<u>Tailoring interventions: How individual differences influence perceptions, motivation, and behaviour</u>

by

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M.A., University of Victoria, 2015
B.A., University of Ottawa, 2009

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Abstract

Climate change mitigation requires changes in greenhouse gas emitting behaviours. This dissertation aims to provide insights into the influences of behaviour change for two high-impact pro-environmental behaviours: climate policy support and consumption of animal products. It does so by using quasi- and randomized experiments and by monitoring changes in behaviour over time. Study 1 examined changes in climate policy support and climate change risk perception over the course of a naturally occurring event: seasonal forest fires. It employed growth curve modeling techniques in a structural equation modeling framework to analyze longitudinal relations between these two constructs over time, and to examine growth in climate change risk perception while controlling for the effect of exposure to forest fires and other extreme weather. Indirect exposure to forest fires (e.g., media) had a modest effect on climate change risk perception. Climate change risk perception for individuals with above-mean perceptions of scientific agreement tended to increase faster than for those with below-mean perceptions. Individuals whose climate change risk perception grew at a faster-than-average rate tended to also grow at a faster-than-average rate for climate policy support. Study 2 provided insight into the psychological influences on consumption of animal products and on willingness to reduce. Following a comprehensive literature review, known influences were examined using Latent Profile Analysis to identify groups of individuals with similar perceptions of facilitators of meat consumption and obstacles to reducing it. Three groups were identified: strong-hindrance meat eaters, moderate-hindrance meat eaters, and reducers. Validation variables confirmed the practicality of the three profiles: groups differed in their current consumption of animal products and in their willingness to reduce. Using these findings, three group-matched interventions were designed in Study 3. Intervention design was informed by four behaviour-change frameworks. Participants were randomly assigned to one of four conditions: control condition, implementation-intention condition, information-and-healthy-recipe condition, and information-and-substitution condition. Then, they completed up to 28 days of food diaries. Multilevel model analyses were employed to examine changes in the consumption of animal products over time. Participants reduced their consumption by 20 grams of CO_2 per day on average. Individuals that were randomly assigned to an intervention condition that matched their meat-eater profile reduced their consumption of animal products by 40 grams CO_2 per day on average. Taken together, these studies highlight the importance of considering individual differences (i.e., tailoring) when designing pro-environmental behaviour interventions.

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Dedication

I dedicate this dissertation to my parents for their never-ending love and support.

Chapter 1: General Introduction

Dissertation Structure

This dissertation is a combination of three distinct studies that focus on high-impact behaviour (i.e., behaviours with large potential for reductions in greenhouse gas emissions), with an emphasis on individual differences in all three studies, and analyses of changes over time (i.e., longitudinal analyses) in two of the three studies. The overall goals of this research are to better understand how individual differences influence predictors of pro-environmental behaviour and how tailoring interventions can help change these behaviours.

Study 1 (Chapter 2) is a natural quasi-experiment during which I examined the effect of seasonal forest fire exposure on climate change risk perception and how changes in risk perception correlate with changes in climate policy support. Repeated measures (i.e., before, during, and after the forest fire season) of fire exposure, climate change risk perception, and climate policy support were gathered over a period of 7.5 months. I hypothesized that the trajectories of change would vary between-individuals according to their climate change beliefs.

Study 2 (Chapter 3) applied a profiling analysis to another high-impact behaviour: consumption of animal products. This study aimed to identify homogenous segments of individuals with similar beliefs about meat eating (e.g., perception of barriers and benefits) within a sample of Canadians. I hypothesized that current dietary patterns and willingness for dietary change would differ between segments.

Building from these findings, behaviour-change frameworks were applied to design three group-matched meat reduction interventions, and these were tested using a randomized control trial in Study 3 (Chapter 4). It included three phases: a profiling phase, a baseline and intervention phase, and repeated measures (i.e., food diaries) phase. The baseline and repeated food diary measures were used to estimate change in animal product consumption over time in a multilevel model. I hypothesized that individuals that were randomly assigned to a group-matched intervention condition would show greater reductions over time.

The studies are preceded by a general introduction, which provides contextual background for the dissertation studies, and are followed by a general discussion (Chapter 5), which provides an overview of the theoretical and practical significance of this research.

Contextual Background: Climate Change

Climate change is a global scale commons dilemma (Hardin, 1968); individuals personally benefit from using carbon-based fuels and emitting greenhouse gases (GHG), while the risks in terms climate change impacts are shared between all users (Capstick, 2013; Lacroix & Richards, 2015). Multiple sources of anthropogenic GHGs (e.g., land-use change, transportation, energy-use, etc.) have a wide range of repercussions across the world, with cascading environmental (e.g., droughts, extreme weather events, biodiversity loss) and social consequences (e.g., food insecurity, destruction of homes; Barros et al., 2014; Swim, Markowitz, & Bloodhart, 2012). The issue is further complicated by large-scale imbalances; nations that emit the most GHG per capita are likely to be the least negatively impacted by climate change, and vice-versa (e.g., Barros et al., 2014).

All the while, no single solution exists. Solutions will need to combine mitigation measures (i.e., reduce source or increase sinks of GHG; Edenhofer et al., 2014) and adaptation measures (i.e., preparing and managing for impacts; Clayton et al., 2015). These solutions involve cultural, lifestyle, and behavioural shifts (Pachauri & Meyer, 2014; Schultz & Kaiser, 2012). The role of environmental psychologists in the discovery and implementation of climate change solutions, in cooperation with natural scientists and technical and policy experts, is becoming more widely recognized (e.g., Cinner, 2018; Clayton et al., 2016; Gifford, 2008; Kazdin, 2009; Pahl & Wyles, 2017; Stern, 2011; Swim et al., 2012). Environmental psychologists can assess the key factors influencing different types of GHG-emitting behaviours, important barriers to adopting these behaviours, and find effective strategies for promoting their uptake.

Pro-environmental Behaviour

Pro-environmental behaviour (PEB) has been defined as behaviour that "changes the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere itself" (Stern, 2000). PEB is often categorized by environmental domain (e.g., energy, transportation, food, waste, purchasing; Gifford, 2014), or by social domain (e.g., private sphere, nonactivist behaviour, environmental activism; Stern; 2000). An individual's behaviour can have positive environmental impacts without them intending to, such as cycling for health reasons. On the other hand, individuals with good environmental intentions often pick the easiest changes, and not necessarily the ones with large environmental impact (Gifford, 2011, 2013; Schultz & Kaiser, 2012; Stern, 2000).

The definition of PEB used in this dissertation does not presume that the behaviour was adopted with pro-environmental intentions in mind. Instead, an attempt is made to divide behaviours according to their relative GHG impact. Recognizing that individuals tend to engage in few PEBs, researchers should focus their efforts on single behaviours that have large potential for reducing GHG emissions and thus helping to mitigate climate change (see Lacroix, 2018). This dissertation will focus on two high-impact behaviours: climate policy support and animal product consumption.

High-impact climate behaviour

Many studies have quantified the relative GHG impacts of household behaviour. Aggregated by environmental domain, housing makes up about 37%, transportation about 32%, and food about 21% of the household GHG emissions in Canada (Ferguson & MacLean, 2011). Focusing specifically on behaviours in the household, Dietz et al. (2009) found that switching to fuel-efficient vehicles had the largest mitigation potential, followed by weatherization (i.e., weatherization includes three actions: sealing drafts, attic insulation, and replacing single-pane windows). However, they only included actions from the housing and transportation domain. When food-domain behaviours were included, Jones and Kammen (2011) found that switching to fuel-efficient vehicles resulted in the largest reduction potential, followed by eating fewer calories, with smaller portions of meat and dairy.

Wynes and Nicholas (2017) concluded that the following actions can be classified as high-impact: living car-free, avoiding one transatlantic flight, buying green energy, buying a more fuel-efficient car or going car-free, and switching to a plant-based diet. They also included having one fewer child in their list of high-action behaviours, but this has been subject to debate (see Basshuysen & Brandstedt, 2018; Pedersen & Lam, 2018; Wynes & Nicholas, 2018a, 2018b). Similarly, Lacroix (2018) concluded that eating fewer animal products and switching to more fuel-efficient vehicles had the largest mitigation potential. Air transportation also had considerable potential, but this varied widely depending on household income and lifestyle.

