judgments and decisions: Moving towards core mechanisms. *Review of General Psychology*, *11*(2), 179–192.

Wolf, J., & Moser, S. C. (2011). Individual understandings, perceptions, and engagement with climate change: Insights from in-depth studies across the world: Individual understandings, perceptions, and engagement with climate change. *Wiley Interdisciplinary Reviews: Climate Change*, *2*(4), 547–569.

Wolsko, C., & Lindberg, K. (2013). Experiencing connection with nature: The matrix of psychological well-being, mindfulness, and outdoor recreation. *Ecopsychology*, *5*(2), 80–91.

Zadra, J. R., & Clore, G. L. (2011). Emotion and perception: The role of affective information. *Wiley Interdisciplinary Reviews: Cognitive Science*, *2*(6), 676–685.

Zelenika, I., Moreau, T., Lane, O., & Zhao, J. (2018). Sustainability education in a botanical garden promotes environmental knowledge, attitudes and willingness to act. *Environmental Education Research*, *24*(11), 1581–1596.

Zelenski, J. M., Dopko, R. L., & Capaldi, C. A. (2015). Cooperation is in our nature: Nature exposure may promote cooperative and environmentally sustainable behavior. *Journal of Environmental Psychology*, *42*, 24–31.

Appendices

Appendix A Experiment transcript

Experiment script

Initially greeting visitors that arrive to the Garden:

Hi there, my name is XXX, we are conducting a study on how botanical gardens can help motivate climate action, would you like to participate? As a thank-you you will receive $10, a free garden entry and a free entry to the TreeWalk! If you agree to participate you may be asked to on the canopy *TreeWalk* and receive information about the botanical garden and what we do here, go on the TreeWalk, or guided through the garden and then asked to fill out a survey in the end. It will take about 45 minutes – 1 hour of your time.

Participant says yes

- Great! So the first thing to do is for you to look over the consent form and provide your consent, please take the time you need and feel free to ask any questions. We will then get you inside and walk to the part of the garden where the study starts. It will be a 5-10 minute walk over. I have a ticket for the entrance for you right here, so if you just want to follow me.

Walk down to TreeWalk area for all conditions.

TreeWalk with education condition:

- Welcome to the Greenheart TreeWalk! The walkway is approximately 300 meters long and has 9 platforms. Maximum height over the forest floor is 22.5 meters. You are not obliged to do the walk and can stay here if you like, or can also give the TreeWalk a try and decide what to do once you've reached the first platform. Please walk with your hands free as the walk way is wobbly. The platforms are more stable. Any questions?
- **Platform 1**
- *Check in with participants.* Please observe how the platforms are attached to the trees. There are two systems in place, the hugging system and the kissing system. The one at your feet is the kissing system. The rods with rubber ends lean against the tree without damaging it. The rods are pulled back as the tree grows thicker. If you look up the trunk you will notice a system of cables that wraps around the tree. This is the hugging systems. The system works like a finger trap. The more you pull or the stronger the pressure, the tighter the cables wrap around the tree. When the pressure is released, when we walk off the platform, the cables also release the pressure from the tree.
- Any questions? Let's continue.

- **Platform 3 – Intro the UN Sustainable Development Goals**
- **Educational Questions**
- Have you ever heard of the UN Sustainable Goals? Yes or No
- If yes, what have you heard about them?

- These 17 goals are associated with 169 targets that support global efforts towards sustainable development for 2015-2030. The objective of them are to hold leadership accountable and shape government actions, draw attention to local needs and build consensus on priorities.
- They were approved in 2015 by the UN Nation States and succeeded the Millennium Development Goals.

- What do you think they mean? Why do you think they are important?
    - They are universal, integrated and indivisible, meaning that all of them need to be achieved in order to achieve a sustainable world, and they focus on the areas of people, planet, prosperity, peace and partnership.

- **Platform 5 – Highlight Goal 15 Life on Land**
- ***What's the Goal here?***
- This goal aims to sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.
- Biodiversity refers to the variety of living species in an ecosystem. Protecting biodiversity and ecosystem services is a key component of addressing climate change and better managing associated threats.

- ***Look around – what biodiversity do you think lives here?***
- ***What do you think are the main threats to biodiversity***? Deforestation, agriculture, urbanization, invasive species, and more!

- What actions can you and your community take to contribute to this SDG Goal?
    - *Suggested answers:* Get engaged in community garden, garden in your back yard, support environmental organizations

- **Platform 6 - Tower – Highlight Goal 11 Sustainable cities and communities**
- What's the Goal here?
- Make cities inclusive, safe, resilient and sustainable
- Some of the targets in this goal are to increase access to sustainable transport for all, protect cultural and natural heritage, address air quality, reduce waste and increase accessibility to green and public spaces.

- What city do you live in?

- **Goal 12 – Sustainable consumption and production**
- What's the Goal and Targets here?
- Ensure sustainable consumption and production patters. Promoting resource and energy efficiency, sustainable infrastructure.
- Achieving economic growth and sustainable development requires that we urgently reduce our ecological footprint by changing the way we produce and consume goods and resources, so it is about doing more with less and initiate a whole life cycle approach to consumption and production. Efficient management of resources is therefore important – including natural resources

- Do you know of any work that has been done or needs to be done in relation to this goal/target?

- What actions can you take?
    - *Suggested answers:* Reuse old items, and recycle what you can. Reduce waste, compost, donate items that are no longer needed.

- **Goal 13 – Climate Action – Goal is to take urgent action to combat climate change and its impact.**
- Do you know of any work that has been done or needs to be done in relation to this goal/target?
- In January 2019, the City of Vancouver declared a climate emergency calling on the staff to amplify efforts to reduce the impacts of climate change through mitigation and adaptation.

- What do you think individuals can do to get involved in this goal?
    - *Suggested answers:* Vote, consume responsibly, restrict air travel, get involved in non-profit work, encourage your workplace to engage in sustainable practices such as printing less, raise conversations

- *Exit TreeWalk, check in with participants.*
- Great, we are at the end, well done.