Although it is difficult to quantify the impact of public-sphere PEB on GHG emissions reductions (e.g., voting, willingness to pay higher taxes), the mitigation potential of these societal-level behaviours should not be underestimated (Clayton et al., 2016). For example, Canada could meet its target of 30% reduction by 2030 by implementing stringent carbon pricing

(Jaccard, Hein, & Vass, 2016). However, it is crucial to consider not only cost-efficiency, but also political acceptability, when evaluating policy options (Jaccard et al., 2016). While carbon pricing is seen as the most cost-effective policy by many economists, it receives low levels of support from the public (Rhodes, Axsen, & Jaccard, 2014). As such, increasing climate policy support is a PEB with large potential for climate change mitigation.

Predictors of PEB

Variables associated with PEBs have been increasingly studied over the last half century (e.g., Hines, Hungerford, & Tomera, 1987; Kollmuss & Agyeman, 2002), leading to the development of models to explain their underlying factors (e.g., value-belief-norm; Stern, Dietz, Abel, Guagnano, & Kalof, 1999). Predictors of PEB can be classified in different ways; some group them under personal and social factors (Gifford & Nilsson, 2014), others call them internal and external factors (Kollmuss & Agyeman, 2002), or intrapersonal and contextual factors (Steg & Vlek, 2009). In this chapter, they are tentatively ordered from general to more situation specific predictors, or from most stable to less stable during adulthood. To avoid repetition, this chapter provides a general overview; the underlying psychological influences specific to climate policy support and to meat consumption are included in the associated dissertation chapters. For a more comprehensive review of PEB predictors, see Bechtel & Ts'erts'man (2002), Clayton et al. (2016), Darnton (2008b), Gifford (2014), and Swim, Clayton, & Howard (2011).

Personality. Personality traits are the "dimensions of individual differences in tendencies to show consistent patterns of thoughts, feelings, and actions" (Roccas, Sagiv, Schwartz, & Knafo, 2002). The 'Big Five' is the dominant approach for personality trait structure, which structures personality traits on five dimensions; openness, conscientiousness, extraversion, agreeableness, and neuroticism (OCEAN; Roccas et al., 2002).

Personality traits are correlated with broad value orientations (Roccas et al., 2002). Openness to experience and agreeableness predict environmental values (Hirsh & Dolderman, 2007). Openness to experience and agreeableness traits, and to a lesser degree neuroticism and conscientiousness, correlate with environmental concern and food choices (Hirsh, 2010; Keller & Siegrist, 2015). However, when other traits are controlled for, only the openness to experience personality trait is positively correlated with PEB (Markowitz, Goldberg, Ashton, & Lee, 2012).

Values. Values are guiding principles based on general goals and motivations; they are relatively stable, transcend situations, and influence PEB indirectly through other predictors like beliefs, norms, and attitudes (Schwartz, 1992, 2012; Steg & De Groot, 2012). Two value theories are commonly used in environmental psychology (Gifford & Nilsson, 2014; Steg & De Groot, 2012). Often used to investigate cooperative behaviour in social dilemmas (e.g., van Lange, van Vugt, Meertens, & Ruiter, 1998), the social value model (Messick & McClintock, 1968) proposes two general value dimensions; pro-self and pro-social (Steg & De Groot, 2012). The pro-self dimension is comprised of individualistic and competitive values, whereas the prosocial dimension is comprised of altruistic and cooperative values.

The Schwartz value scale (Schwartz, 1992) is widely applied by environmental psychologists and posits the existence of 10 universal values. Structurally, these universal values form two value dimensions, each comprised of conflicting value clusters at each end (Schwartz, 2012). The openness to change and conservation (sometimes called traditionalism) value clusters form one dimension. The other dimension includes self-transcendence values at one end, and self-enhancement values at the other (Dietz, Fitzgerald, & Shwom, 2005; Schwartz, 2012; Steg & De Groot, 2012). Individuals have similar value structures, but they differ in the priority (i.e., relative importance) they assign to these values.

Values can be primed to be focal and influence behaviours in different situations, but only if an individual endorses the primed value (i.e., value-congruent actions; Steg & De Groot, 2012). Sometimes values do not have a strong cognitive basis; instead the value might be motivated by affect, cultural consensus, or social norms (Maio, 2010; Maio & Olson, 1998; Maio, Olson, Bernard, & Luke, 2003). Called "cultural truisms", these broadly endorsed values are more susceptible to change than other values because they lack cognitive support (Maio & Olson, 1998).

In the environmental domain, many researchers focus on egoistic, altruistic, biospheric, and, more recently, hedonic values, which fall under the broad value clusters of self-enhancement and self-transcendence (Steg & De Groot, 2012; Steg, Perlaviciute, van der Werff, & Lurvink, 2014). Self-enhancement values (i.e., egoistic and hedonic) are positively correlated with frequency of car use, negatively correlated with preferences for an energy-efficient car, and negatively correlated with acceptability of energy-reduction policies and environmental activism (Abrahamse & Steg, 2011; Steg, Perlaviciute, et al., 2014; Steg & Groot, 2010). On the other hand, self-transcendent values (i.e., altruistic and biospheric) are positively correlated with preferences for environmental products, acceptability of energy-reduction policies, and environmental activism (de Groot & Steg, 2010; Steg, Perlaviciute, et al., 2014; Stern et al., 1999).

Worldviews. Whereas values represent broad motivations, worldviews are an integrated set of *beliefs* about how the world works (Swim et al., 2009). *Beliefs* refer to an individual's evaluation of whether two things are related (Schwartz, 2012). Environmental worldviews are general beliefs about human-environment interactions and are not easily changed in adults; a longitudinal study demonstrated that worldviews (i.e., new ecological paradigm) did not change significantly after four years of adult environmental education (Shephard et al., 2015). During adolescence, worldviews are still forming and thus have a weaker effect on environmental attitudes (Stevenson, Peterson, Bondell, Moore, & Carrier, 2014).

The new ecological paradigm (NEP) is the most commonly used scale to measure broad environmental worldviews, and focuses on beliefs about limits to growth and human mastery over nature (Dunlap & Liere, 1978; Dunlap, Van Liere, Mertig, & Jones, 2000). Scores on the NEP scale positively correlate with household energy-conservation, climate change and water quality risk perception, political action, willingness to pay, and writing letters to politicians (Overdevest & Christiansen, 2013; Poortinga, Steg, & Vlek, 2002; Stern, Dietz, & Guagnano, 1995; Whitmarsh, 2008), and negatively correlate with climate change skepticism (Whitmarsh, 2011).

Social norms, personal norms, and identity. Social norms are general rules of social conduct that guide behaviour (Schultz & Kaiser, 2012; Schwartz, 2012). Different types of social norms simultaneously exert social pressure on an individual (see Park & Smith, 2007). Descriptive norms are beliefs about what is common behaviour in a group (e.g., "most of my friends drive to work"; Gifford, 2014; Schultz & Kaiser, 2012; Steg, Bolderdijk, et al., 2014). Injunctive norms are beliefs about general social approval (e.g., "most people would approve of recycling"), and subjective norms are beliefs that important others would approve (e.g., "my friends would approve of me recycling").

Self-identity is defined as "the label used to describe oneself" (Whitmarsh & O'Neill, 2010). Individuals have an environmental identity when nature is included in their self-concept or when they label themselves as pro-environmental (Clayton, 2012; Gifford, 2014; Steg, Bolderdijk, et al., 2014). Personal norms are social norms that have become internalized and are now part of an individual’s self-concept or identity (Bamberg & Moeser, 2007; Gifford & Sussman, 2012). They represent an individual’s felt moral obligations to engage in PEB (Ajzen, 1991; Bamberg & Moeser, 2007; Nordlund & Garvill, 2003). Perceived social norms can influence attitudes and behaviour directly or indirectly through these personal or moral norms.

A meta-analysis demonstrates that social norm interventions can increase energy-conservation, water conservation, recycling, composting, and towel re-use in hotel rooms (Abrahamse & Steg, 2013). However, additional factors moderate the role of social norms on behaviour. Social norms have a larger effect on PEB intentions when the injunctive and descriptive norms align (Abrahamse & Steg, 2013; Smith et al., 2012). For individuals that currently engage in above-average levels of PEB, descriptive norm interventions may have adverse effects (Abrahamse & Steg, 2013; Aitken, Mcmahon, Wearing, & Finlayson, 1994; Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Research suggests that identification with the group moderates the effect of social norm on behaviour (Nigbur, Lyons, & Uzzell, 2010; Terry, Hogg, & White, 1999), and that those who value conformity are more susceptible to social pressure than others (Schwartz, 2012; Steg, Bolderdijk, et al., 2014).

In addition, characteristics of the behaviour itself might influence the effect of social norms. Some behaviours, referred to as “status behaviour” (e.g., Tesla vehicles), may be adopted to gain social status, but individuals engaging in them are not always environmentally oriented (Welsch & Kühling, 2009). Similarly, some behaviour changes might threaten an individual’s identity and thus be more resistant to change. For example, an individual who identifies as masculine might feel threatened by the suggestion of reducing meat consumption because it is tied to perceptions of masculinity in Western societies (Jaspal, Nerlich, & Cinnirella, 2014).

Attitudes and concern. Whereas worldviews are general beliefs about how the world works, more specific beliefs form the cognitive components of attitudes and concern. Attitudes are a psychological tendency that express an individual's evaluation of an object, people, group, or idea (Hitlin & Pinkston, 2013; Visser & Cooper, 2007). Attitudes are believed to be less stable than, and influenced by, values and worldviews, and more proximal to behaviour (e.g., Stern et al., 1999).

However, distinguishing between attitudes and concern is challenging because they overlap conceptually and are sometimes used synonymously. For example, environmental attitude is defined as concern for environmental quality, as the evaluation of or caring about environmental issues, or simply as environmental concern (Dunlap & Jones, 2002; Gifford & Sussman, 2012; Schultz & Kaiser, 2012). Environmental concern is defined as "the degree to which people are aware of problems regarding the environment and support efforts to solve them" and is comprised of attitudinal components (Dunlap & Michelson, 2002).

Although empirically attitudes are sometimes equated to only their affective component (Dunlap & Michelson, 2002), the prevailing view of attitudes includes three components: cognitive (i.e., beliefs and knowledge), affective (i.e., emotion and feeling), and conative (i.e., actions or intent; Dunlap & Michelson, 2002; Gifford & Sussman, 2012; Hitlin & Pinkston, 2013; Maio et al., 2003). For example, an individual may have a negative attitude toward climate change because they believe it will cause harm to themselves personally (cognitive), they feel worried (affective), and they intend to act by driving less (conative).

However, an individual can simultaneously experience a combination of positive and negative evaluations across these three attitudinal components (e.g., I feel worried, but I don't do anything). In such cases, they experience cognitive-dissonance (i.e., psychological discomfort caused by mismatched cognitions, for example attitude and behaviour; Festinger, 1957), and may be motivated to either change their attitude or change their behaviour to achieve internal consistency (Festinger, 1957; Gifford & Sussman, 2012).

Environmental attitudes and concern often correlate with PEB (Bamberg & Moeser, 2007; Gifford & Sussman, 2012), including transportation choices (Abrahamse, Steg, Gifford, & Vlek, 2009; Heath & Gifford, 2002; Tikir & Lehmann, 2011; Verplanken & Orbell, 2003), intentions to recycle (Nigbur et al., 2010; Tonglet, Phillips, & Bates, 2004), and energy-conservation (Scott, Jones, & Webb, 2014). Environmental concern predicts willingness to sacrifice to protect the environment (Oreg & Katz-Gerro, 2006). In general, attitudes are more strongly linked to behaviour when they are "strong, based on personal experience, and salient" (Clayton & Myers, 2015).

Attitude-behaviour gap

Compared to values, worldviews, and social norms, attitude is more proximal to behaviour. In situations where an individual's attitudes are favorable to PEB, why do they sometimes not behave in a coherent way (i.e., attitude-behaviour gap; Kollmuss & Agyeman, 2002; Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007)? This is likely due to psychological barriers which limit the uptake of climate-positive behaviour (Blake, 1999; Gifford, 2011; Lorenzoni et al., 2007; Patchen, 2010; Stoll-Kleemann, O'Riordan, & Jaeger, 2001; Takacs-Santa, 2007). Barriers that are particularly relevant to the behaviours of focus in this dissertation are summarized below. For a more comprehensive list of psychological barriers, see the Dragons of inaction (Gifford, 2011).

Dual process systems. Social psychologists generally agree that there is a distinction between automatic or emotion-based processing (i.e., system 1) and conscious or cognition-based processing (i.e., system 2; Hitlin & Pinkston, 2013), as reflected in many dual process theories (e.g., Chaiken, 1987; Kahneman, 2003; Petty & Cacioppo, 1986). Whereas attitudes formed through systematic processing are more durable and more closely linked to behaviour, automatic attitudes are more flexible, situation-specific, and can be more easily changed (Hitlin & Pinkston, 2013; Visser & Cooper, 2007). One possible explanation for the attitude-behaviour gap is that many actions are intuitive (i.e., based on system 1), and that habitual behaviours are guided more by situational cues than by attitudes (Aarts, Verplanken, & van Knippenberg, 1998; Kahneman, 2003). In a recent study, attitudes were the strongest predictor of intentions to reduce meat eating, but habit strength was the strongest predictor of self-reported meat consumption behaviour (Rees et al., 2018).

Perceived efficacy. The perceived (or actual) ability to perform a behaviour is another possible explanation for the attitude-behaviour gap. For example, higher levels of perceived efficacy lead to more danger control responses (e.g., intention to take action) and less fear-control responses (e.g., denying the threat of climate change; Xue et al., 2016). Similarly, stronger perceptions of collective efficacy (i.e., group's capability to achieve the desired goal) lead to more motivation to participate in climate action (Bamberg, Rees, & Schulte, 2018; Roser-Renouf & Maibach, 2018). In addition, societal infrastructure can either support or impede PEB. Sometimes, access to facilities (e.g., composting), services (e.g., public transportation), or products (e.g., meat-replacement products) is lacking, and thus acts as a direct barrier to PEB. Contextual factors can influence PEB directly, or indirectly by decreasing motivation (Steg & Vlek, 2009).

Conflicting goals. According to goal-framing theory, three different goal frames influence PEB: hedonic, gain, and normative goals (Lindenberg & Steg, 2007, 2013; Steg, Bolderdijk, et al., 2014). Hedonic goals are short-term goals that focus on increasing immediate pleasure, often while minimising effort. Gain goals are more long-term goals that focus on increasing an individual’s amount of resources (e.g., money or status). Normative goals focus on the proper course of action, influenced by injunctive (i.e., what an individual should do) and descriptive (i.e., what others do) norms. The theory suggests that the strength of each goal varies between situations and individuals. For example, taste preferences, which are a hedonic goal, are an important barrier to reducing meat consumption for many individuals (e.g., Charlebois et al., 2019; de Boer, Hoogland, & Boersema, 2007; Mullee et al., 2017).

Single-action bias. The single-action bias, or tokenism, is the tendency for individuals to do only one action when responding to a threat (e.g., recycling in response to environmental problems; Gifford, 2011; Weber, 2010). This single action is likely enough to resolve the individual’s experience of cognitive dissonance. Recent research has demonstrated that the tokenism barrier applies to climate-positive food choices (e.g., "My environmental actions already make enough of a difference," Gifford & Chen, 2017).

Changing Pro-environmental Behaviour

Behavioural models attempt to explain the underlying factors or predictors influencing a behaviour (Darnton, 2008a; van der Linden, 2013). The Theory of planned behaviour (Ajzen, 1991) and the Value-belief-norm model (Stern et al., 1999) are examples of behavioural models that have been widely applied to explain variance in PEB. For a comprehensive review of behavioural models, refer to Gifford (2014), Steg & Vlek (2009), and Sussman, Gifford, & Abrahamse (2016).

Theories of change attempt to explain the process of change (e.g. Mastery Modelling and Social Cognitive Theory; Bandura, 1977, 1986). These theories generally agree that behaviour change is a multistage process, that the process differs between changing behaviour and maintaining behaviour, and that contextual factors sometimes constrain behaviour (Glanz & Bishop, 2010). Theories of change are useful to identify relevant intervention techniques and have led to the development of applied behaviour-change frameworks (e.g., Behaviour Change Wheel; Michie, van Stralen, & West, 2011) for precisely that purpose.

In sum, behavioural models offer a menu of factors, whereas theories of change help create the recipe for changing behaviour (Darnton, 2008a; Rubinstein, 2018; van der Linden, 2013). As such, both behavioural models and theories of change have an important role to play in the design of rigorous and evidence-based interventions.

Developing interventions

Experts generally agree that intervention designers should start by identifying a clear behavioural objective, their target audience, and the relevant factors influencing the behaviour for that audience, while recognizing that these may vary across situations (e.g., Rubinstein, 2018; Steg & Vlek, 2009; Stern, Gardner, Vandenbergh, & Dietz, 2010). Once the key factors have been identified, intervention designers should determine which behaviour-change techniques are most suited to address these factors, keeping in mind their time and resource constraints. Finally, intervention designers should develop, test, and carefully evaluate interventions. Darnton (2008a) proposed Nine Principles for developing interventions, in which he emphasizes the use of behavioural models in the early stages. He recommends a circular approach where findings from each step are fed back into the design strategy.