- *Distribute survey, then payment and possibility for them to donate to the Botanical Garden, and thank them for their participation and time. Offer guidance on where to go if they want to continue their visit in the Garden.*

Treewalk condition, no education:

- Welcome to the Greenheart *TreeWalk*! The walkway is approximately 300 meters long and has 9 platforms. Maximum height over the forest floor is 22.5 meters. You are not obliged to do the walk and can stay here if you like, or can also give the TreeWalk a try and decide what to do once you've reached the first platform. Please walk with your hands free as the walk way is wobbly. The platforms are more stable. Questions?

- ***Platform 1***
- *Check in with participants.* Please observe how the platforms are attached to the trees. There are two systems in place, the hugging system and the kissing system. The one at your feet is the kissing system. The rods with rubber ends lean against the tree without damaging it. The rods are pulled back as the tree grows thicker. If you look up the trunk you will notice a system of cables that wraps around the tree. This is the hugging systems. The system works like a finger trap. The more you pull or the stronger the pressure, the tighter the cables wrap around the tree. When the pressure is released, when we walk off the platform, the cables also release the pressure from the tree.
- Any Questions? Let's continue.

- This information can be given at any time, or at platform 3 and 6.

- *Throughout the walk the participants will be guided, and receive some technical information but no further information regarding environment or sustainability will be presented by the investigator. participants will therefore be encouraged to continue if they linger for too long. Participants may ask questions, if they relate to nature, sustainability etc. the investigator will not give a proper answer, e.g., "that is a good question, I have been wondering that myself! Hmm maybe…"*

    - *Technical information: How many the platform can hold: 20-25*
    - *When the TreeWalk was constructed*
    - *Facts about the TreeWalk: It hangs from huge Douglas firs, cedars and grand firs, some of which are over 100 years old*
        - *It is 310 metres long*
        - *At the highest you are 23 metres above the forest floor*
        - *It is minimally invasive unlike many other canopy walkways as there are no bolts used, instead there is a kissing bar. This way the trees will have no damage and will not rot like traditional walkways with bolts*

- *Exit TreeWalk, check in with participants.*
- Great, we are at the end, well done.

- *Distribute survey, then payment and possibility for donation, and thank them for their participation and time. Offer guidance on where to go in the garden.*

Nature condition, with education:

- Welcome to the Botanical Garden, and thank you for signing up for my study! This is a place housing many different species, and we are now going to go on a walk for approximately 20 minutes in the Asian Garden. We will stop periodically and discuss some of the biodiversity that lives here and sustainable development. Any questions?

- **Below Platform 1**
- *Check in with participants.* Please observe how the platforms are attached to the trees. There are two systems in place, the hugging system and the kissing system. The one at your feet is the kissing system. The rods with rubber ends lean against the tree without damaging it. The rods are pulled back as the tree grows thicker. If you look up the trunk you will notice a system of cables that wraps around the tree. This is the hugging systems. The system works like a finger trap. The more you pull or the stronger the pressure, the tighter the cables wrap around the tree. When the pressure is released, when we walk off the platform, the cables also release the pressure from the tree.
- Any questions? Let's continue.

- **Platform 3 – Intro the UN Sustainable Development Goals**
- **Educational Questions**
- Have you ever heard of the UN Sustainable Goals? Yes or No
- If yes, what have you heard about them?
- These 17 goals are associated with 169 targets that support global efforts towards sustainable development for 2015-2030. The objective of them are to hold leadership accountable and shape government actions, draw attention to local needs and build consensus on priorities.
- They were approved in 2015 by the UN Nation States and succeeded the Millennium Development Goals.

- What do you think they mean? Why do you think they are important?
    - They are universal, integrated and indivisible, meaning that all of them need to be achieved in order to achieve a sustainable world, and they focus on the areas of people, planet, prosperity, peace and partnership.

- **Platform 5 – Highlight Goal 15 Life on Land**
- ***What's the Goal here?***

- This goal aims to sustainably manage forests, combat desertification, halt and reverse land degradation, halt biodiversity loss.
- Biodiversity refers to the variety of living species in an ecosystem. Protecting biodiversity and ecosystem services is a key component of addressing climate change and better managing associated threats.
- ***Look around – what biodiversity do you think lives here?***
- ***What do you think are the main threats to biodiversity***? Deforestation, agriculture, urbanization, invasive species, and more!
- What actions can you and your community take to contribute to this SDG Goal?
    - *Suggested answers:* Get engaged in community garden, garden in your back yard, support environmental organizations

- **Platform 6 - Tower – Highlight Goal 11 Sustainable cities and communities**
- What's the Goal here?
- Make cities inclusive, safe, resilient and sustainable
- Some of the targets in this goal are to increase access to sustainable transport for all, protect cultural and natural heritage, address air quality, reduce waste and increase accessibility to green and public spaces.
- What city do you live in?

- **Goal 12 – Sustainable consumption and production**
- What's the Goal and Targets here?
- Ensure sustainable consumption and production patters. Promoting resource and energy efficiency, sustainable infrastructure.
- Achieving economic growth and sustainable development requires that we urgently reduce our ecological footprint by changing the way we produce and consume goods and resources, so it is about doing more with less and initiate a whole life cycle approach to consumption and production. Efficient management of resources is therefore important – including natural resources

- Do you know of any work that has been done or needs to be done in relation to this goal/target?
- What actions can you take?
    - *Suggested answers:* Reuse old items, and recycle what you can. Reduce waste, compost, donate items that are no longer needed.

- **Goal 13 – Climate Action – Goal is to take urgent action to combat climate change and its impact.**

- Do you know of any work that has been done or needs to be done in relation to this goal/target?
- In January 2019, the City of Vancouver declared a climate emergency calling on the staff to amplify efforts to reduce the impacts of climate change through mitigation and adaptation.
- What do you think individuals can do to get involved in this goal?
    - *Suggested answers:* Vote, consume responsibly, restrict air travel, get involved in non-profit work, encourage your workplace to engage in sustainable practices such as printing less, raise conversations

- *Exit TreeWalk, check in with participants.*
- Great, we are at the end, well done.
- *Distribute survey, then payment and possibility for them to donate to the Botanical Garden, and thank them for their participation and time.*

Nature condition, no education:

- Welcome to the Botanical Garden, and thank you for signing up for my study! This is a place housing many different species, and we are now going to go on a walk for approximately 20 minutes in the Asian Garden. You are free to let your thoughts wander and reflect as you wish.

- *Throughout the walk the participants will be guided, and receive some technical information about the TreeWalk but no further information regarding environment or sustainability will be presented by the investigator. participants will therefore be encouraged to continue if they linger for too long. Participants may ask questions, if they relate to nature, sustainability etc. the investigator will not give a proper answer, e.g., "that is a good question, I have been wondering that myself! Hmm maybe…"*

    - *Technical information: How many the platform can hold: 20-25*
    - *When the TreeWalk was constructed*
    - *Facts about the TreeWalk: It hangs from huge Douglas firs, cedars and grand firs, some of which are over 100 years old*
        - *It is 310 metres long*
        - *At the highest you are 23 metres above the forest floor*
        - *It is minimally invasive unlike many other canopy walkways as there are no bolts used, instead there is a kissing bar. This way the trees will have no damage and will not rot like traditional walkways with bolts*

- Great, we have come to the end, how are you doing?

- *Distribute survey, then payment and possibility for them to donate to the Botanical Garden, and thank them for their participation and time. Offer guidance on where to go in the garden.*

Control condition, survey only:

- *They will be led to the TreeWalk area and will be presented with the survey at the end of the TreeWalk.*
- *Once you arrive at the TreeWalk area of the Garden*: Thank you again for signing up for my study. The first step is to fill out a survey, it will take you around 5-10 minutes.
-
- *Distribute survey, then inform them that the study is complete for them. Offer payment and possibility for them to donate to the Botanical Garden, and thank them for their participation and time. Offer the ticket for complimentary entrance to the TreeWalk.*

-

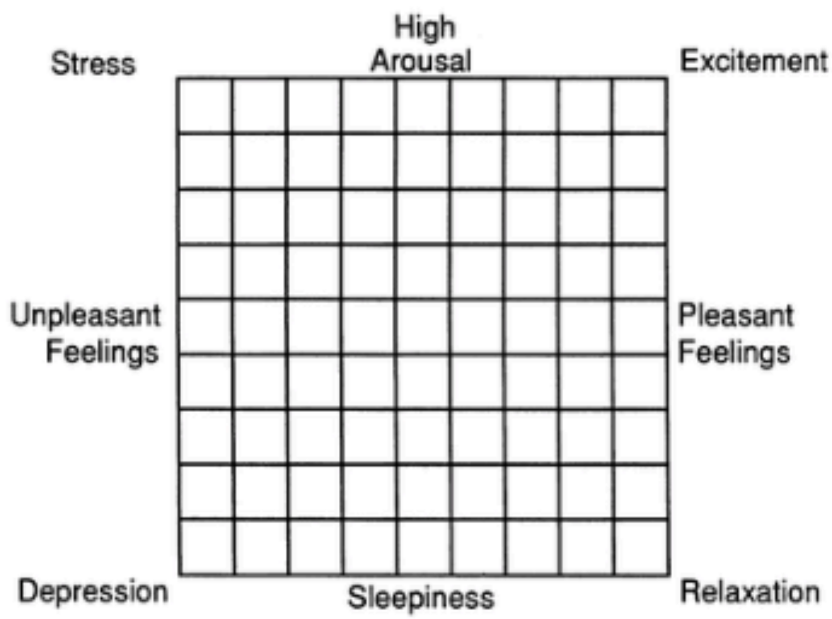
Appendix B Survey

Survey, page 1

Survey

Q1. Below is a grid that can capture how you are feeling at this moment. Along the horizontal axis, it asks the degree to which you experience pleasant feelings right now, from unpleasant feelings at the left to pleasant feelings at the right. Along the vertical axis, it asks the degree to which you feel aroused right now, from feeling highly alert (e.g., wide awake, or activated) at the top to feeling sleepy at the bottom. In other words, the grid can be used to describe any positive or negative feelings, as well as your level of alertness. The labels shown at the corners are merely landmarks to help you understand the affect grid.

Please look over the entire grid to get a feel for the meaning of the various areas. Then please put an X in a cell anywhere in the grid to indicate the exact shade and intensity of the feeling you are experiencing right now. Please only mark one square.



Ethics ID: H19-00360 Version 3: 25. April 2019

For each of the following, please rate the extent to which you agree with each statement, using the scale from 0 to 10 as shown below. Please respond as you really feel, rather than how you think "most people" feel. There is no right or wrong answer. Your information will be kept strictly confidential.

Q2. Nature is valuable for its own sake.
0........1........2........3........4........5........6........7........8........9........10
Strongly Disagree *Strongly Agree*

Q3. I need time in nature to be happy.
0........1........2........3........4........5........6........7........8........9........10
Strongly Disagree *Strongly Agree*

Q4. It makes me sad to see natural environments destroyed.
0........1........2........3........4........5........6........7........8........9........10
Strongly Disagree *Strongly Agree*

Q5. Humans are as much a part of the ecosystem as other animals.
0........1........2........3........4........5........6........7........8........9........10
Strongly *Disagree* Strongly *Agree*

Q6. Humans are severely abusing the environment.
0........1........2........3........4........5........6........7........8........9........10
Strongly Disagree *Strongly Agree*

Q7. The so-called "ecological crisis" facing humankind has been greatly exaggerated.
0........1........2........3........4........5........6........7........8........9........10
Strongly Disagree *Strongly Agree*

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Q8. The Earth is like a spaceship with very limited room and resources.

0........1........2........3........4........5........6........7........8........9........10

Strongly Disagree | *Strongly Agree*

Q9. If things continue on their present course we will soon experience a major ecological catastrophe.

0........1........2........3........4........5........6........7........8........9........10

Strongly Disagree | *Strongly Agree*

Q10. My ideal vacation spot would be a remote, wilderness area.