Diagnostic tools. Behaviour-change frameworks serve as diagnostic tools to identify the key influencing factors for each behaviour and audience. In the dissertation studies, I prioritized frameworks that incorporate behavioural models in their diagnostic (e.g., COM-B model in the

Behaviour Change Wheel framework; Michie et al., 2011), and those that have been developed for use specifically with PEB (e.g., stage model of self-regulated change; Bamberg, 2013b).

Behaviour-change techniques. Because success varies across behaviour, audience, and context, interventions designers should consult behaviour-change frameworks to select the appropriate techniques (Rubinstein, 2018). Each behaviour-change framework suggests techniques that effectively address the outcomes of their diagnostic. For example, if the COM-B model finds that the audience lacks the physical capability to prepare a vegetarian meal, the Behaviour Change Wheel framework (Michie et al., 2011) endorses the use of training and enablement to increase physical capability.

Modeling change

Historically, change over time has been studied using pre and post-test designs and analyzed using ANOVA or multiple regression (Duncan & Duncan, 2004). However, these statistical approaches do not allow for missing data (e.g., attrition), which is common in longitudinal studies. They also only look at average changes (i.e., fixed effects), and treat individual variability around the mean as error variance. But individual variability can provide valuable information. For example, statistical models that include individual variability as random effects can compare the average effects of two different intervention conditions, and they can also provide information about the variables that are associated with individuals having higher or lower starting points and rates of change (Curran, Obeidat, & Losardo, 2010).

Using repeated measures data, growth curve modelling techniques allow to test between-person differences in within-person change over time, or inter-individual differences in intra-individual change over time (Curran et al., 2010; Duncan & Duncan, 2004; Hine, Corral-Verdugo, Bhullar, & Frias-Armenta, 2016). Growth trajectories (i.e., intercept and slope) are estimated for every individual based on their repeated observations, and these individual growth patterns are then used to predict average growth for the entire sample.

Growth curves can be modeled using structural equation modeling or multilevel models (Curran et al., 2010; Hox & Stoel, 2005). The choice of framework depends on the data structure and research questions (Hox & Stoel, 2005). Structural equation modeling allows to extend the path model, for example, by combining multiple growth curve models (e.g., modeling climate change risk perception and policy support, Chapter 2). With smaller sample sizes and larger number of repeated-measures, multilevel models are preferable (e.g., modeling up to 28 days of food diary data per participant, Chapter 4).

Pro-environmental interventions

Many researchers have focused their efforts on evaluating the effectiveness of interventions to promote PEB (Byerli et al., 2018; Nisa, Bélanger, Schumpe, & Faller, 2019; Osbaldiston & Schott, 2012). Their reviews generally conclude that while the success of interventions strategies likely varies between types of PEB (e.g., transportation choices or water use; Byerli et al., 2018; Osbaldiston & Schott, 2012), choice architecture (i.e., nudging) and social comparison messages have the largest average effect sizes. The authors recommend that future research focus on high-impact PEB, on using experimental approaches to evaluate their effectiveness, and include follow-up measures to evaluate any lasting effects.

Although these recommendations provide an excellent starting point for designing interventions, they overlook one key aspect: the use of behaviour-change frameworks to guide their design. Specifically, researchers should move away from one-size-fits-all approaches and instead endeavor to gain a better understanding of how behavioural influences vary between individuals, and how this can inform the design of tailored interventions.

Chapter 2: Climate Change Beliefs Shape the Interpretation of Forest Fires

with Robert Gifford and Jonathan Rush

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Abstract

Using a naturalistic quasi-experimental design and growth curve modeling techniques, a recently proposed climate change risk perception model was replicated and extended to investigate changes in climate change risk perception and climate policy support in relation to exposure to forest fires. At the start of the study, above-average indirect exposure to forest fires (e.g., through media and conversations) was associated with stronger climate change risk perception, but direct exposure to forest fires (e.g., seeing smoke) and other types of extreme weather events was not. Over time, changes in climate change risk perception were positively associated with changes in climate policy support. However, individual differences in growth trajectories occurred. For example, in this naturalistic setting without any intervention, the climate change risk perceptions of individuals with weaker perceptions of scientific agreement on climate change were less likely to be positively influenced by fire exposure than those of individuals with stronger perceptions of scientific agreement. These findings highlight the importance of tailoring climate change communication.

Introduction

Climate scientists are virtually certain that the Earth's climate has warmed by 1 degree Celsius since pre-industrial levels (Masson-Delmotte et al., 2018), and that this climatic change is driven by an increase in greenhouse gas emissions caused by economic and population growth (Pachauri & Meyer, 2014). Globally, climate change presents risks of extreme weather events, flooding, and droughts, to name a few (Masson-Delmotte et al., 2018). Although a single event is not easily attributable to climate change, scientists estimate that 75% of hot temperature extremes and 18% of precipitation extremes around the world are a product of it (Fischer & Knutti, 2015).

North American forests are vulnerable to increases in droughts, high temperatures, insect outbreaks, and wildfire activity (Romero-Lankao et al., 2014). Wildfires occur naturally but, since the mid-1980s, are more frequent, last longer, and wildfire seasons are longer (Romero-Lankao et al., 2014). These increases have been caused in part by historical fire suppression practices and changes in land-use, but climate change also plays a role (e.g., droughts, hot temperatures, lightning increase; Abatzoglou & Williams, 2016; Romps, Seeley, Vollaro, & Molinari, 2014).

In the western United States, climate change has doubled the area burned by forest fires during the last three decades, compared to what would be expected based on natural climate variability alone, and nine additional days of high-fire potential per year have occurred in the last 15 years (Abatzoglou & Williams, 2016). In Canada, the forested areas burned are predicted to double by 2100, and each fire season is predicted to last 20 days longer on average (Flannigan et al., 2013; Gillett, Weaver, Zwiers, & Flannigan, 2004).

Climate change risk perception

Experts tend to base their risk perception on statistical analyses and models (e.g., number of fatalities), while members of the public often base their risk perception on affect and personal experience, which leads them to undervalue some risks and overvalue others (Slovic, 1987; Swim et al., 2009). An affect heuristic, or a reliance on feelings in guiding judgment, can lead to dreaded events being perceived as more risky (e.g., a plane crash; Fischhoff, Slovic, Lichtenstein, Read, & Combs, 1978; Slovic, Finucane, Peters, & MacGregor, 2007). An availability heuristic, or a tendency to judge risks based on what can be recalled from memory, can lead to an overestimation of notable hazards and an underestimation of hazards that have never been personally experienced (Kahneman & Tversky, 1979; Slovic, Fischhoff, & Lichtensein, 1982).

Climate change is a slow and distant process that is difficult to detect through personal experience (Lorenzoni, Pidgeon, & O'Connor, 2005; McDonald, Chai, & Newell, 2015; Swim et al., 2012). Whether individuals associate these with climate change or not, some of its consequences can be personally experienced from natural disasters such as flooding, droughts, or forest fires, which correlate with stronger climate change concern (Akerlof, Maibach, Fitzgerald, Cedeno, & Neuman, 2013; Hornsey, Harris, Bain, & Fielding, 2016; Konisky, Hughes, & Kaylor, 2015; Martin, Martin, & Kent, 2009; Mazur, 2006; Reser, Bradley, Ellul, & Callaghan, 2012; Safi, Smith, & Liu, 2012; Spence, Poortinga, Butler, & Pidgeon, 2011; Swim et al., 2012; Weinstein, 1989). Experiencing natural disasters also correlates with disaster preparedness, although the evidence is mixed and possibly short-lived (Lindell, 2013; Martin et al., 2009; McGee, McFarlane, & Varghese, 2009).

Individuals might rely on scientific models to evaluate the risks associated with climate change (Swim et al., 2009), and those who perceive a larger scientific agreement on climate change tend to believe that climate change is occurring (Lewandowsky, Gignac, & Vaughan, 2013; Maibach, Myers, & Leiserowitz, 2014; McCright, Dunlap, & Xiao, 2013; van der Linden, Leiserowitz, Feinberg, & Maibach, 2015). Through processes of biased assimilation, individuals with hierarchical and individualistic cultural worldviews tend to perceive less climate change risk (i.e., cultural cognition theory; Akerlof et al., 2013; Kahan, Jenkins-Smith, & Braman, 2011; Lacroix & Gifford, 2018).

Recently, a climate change risk perception model (CCRPM) was proposed (van der Linden, 2015), that explained 68 % of the variance in climate change risk perception. The model includes cognitive (i.e., climate change knowledge), experiential (i.e., affect and experience with extreme weather), socio-cultural (i.e., values and social norms), and demographic predictors. Its experiential and socio-cultural predictors are most influential, but the author pointed to a need for further testing and validation of the model outside the United Kingdom.