0........1........2........3........4........5........6........7........8........9........10

Strongly Disagree | *Strongly Agree*

Q11. I always think about how my actions affect the environment.

0........1........2........3........4........5........6........7........8........9........10

Strongly Disagree | *Strongly Agree*

Q12. My connection to nature and the environment is a part of my spirituality.

0........1........2........3........4........5........6........7........8........9........10

Strongly Disagree | *Strongly Agree*

Q13. I take notice of wildlife wherever I am.

0........1........2........3........4........5........6........7........8........9........10

Strongly Disagree | *Strongly Agree*

Q14. My relationship to nature is an important part of who I am.

0........1........2........3........4........5........6........7........8........9........10

Strongly Disagree | *Strongly Agree*

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Q15. I feel very connected to all living things and the earth.

0........1........2........3........4........5........6........7........8........9........10

Strongly Disagree — *Strongly Agree*

Please answer the following questions. These are completely voluntary.

Q16. As a thank you for your participation in this study, you will receive $10. Would you like to donate some or all of this to the UBC Botanical Garden? This is completely voluntary. If you would like to donate, please write down the amount, and deposit the money in the donation box. If not, please leave it blank and move onto the next question.

Amount to donate:____

Q17. Would you like to sign up to receive a monthly newsletter from UBC Botanical Garden? If yes, please provide your email below. Sign-up is completely voluntary and you can unsubscribe at any time. If not, please leave it blank and move onto the next question.

Email:____

Q18. Would you like to sign up to receive information about volunteer opportunities from UBC Botanical Garden? If yes, please provide your email below. Sign-up is completely voluntary and non-committing, and you can unsubscribe at any time. If not, please leave it blank and move onto the next question.

Email:____

Below are four petitions that are* fully voluntary *but available for signing if you desire to support any of these causes.

Action Needed to Conserve Biodiversity in Canada

The Canadian government must provide a national framework for the conservation of Canada's biodiversity. Canada is home to approximately 80,000 species of plants and animals. Canadian biodiversity is spread across a wide range of landscapes and ecosystems, but the greatest biodiversity is found in the southern areas where most Canadians live. Canada's biodiversity is under pressure from urbanization, economic growth, climate change, and reliance on natural resources. The Canadian government must provide effective leadership and coordinate actions required to meet the 2030 biodiversity targets.

Name: ____

Email: ____

Action Needed to Reduce Income Inequality in Canada

The Canadian government needs to prioritize the reduction of income inequality. The top 100 Canadian income earners hold as much wealth as the bottom 10 million, and the gap between the wealthy and everyone else in Canada is growing faster than in most of the developed world. The Canadian government must take action to reduce income inequality by implementing a federal minimum wage, ask corporations to pay their fair share, and stop unfair trade deal that threaten jobs and drive down wages.

Name: ____

Email: ____

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Action Needed to Implement a National No-Poverty Strategy

The Canadian government needs to set ambitious targets in order to reduce poverty in Canada. Currently, one in seven people in Canada live in poverty. The Government must prioritize the development of a Canadian Poverty Reduction Strategy that would set targets to reduce poverty, as well as to measure and publicly report on progress. The implementation must involve testing and evaluating new and promising poverty reduction initiatives, which would include investments in affordable housing, skills training, early childhood education and youth mental health.

Name: ____

Email: ____

Action Needed to Implement a Forest Conservation Strategy

The Canadian government must protect the ancient forests of Canada. Currently, temperate rainforests and ancient forests are being cut down, which is destroying the habitat of species such as bears, wolves and salmon. Forests play a critical role for maintaining wildlife and in absorbing and storing greenhouse gases which help mitigate the impacts of climate change. Canada needs a comprehensive solution for sustainable use of natural resources, maintaining the forests' role in storing carbon, and conserving the wildlife that call the forest home.

Name: ____

Email: ____

Q19. Have you ever signed a petition? ☐ Yes ☐ No

Q20. If yes, what kinds of petitions have you signed?

____

Q21. Do you believe that petitions have the potential to impact change?

☐ Yes ☐ No

The following questions are for general purposes. Your responses will be kept strictly confidential.

Q22. How many participants were in your group? ☐1 ☐2 ☐3 ☐4

Q23. Gender: ☐ Male ☐ Female ☐ Other ☐ Prefer not to say

Q24. Age: _______

Q25. Which city do you currently live in? ____________________

Q26. How do you feel about your current financial situation?
0..........1..........2..........3..........4..........5..........6..........7..........8..........9..........10
Feel overwhelmed *Sometimes feel worried* *Not worried* *Feel comfortable*

Q27. Which of the following best describes your political views?
☐ Strongly liberal ☐ Liberal ☐ Slightly liberal ☐ Middle of the road
☐ Slightly Conservative ☐ Conservative ☐ Strongly conservative

Thank you for your time!

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For researcher use only:

1. Name of researcher: _________

2. Condition: ___

3. Date: _____________

4. Day: ___________

5. Time started: ___________

6. Participant ID: __________

7. Number of participants in group: _____

8. Weather: ____________

Appendix C Regression analyses

Table C.1. Regression analyses reporting standardized results, including the conditions and interaction (Walk*Education), the variables arousal, valence, group size, demographics (financial status, political orientation, and age), and ratings from the three environmental scales (ECO = Eco-Centrism, NEP = New Ecological Paradigm, NR = Shortened Nature Relatedness) to predict pro-environmental behaviour. Condition in parenthesis indicates reference group (* p<.01, ** p<.001, *p<.001).

Dependent Variable	Predictor	*B*	*SE*	*t* value	*p* value
Donation	Walk (TW)	-0.003	0.06	-0.05	.96
	Education (no education)	0.04	0.05	0.77	.44
	Arousal	0.06	0.06	1.05	.30
	Valence	0.17**	0.05	3.09	.002
	Group size	0.12*	0.06	2.11	.04
	Financial	0.21***	0.06	3.71	<.001
	Political	0.14*	0.06	2.26	.02
	Age	0.05	0.06	0.77	.44
	ECO	0.1	0.06	1.66	.09
	NR	0.05	0.06	0.75	.45
	NEP	-0.13*	0.06	2.08	.04
	Walk*Education	-0.11*	0.05	-2.07	.04
Petitions	Walk (TW)	-0.01	0.06	-0.12	.9
	Education (no education)	-0.03	0.05	-0.62	.53
	Arousal	-0.02	0.06	-0.05	.96
	Valence	0.04	0.06	0.71	.48
	Group size	-0.14*	0.06	-2.47	.01

	Financial	-0.002	0.06	-0.04	.97
	Political	-0.21***	0.06	-3.43	<.001
	Age	-0.21***	0.06	-3.42	<.001
	ECO	0.12	0.06	1.82	.07
	NR	0.05	0.06	0.89	.38
	NEP	0.05	0.06	0.84	.40
	Walk*Education	0.08	0.06	1.48	.14
Newsletter and volunteer sign-ups	Walk (TW)	-0.02	0.06	-0.35	.73
	Education (no education)	0.004	0.06	0.07	.94
	Arousal	-0.07	0.06	-1.17	.24
	Valence	-0.11*	0.06	-1.97	.05
	Group size	-0.02	0.06	-0.27	.79
	Financial	-0.07	0.06	-1.17	.24
	Political	-0.01	0.06	-0.09	.93
	Age	-0.09	0.06	-1.37	.17
	ECO	-0.05	0.07	-0.69	.49
	NR	0.2**	0.06	3.09	.002
	NEP	-0.01	0.07	-0.19	.84
	Walk*Education	-0.03	0.06	-0.58	.56

Appendix D Correlations

The following figures report correlations between the dependent variables and covariates included in the study for each condition. Env_P signifies environmental petitions; S_P signifies social petitions; and Sum_NV signifies a summed score of newsletter signups and volunteer signups. * indicates statistical significance at $p < .05$ level.

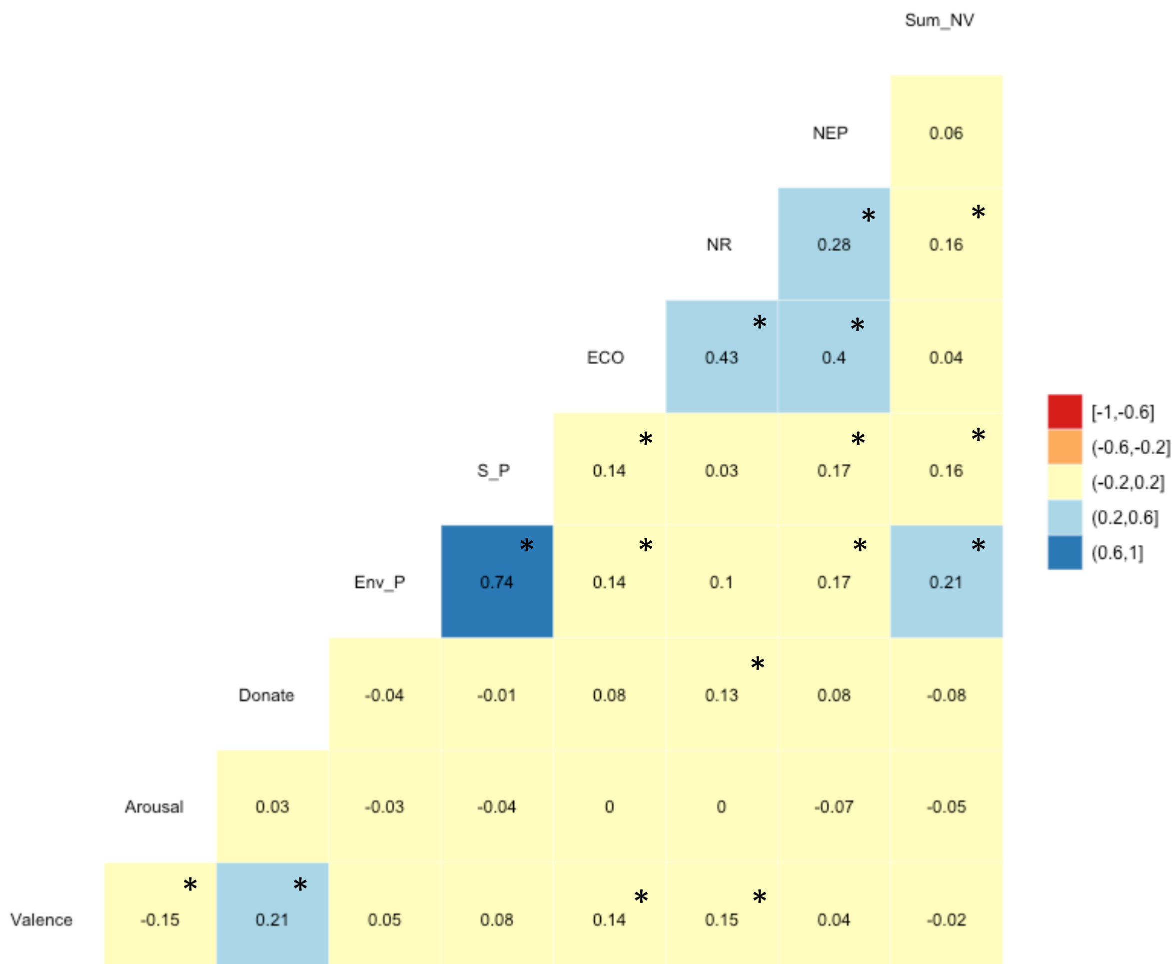

Figure D.1. Correlation matrix for entire dataset (*N* = 419).