Climate policy support

Personal experience with extreme weather also influences climate policy support (e.g., increased implicit preferences for green politicians), mediated by climate change beliefs and climate change risk perception (Rudman, McLean, & Bunzl, 2013). Climate change risk perception is closely linked to climate policy support, and is its main predictor when compared to demographic variables, political ideology, area of residence, and climate change knowledge (Dietz, Dan, & Shwom, 2007; Park & Vedlitz, 2013; Rhodes et al., 2014; Stern et al., 1999).

Furthermore, values have an indirect effect on policy support through worldviews (i.e., new ecological paradigm and trust in relevant institutions) and climate change risk perception

(Dietz et al., 2007). Climate change beliefs, such as perceived scientific agreement, belief that climate change is happening, and belief that people should do more, have a large effect on policy support (Ding, Maibach, Zhao, Roser-Renouf, & Leiserowitz, 2011, McCright et al., 2013).

The present study

Although prior studies suggest that experience with extreme weather events is related to increases in climate change risk perception, and others suggest that climate change risk perception correlates with climate policy support, these relations have yet to be tested experimentally. The present study is grounded in the climate change risk perception model (CCRPM; van der Linden, 2015), but it proposes and tests extensions to the model related to changes in climate change risk perception and climate policy support in relation to exposure to forest fires, using a quasi-experimental approach. Does exposure to seasonal forest fires influence climate change risk perception and climate policy support? Does the rate of change vary as a function of individual differences?

In this attempt to replicate the CCRPM, we hypothesized that socio-demographic variables, cognitive factors, experiential processes, and socio-cultural influences would significantly predict climate change risk perception (Hypothesis 1). We also predicted that recent direct and indirect exposure to forest fires, and the belief in scientific agreement on climate change, would explain significantly more variance when added to the CCRPM (Hypothesis 2).

Next, we predicted that exposure to forest fires and other weather extremes are associated with climate change risk perception (Hypothesis 3), that changes in climate change risk perception will predict changes in climate policy support (Hypothesis 4), and that changes in climate policy support will be associated with changes in climate change risk perception after adjusting for exposure to forest fires (Hypothesis 5).

We also hypothesized that individual differences would occur in within-person changes over time. That is, we predicted that trajectories of change for climate change risk perception and climate policy support would vary across individuals (Hypothesis 6). Finally, we predicted that between-person differences in climate change beliefs (i.e., the perception of scientific agreement on climate change and the belief that climate change impacts forest fires) would account for differences in the growth trajectories of climate change risk and policy support (Hypothesis 7).

Method

Study design

A repeated-measures naturalistic quasi-experimental design was chosen because randomly assigning participants to different levels of fire exposure was not possible, nor could the precise timing and location of forest fires be predicted. Rather than artificially manipulating fire exposure, we measured changes in direct and indirect fire exposure over the course of the study.

Repeated observations using online surveys at three points over a 7.5-month period were employed to monitor changes in fire exposure, climate change risk perception, and climate policy support. The first survey was administered at the beginning of the forest fire season, at which point the independent variables were also measured. The second survey was administered at peak forest fire activity, which was estimated by daily monitoring of the fire danger forecasts provided by Natural Resources Canada (see Appendix A). The third survey was administered after the fire season had concluded. Its purpose was to measure whether any observed changes in the outcome variables persisted over time.

Measures

Climate change knowledge, values, descriptive and prescriptive norms, and affect were measured during the first phase of the study using items from the CCRPM (van der Linden, 2015). Some items were modified slightly; a forest fire item was added to the measure of climate change impact knowledge and one item was removed from the climate change response knowledge scale. The climate change knowledge scales had low reliability (i.e., from .51 to .67) and were therefore treated as an omnibus measure and scored based on the sum of correct answers. All other scales from the CCRPM were adequately reliable. Survey items, reliability, means, and standard deviations are included in Appendix A.

Three past-exposure-to-forest-fire items were created to measure personal experience with forest fires over the last 5 years (i.e., sensory exposure, evacuation, and property damage). Past exposure to other types of extreme weather was measured using a slightly modified item from the CCRPM (i.e., by changing it from flood to forest fire; van der Linden, 2015).

Perceived scientific agreement on climate change (van der Linden, Leiserowitz, Feinberg, & Maibach, 2015) and the belief that climate change plays a role in the frequency and intensity of forest fires were each measured with a single item. Sociodemographic variables (e.g., age, gender, education, income, political ideology) were also measured.

Repeated measures. Exposure to forest fires was measured during all three phases of the study and included in growth curve models as time-varying covariates. Recent exposure to forest fires and to extreme weather were measured using the same items as above, but by instructing participants to consider their experience in the year of the study only (as opposed to exposure over the last 5 years). Indirect exposure to forest fires was measured using four items (i.e., exposure through media, social media, friends or family, and colleagues).

Dependent variables were also measured during all three phases of the study. Climate change risk perception was measured using eight items (i.e., from the CCRPM; van der Linden, 2015). A policy-support scale was developed using 14 items, gathered from multiple sources (e.g., more stringent auto emissions standards for automobiles; Dietz et al., 2007; McCright et al, 2013; Rhodes et al., 2014).

Participants

Participants were recruited using a panel recruitment agency (i.e., Turk Prime). For quality control, attention-checking items were included in different sections of the survey (e.g., "Please confirm that you are paying attention by selecting strongly agree"). Fifty-eight participants were removed because they incorrectly answered at least one of the attention-checking items (i.e., 12.5% of the initial sample).

The sample consisted of 406 residents of Canada. Their mean age was 31.4 years (*SD* = 8.5 years), and the sample included 240 males (59.1%), 164 females (40.4 %), and 2 others (0.5%). A few participants (n = 4 or 1%) had not completed high school, 91 participants had a high school diploma or equivalent (22.4%), 97 completed college (23.9 %), 153 had a bachelor's degree (37.7%), and the rest had a post-graduate or professional degree (*n* = 61 or 15.1 %). Participants were slightly more politically liberal than conservative (*M* = 2.62 on 5-point scale). This study sought to collect as large a sample as was feasible within the study timeframe. Based on power considerations outlined by Rast and Hofer (2014), it was determined that this sample size was sufficiently powered to reliably detect covariances among rates of change.

This repeated-measures study included three phases (see Figure 1). Phase 1 participants were invited to participate again in subsequent phases. The participants were paid $1 for completing each survey and returning participants entered a $50 draw to help increase retention rates. At phase 1, the sample consisted of 406 participants, of which 206 (51%) did not return. This attrition rate is not uncommon in longitudinal studies (e.g., Fischer, Dornelas, & Goethe, 2001; Goodman & Blum, 1996; Hox, 2002). However, attrition bias can occur, and therefore, mechanisms of missingness were carefully considered next.

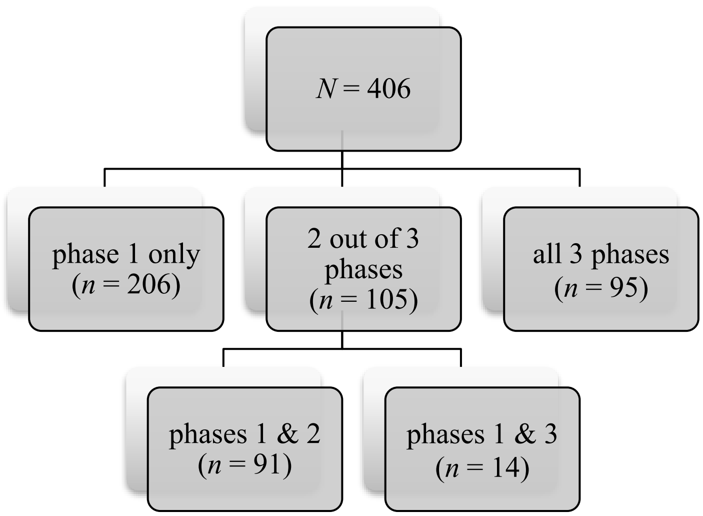

Figure 1. Sample size and attrition

Mechanisms of missingness. Growth curve models can handle partially missing data (e.g., some individuals having fewer observations) when the data are missing at random or completely at random (Curran et al., 2010). To examine the mechanisms of missingness, a dummy variable was created for participants returning (coded 1) and not returning (coded 0), and it was entered as the dependent variable in logistic regression analyses. Participants who did not return were likely to be younger (*MD* = -3.08, *t* = -.3.69, *p* <.001), have weaker prescriptive norms (*MD* = -.27, *t* = -.26, *p* =.01), and weaker knowledge about climate change responses (*MD* = -.49, *t* = -3.02, *p* <.01). The outcome variables (i.e., climate change risk perception and policy support) did not significantly differ between participants returning and not returning. Thus, the data are assumed to be missing at random; missingness was related to other observed variables (e.g., age) but not to the outcome variables (Nicholson, Deboeck, & Howard, 2015).