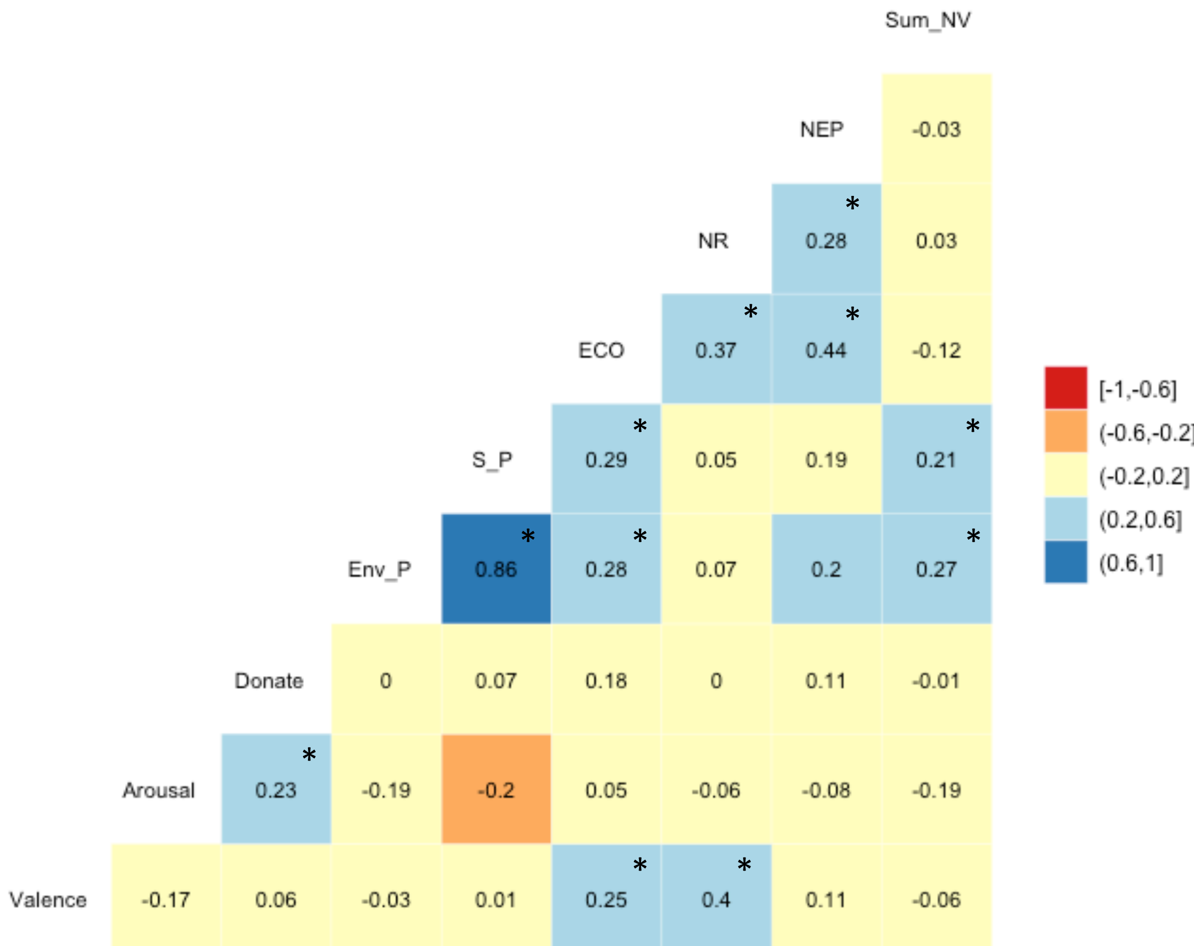

Figure D.2. Correlation matrix for TreeWalk and education condition.