Scales. The climate change knowledge scales had low reliability (i.e., from .51 to .67) and were therefore treated as an omnibus measure and scored based on the sum of correct answers. All other scales from the CCRPM were adequately reliable. Reliability, means, and standard deviations are included in Appendix A.

Analyses

Multiple linear regression and correlation analyses were used to test the first two hypotheses. Growth curve model analyses within a structural equation modeling framework were used to examine the longitudinal relations between exposure to forest fires, climate change risk perception, and climate policy support (Hypotheses 3 to 7).

Fitting univariate growth curve models. Time was coded according to the sampling period for the three phases; 0 (months) for phase 1, 2.5 (months) for phase 2, and 7.5 (months) for phase 3. However, a wildfire occurred during the first phase of data collection. Named Canada's top news story of the year (Krugel, 2016), the wildfire in Fort McMurray, Alberta, received national coverage and resulted in a sudden increase in self-reported indirect exposure to forest fire nine days into the initial data collection period. To account for this sudden increase, a before-and-after Fort McMurray dummy variable was created and coded for each participant. The sample was almost evenly split between before (44%) and after (56%) participants. No such increases were noticeable during phases two and three.

A growth curve model for three repeated-measures of climate change risk perception was fitted using maximum likelihood estimation and the built-in growth curve model plugin in AMOS. The repeated measures for climate change risk perception were regressed onto the intercept and slope latent factors. The regression weights for the intercepts were fixed at 1.0, and the regression weights for the slopes were fixed at 0, 2.5, and 7.5 to account for time (in months) from the beginning until the end of the study period. The error variance (i.e., between-person differences) for the intercept and slope latent factors were co-varied. The error variance for the three repeated measures were constrained to be equal. The newly created control variable before-and-after Fort McMurray was included as a covariate directly predicting the intercept and slope latent factors (Figure 2).

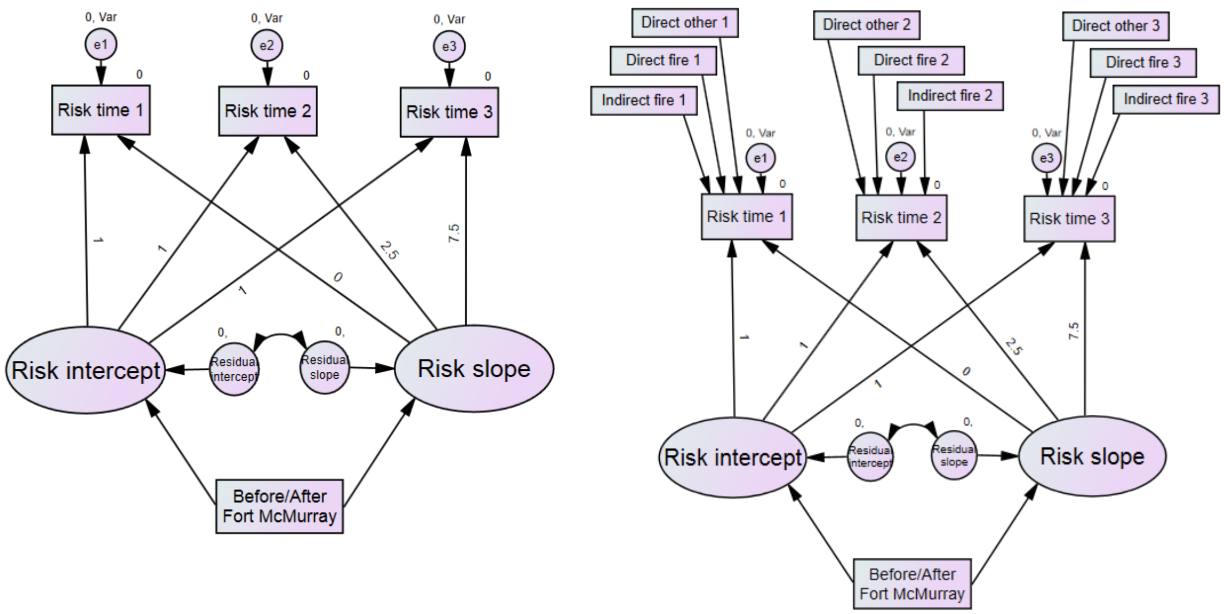

Figure 2. Climate change risk perception growth curve models without (left) and with (right) time-varying covariates.

Because forest fires and other extreme weather events occur irregularly, a linear growth trajectory was not estimated. Instead, the repeated measures of direct exposure to forest fires, direct exposure to other extreme weather events, and indirect exposure to forest fires at each phase were treated as a time-varying covariates (TVC) and directly predicted the repeated measures of climate change risk perception for that same phase.

Fitting multivariate growth curve models. Multivariate growth curve models simultaneously estimate the growth trajectories for two or more constructs (i.e., they combine univariate models), in this case, climate change risk perception and climate policy support

(Figure 3). To build this model, a second univariate model was fitted using the three repeated measures of climate policy support. The model is the same as for climate change risk perception, except for the exclusion of the before-and-after Fort McMurray predictor variable. The latent factor residuals (i.e., between-person differences) for climate change risk perception and climate policy support were co-varied in a multivariate model.

The repeated measures of exposure to forest fires and other extreme weather were later added as time-varying covariates to investigate the relations between forest fires, climate change risk perception, and climate policy support. Climate change beliefs (i.e., perceived relation between climate change and forest fires, and the perceived scientific agreement on climate change) were added as time-invariant covariates to examine between-person differences.

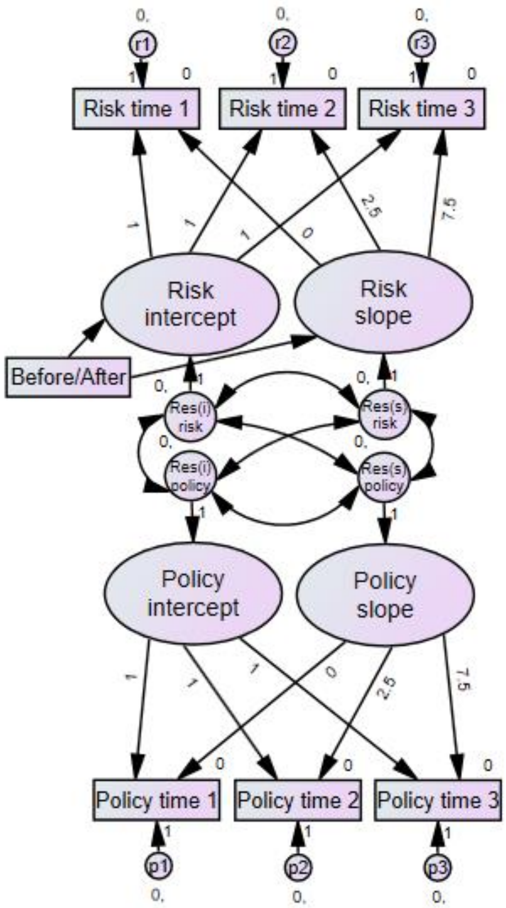

Figure 3. Multivariate growth curve model for climate change risk perception and climate policy support.

Note. In a subsequent model, not shown, climate change beliefs are included as time-invariant covariates.

Evaluating model fit

Models generally provide an adequate fit to the data when they meet the following cut-off values: a χ^2-to-degrees-of-freedom ratio smaller than 3, a comparative fit index (CFI) larger than .9, a root mean square error of approximation (RMSEA) smaller than .08 for adequate fit, and smaller than .05 for a very good fit (Bollen & Curran, 2006; Hoyle, 2012; Kline, 2012; Stevens, 2002).

Results

The climate change risk perception model

To test Hypothesis 1, predictors from the CCRPM (van der Linden, 2015) were entered simultaneously in multiple regression analyses. Predictors included socio-demographic variables, cognitive factors (i.e., climate change knowledge), experiential processes (i.e., affect and past exposure) and socio-cultural influences (i.e., values and social norms). The dependent variable was the baseline measure of climate change risk perception. This model explained 53.7% of the variance in climate change risk perception (Table 1, Model 1). Thus, Hypothesis 1 was supported.

Table 1

Climate change risk perception model (N = 406)

Independent variables	Model 1	Model 2	Model 3
Age	-.16 (<.001)	-.15 (<.001)	-.14 (<.001)
Gender	.04 (.22)	.05 (.21)	.05 (.22)
Education	-.06 (.10)	-.06 (.09)	-.07 (.06)
Political party	.11 (<.01)	.11 (<.01)	.09 (.01)
Cause knowledge	-.09 (.05)	-.07 (.11)	-.09 (.06)
Impact knowledge	.13 (<.01)	.11 (<.01)	.10 (.01)
Response knowledge	.14 (.001)	.14 (.001)	.11 (.01)
Descriptive norms	.07 (.12)	.07 (.14)	.06 (.16)
Prescriptive norms	.18 (<.001)	.17 (<.001)	.18 (<.001)
Biospheric values	.16 (.001)	.14 (<.01)	.16 (<.001)
Altruistic values	.02 (.60)	.02 (.58)	.02 (.70)

Egoistic values	.02 (.63)	.02 (.52)	.02 (.58)
Affect	.37 (<.001)	.36 (<.001)	.33 (<.001)
Past exposure (other)	.002 (.96)	-.01 (.85)	-.01 (.88)
Past exposure (fire)	.05 (.13)	.04 (.32)	.03 (.47)
Recent direct exposure (other)	-	.08 (.03)	.08 (.02)
Recent direct exposure (fire)	-	.01 (.86)	-.002 (.96)
Indirect exposure (fire)	-	.09 (.02)	.08 (.02)
Perceived scientific agreement	-	-	.11 (<.01)
adjusted R^2	.54	.55	.55
Δ adj.	-	.01	.01
F_{change}	$33.26_{15,390}$ (<.001)	$4.04_{3,387}$ (<.01)	$7.10_{1,386}$ (<.01)

Note. The dependent variable is climate change risk perception. Entries are standardized coefficient betas, with p-values in parentheses. Degrees of freedom are indicated in subscript.

The above model included past personal experience with extreme weather and with forest fires [e.g., “How often have you personally experienced any type of extreme weather (other than forest fires)”]. Hypothesis 2 proposed that recent direct personal experience (i.e., during the year of the study) and indirect exposure to forest fires (e.g., through the media) also influence climate change risk perception. The model was extended to include three additional predictors in the second step of a stepwise regression, which significantly improved the model (Model 2; $F_{change} = 4.04_{3,387}$, $p < .01$). Recent exposure to extreme weather events (other than fire) and indirect exposure to forest fires significantly predicted climate change risk perception. The model was further significantly improved by adding belief in scientific agreement on climate change as a covariate (Model 3; $F_{change} = 7.10_{1,386}$, $p < .01$). Hypothesis 2 was supported.

Investigating relations between constructs over time

To test Hypothesis 3, that exposure to forest fires and other types of extreme weather correlates with climate change risk perception, a growth curve model for climate change risk perception was first fitted. The model had very good fit (Table 2). The model estimated a significant mean intercept ($\mu = 3.50$, $p < .001$) and slope ($\mu = .02$, $p = .03$) for climate change risk perception, meaning that the average person had an initial climate change risk perception of 3.50 (on a 5-point scale), and that climate change risk perception grew at a rate of 0.02 points per month.

Next, exposure to forest fires and other extreme weather were added to the model as time-varying covariates (TVC). This allowed to test whether each repeated measure of climate change risk perception was influenced by extreme weather at that time. TVCs were grand mean centered around time 1 levels. As shown in Table 3, controlling for the Fort McMurray fire, indirect fire exposure at time 1 significantly influenced climate change risk perception at that time ($\gamma = .13$, $p < .001$) over and above the underlying growth trajectory of climate change risk perception. That is, individuals who reported greater indirect exposure to forest fires at time 1 tended to have stronger climate change risk perceptions at that time, compared with what was expected from their individual growth trajectories alone. Indirect fire exposure at time 2 and time 3 was not significant, nor were the direct measures of personal experience with forest fires and extreme weather events. Hypothesis 3 was partially supported; indirect exposure to forest fires significantly predicted climate change risk perception. However, this model’s fit was poor (Table 2).

Table 2

Model fit indices

Models	Chi-square	Chi-square/df	CFI	RMSEA [95% CI]
Climate change risk perception	4.88_{4} **(*p* = .30)**	**1.22**	**1.0**	**.02 [.00, .08]**
Climate change risk perception with TVCs	379.39_{67} (*p* < .001)	5.66	.55	.11 [.10, .12]
Climate policy support	2.29_{3} **(*p* = .51)**	**.76**	**1.0**	**.00 [.00, .08]**
Climate change risk and climate policy support	13.25_{11} **(*p* = .28)**	**1.21**	**1.0**	**.02 [.00, .06]**
Climate change risk, climate policy support, and TICs	12.395_{11} **(*p* = .36)**	**1.13**	**1.0**	**.02 [.00, .06[**

Note. Values in bold indicate adequate fit (i.e., $\chi^2/df < 3$, *CFI* > .90, *RMSEA* < .08). TVC = time-varying covariates (i.e., indirect fire exposure, direct fire exposure, exposure to other extreme weather). TIC = time-invariant covariates are climate change beliefs (i.e., perceived relation between climate change and forest fires, perceived scientific agreement on climate change). Degrees of freedom are indicated in subscript. Climate change risk, climate policy support, and TVC model failed to converge on an admissible solution.

Do changes in climate change risk perception coincide with changes in climate policy support? To test Hypothesis 4, a growth curve model for climate policy support was first fitted, and it had a very good fit (Table 2). The mean intercept was significant ($\mu = 3.38$, p <.001, on a 4-point scale). The mean slope was not significant ($\mu = -.00$, $p = .59$). Next, a multivariate growth curve model was fitted, combining the growth curve models for climate change risk perception and climate policy support (Figure 3). This model also had very good fit (Table 2).

As specified in Table 3, covariance between the intercept residuals was significant (φ = .28, *r* = .69, *p* < .001), indicating that individuals with above-mean initial values of climate change risk perception tended to also have above-mean initial values for climate policy support. Covariance between the slope residuals was also significant (φ = .001, *r* = .45, *p* < .001), indicating that individuals whose climate change risk perception grew at a faster-than-average rate tended to also grow at a faster-than-average rate for climate policy support. These effect sizes were large, based on Cohen (1992), thus providing strong support for Hypothesis 4.

Table 3

Multivariate model estimates

	Climate change risk and climate policy support	Climate change risk, climate policy support, and beliefs[a]
Correlation between residuals		
Intercept risk <--> Intercept policy	.69 (< .001)	.69 (< .001)
Slope risk <--> Slope policy	.45 (< .001)	.45 (< .001)
Intercept risk <--> scientific agreement	-	.43 (< .001)
Intercept risk <--> link fires and climate change	-	.52 (< .001)
Intercept policy <--> scientific agreement	-	.40 (< .001)
Intercept policy <--> link fires and climate change	-	.45 (< .001)
Slope risk <--> scientific agreement	-	.23 (.02)
Slope risk <--> link fires and climate change	-	.09 (.21)
Slope policy <--> scientific agreement	-	.07 (.51)
Slope policy <--> link fires and climate change	-	.13 (.21)
Link fires and climate <--> scientific agreement	-	.34 (< .001)
Variances		
Risk intercept	.76 (< .001)	.75 (< .001)
Risk slope	.004 (.03)	.004 (.03)

Policy intercept	.21 (< .001)	.22 (< .001)
Policy slope	.001 (.04)	.001 (.04)

Note. Values are unstandardized estimates with *p*-value in parentheses. [a]Beliefs include the perceived relation between climate change and forest fires, and perceived scientific agreement.

Next, to examine Hypothesis 5, indirect exposure to forest fires was added to the multivariate model as a time-varying covariate. This model failed to converge on an admissible solution. Therefore, support for Hypothesis 5 could not be established.

Between-person differences

The last two hypotheses predicted important differences between individuals in their initial levels and rates of change over time. Between-individual differences were evaluated from variance estimates of the intercept and slopes in the multivariate growth curve model (i.e., climate change risk and climate policy support; Curran et al., 2010). Hypothesis 6 was supported: significant between-person differences occurred in the initial levels and rates of change for climate change risk perception and climate policy support (see variance estimates in Table 3).

To test Hypothesis 7, that between-person differences in climate change beliefs explain changes in climate change risk and policy support over time, the perceived relation between climate change and forest fires and the perceived scientific agreement on climate change variables were included as a time-invariant covariates (TIC). Their residuals were co-varied with the intercept and slope residuals. This model had very good fit (Table 2).