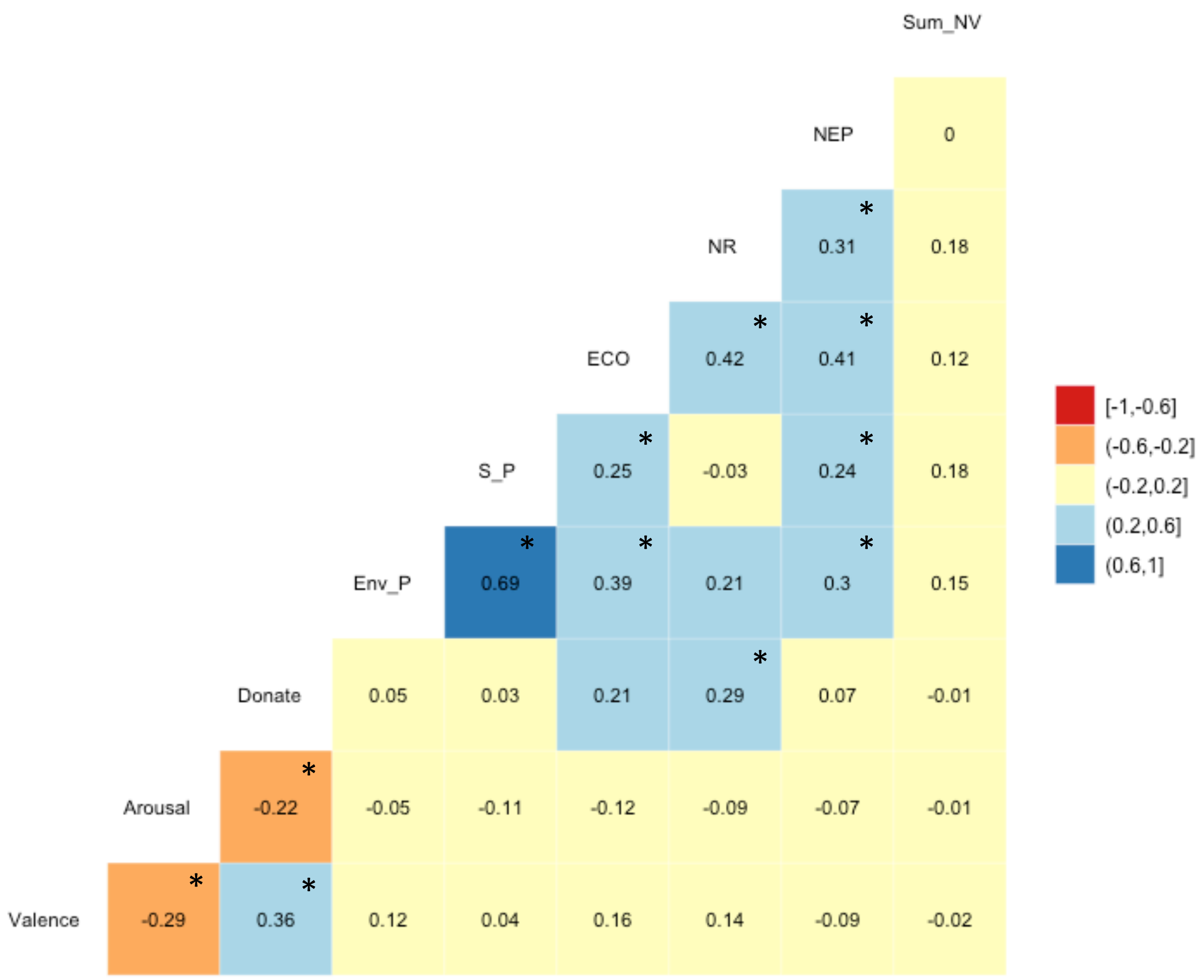

Figure D.3. Correlation matrix for TreeWalk condition.

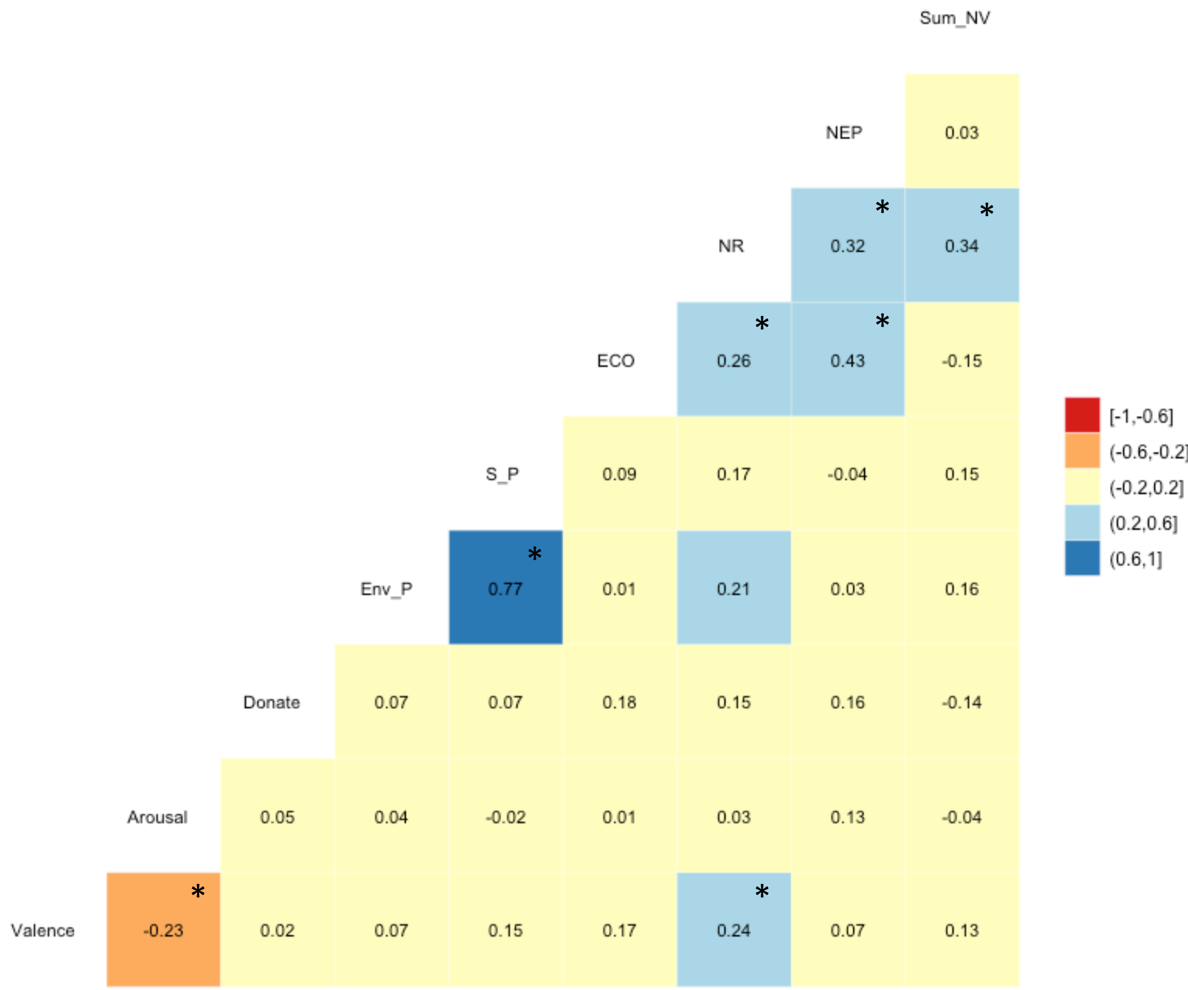

Figure D.4. Correlation matrix for ground walk and education condition.

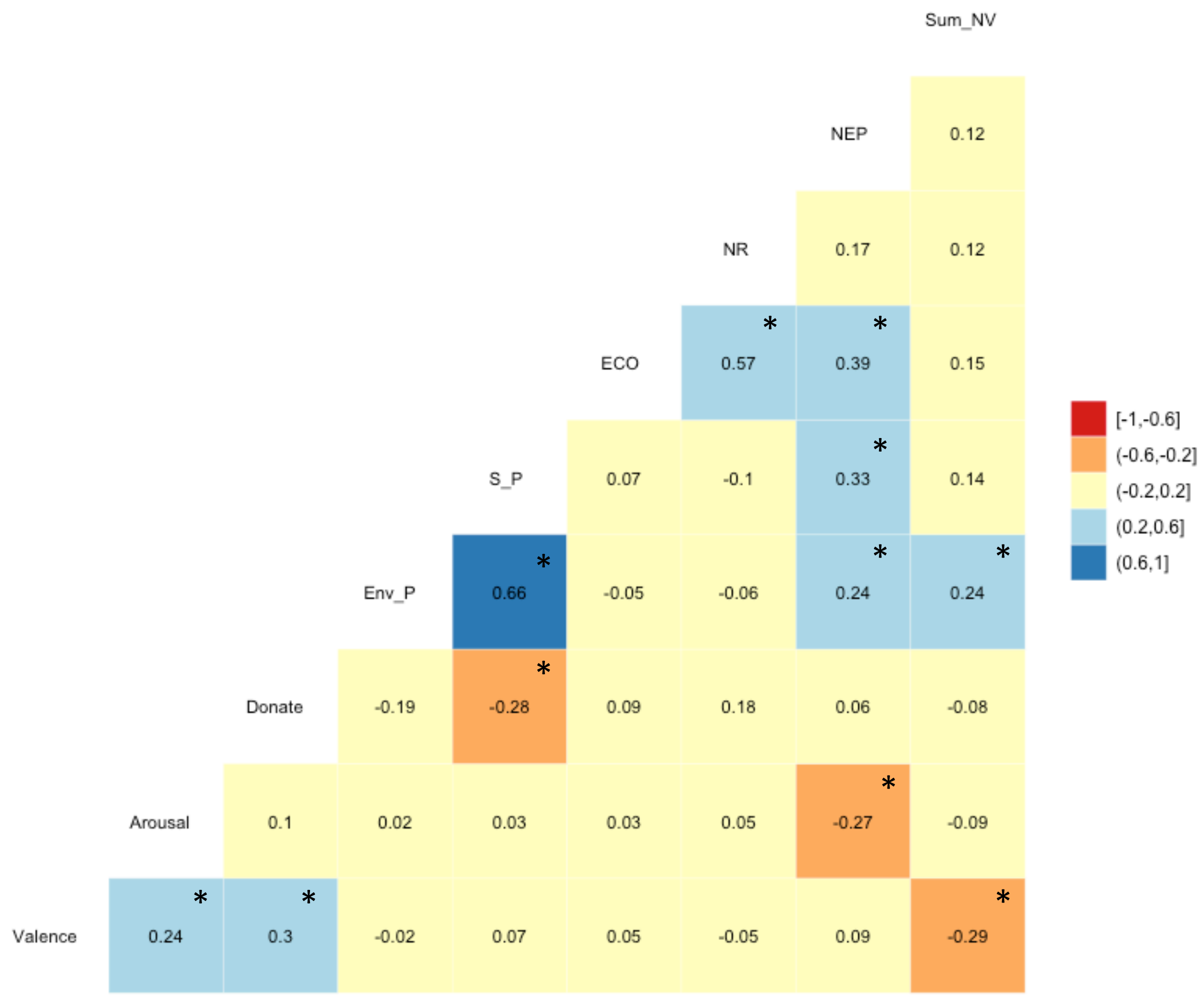

Figure D.5. Correlation matrix for ground walk condition.

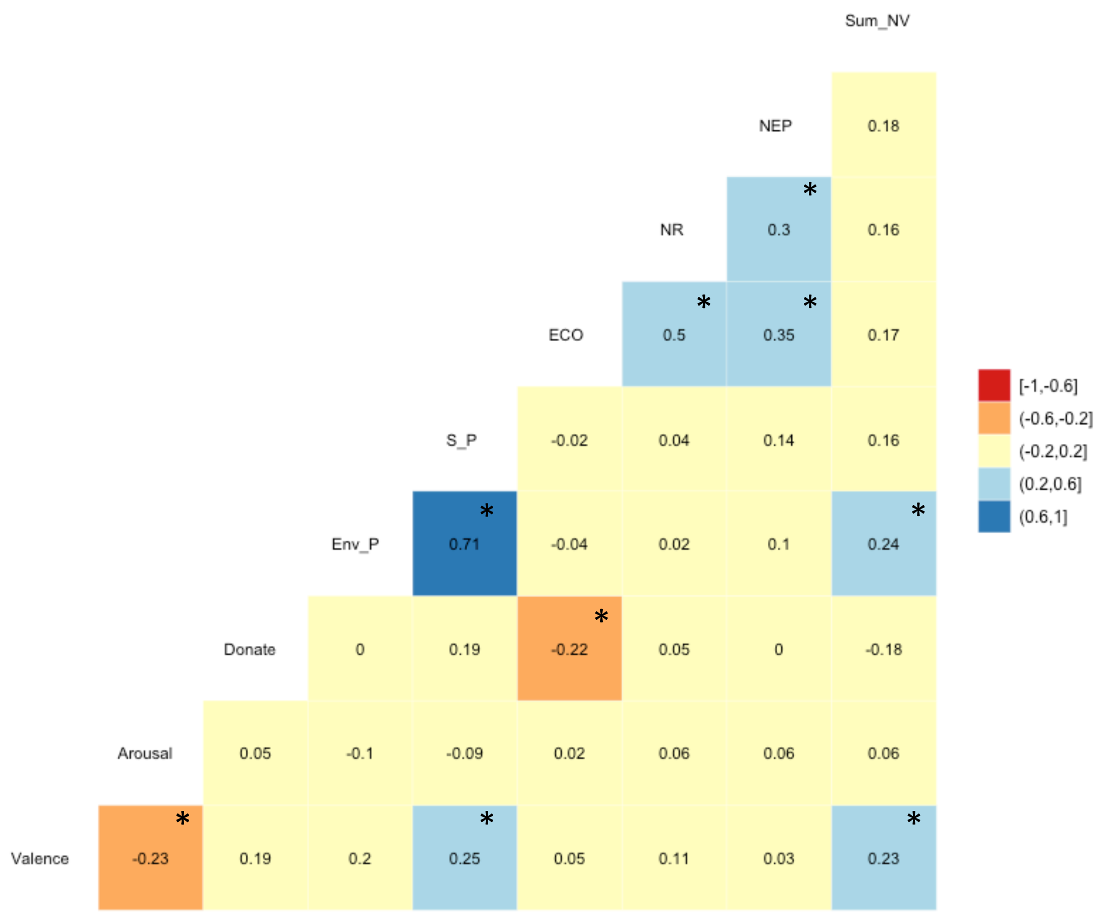

Figure D.6. Correlation matrix for control condition.