The model revealed that individuals with above-mean perceptions of scientific agreement on climate change also tended to have above-mean initial levels of climate change risk perceptions (r = .43, p < .001) and climate policy support (r = .40, p < . 001), and that individuals with above-mean perceived relation between climate change and forest fires also tended to have above-mean initial levels of climate change risk perceptions ($r = .52$, $p < .001$) and climate policy support ($r = .45$, $p < .001$). Furthermore, climate change risk perception for individuals with above-mean perceptions of scientific agreement tended to increase at a faster rate than for individuals with weaker perceptions of scientific agreement ($r = .23$, $p = .02$). The differences in climate change risk perceptions between individuals with above- and below-mean perceived scientific agreement on climate change are illustrated in Figure 4. Therefore, Hypothesis 7 was supported; climate change beliefs significantly explained the growth trajectories for climate change risk perception and climate policy support.

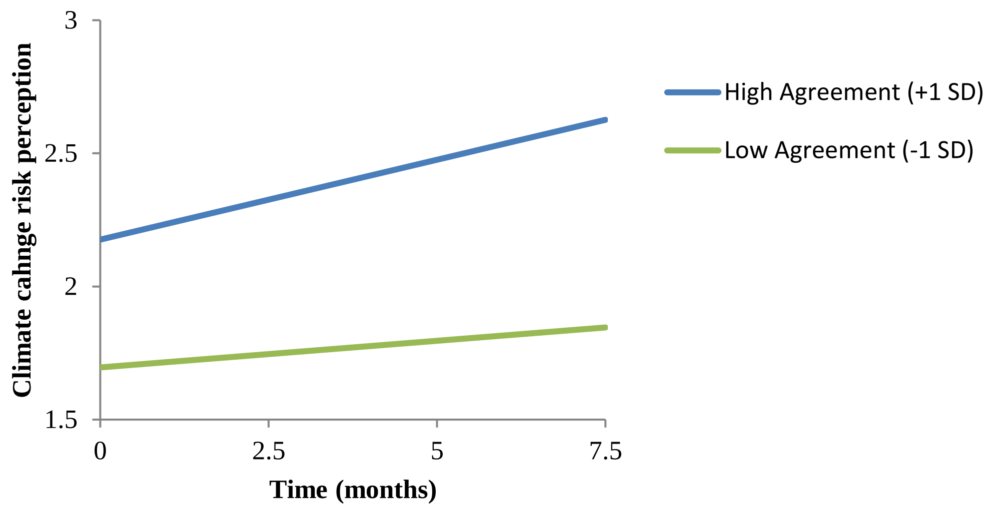

Figure 4. Climate change risk perception for individuals with above-mean and below-mean perceptions of scientific agreement on climate change.

Note. Climate change risk perception was measured on a 5-point scale.

Discussion

Our first goal was to replicate a recently proposed climate change risk perception model (CCRPM; van der Linden, 2015). As predicted, the CCRPM did explain a substantial proportion of variance in climate change risk perception in this study. Adding recent direct and indirect fire exposure to the model, indirect exposure to forest fires was significant, although past and direct personal experience with forest fires was not. The model was further improved by adding a measure of self-reported estimate of scientific agreement on climate change, which significantly predicted climate change risk perception.

Second, we proposed the extensions to the model: changes in climate policy support are associated with changes in climate change risk perception, which in turn are predicted by exposure to forest fires and other types of extreme weather. All our hypotheses were supported, except for one which could not be supported because the model failed to converge on an admissible solution. In sum, exposure to forest fires has a modest indirect effect on climate change risk perception, climate change risk perception and climate policy support tend to travel in the same direction over time, and the perception of scientific agreement on climate change influences the magnitude of shifts in climate change risk perception.

Theoretical and practical implications

The CCRPM was originally developed on a British sample and the present study demonstrated additional support for it using a Canadian sample. Affect, values, and social norms are again shown to be important predictors of climate change risk perception. Although its elements produced a large effect size, the CCRPM explained less variance in climate change risk perception in this study than in van der Linden's (2015) original study (our adj. R^2 = .54 vs. his adj. R^2 =.68). Slight differences in measurement might partially explain these differences. First, we separated the effects of indirect and direct exposure to fires. Our results suggest that indirect exposure to forest fires predict climate change risk perception, possibly even more strongly than direct exposure. Second, whereas items from the climate change knowledge scales in the original study were averaged, the scales in this study were scored according to the number of correct answers.

Indirect exposure to forest fires had a small effect on the initial levels of climate change risk perception. However, greater indirect exposure to forest fires (at peak forest fire activity and after the fire season had ended) and greater direct experience with forest fires and other types of extreme weather events (at any time point) did not significantly correlate with climate change risk perceptions. On the other hand, individuals with an above-average perceived relation between climate change and forest fires and an above-average perception of scientific agreement reported stronger perceptions of climate change risk. Furthermore, climate change risk perception tended to increase during the forest fire season for individuals that perceived a strong scientific agreement.

The present results complement those of a recent work in which communities with strong climate change beliefs were more likely to report increased climate change concerns after having been impacted by forest fires (Zanocco et al., 2018). Together, these findings suggest that how individuals interpret extreme weather events has a larger effect on climate change risk perception than does personal exposure to these extreme weather events.

The existence of significant individual differences in the initial levels and rates of change of climate change risk perception and climate policy support indicate the need for interventions that are tailored to the motivations and barriers faced by different population segments (Maio et al., 2007; Mckenzie-Mohr, 2011; Reynolds, 2010; Schultz, 2014). For example, the present findings suggest that the climate change risk perceptions of individuals with weaker perceptions of scientific agreement on climate change are less likely to be influenced by indirect exposure to forest fires. One promising approach for targeting such individuals is to focus on communicating the scientific consensus on climate change (i.e., gateway belief model; van der Linden et al., 2015). Efforts have already begun to identify effective ways of communicating this consensus (e.g., van der Linden, Leiserowitz, Feinberg, & Maibach, 2014; van der Linden, Leiserowitz, Rosenthal, & Maibach, 2017) and for improving public engagement with climate change (Jones, Hine, & Marks, 2017; van der Linden et al., 2015; Whitmarsh, O'Neill, & Lorenzoni, 2013).

Previous studies that suggested a relation between exposure to extreme weather events and climate change risk perception were cross-sectional (e.g., Konisky et al., 2015; Safi et al., 2012). To the best of our knowledge, the present study is the first to examine the relation between exposure to extreme weather and climate change risk perception using repeated measures (i.e., before, during, after), a quasi-experimental design, and growth curve model analysis. This design can be used to study other types of seasonal weather extremes (e.g., droughts, floods, heat waves).

Climate change risk perception increased slightly over the duration of this study (i.e., from 3.50 to 3.65 on a 5-point scale). This growth occurred in the absence of a controlled intervention. Coupled with a well-designed intervention, the effect could be substantially larger. A small window of opportunity (i.e., "teachable moment") can promote behaviour changes following a natural disaster (Martin et al., 2009; Sisco, Bosetti, & Weber, 2017). However, special consideration should also be given to the role of increasing perceived efficacy to avoid fear-control processing (i.e. denying a threat or discrediting the messenger; Drummond et al., 2018; Landry, Gifford, Milfont, Weeks, & Arnocky, 2018; Witte & Allen, 2000; Xue et al., 2016). For an overview of pro-environmental communication, see Klöckner (2015).

The present findings might not be representative of a typical forest fire season or of the general population. The fire in Fort McMurray had large impacts on the Canadian economy: not only were nearly 90,000 residents evacuated and 2,400 homes destroyed, it also drastically reduced oil production (Krugel, 2016). Fort McMurray is located in the Athabasca Oil Sands, where approximately 60 % of Canadian crude oil is produced (Government of Canada, 2019). While the evacuation order was in effect, views of this fire as a climate change irony were expressed on social media, which was perceived to be insensitive and unjust (Cheadle, 2016). Presumably, this may have caused some mistrust and reactance (see Gifford, 2011).

Limitations and future studies

Some limitations apply to this study. Natural experiments inherently offer less control over the predictor variables, in this case forest fires. Exemplifying this limitation, a large fire ignited during the first phase of this study. We attempted to compensate for this lack of control incorporating a control variable into our models. Nevertheless, future studies might be improved by starting data collection earlier in the season, to better prepare for this uncertainty.

Furthermore, this study included self-reports of exposure to forest fires. Future research should measure actual proximity to forest fires and other weather events to control for their effects on climate change risk perception. For example, this could be done by using geographic information system (GIS) software to compare the physical location of the study participants with real forest fire data.

Experience with extreme weather is related to climate change risk perception up to four months after the event (Konisky et al., 2015). Similarly, in the present study, climate change risk perception continued to increase, on average, months after the forest fire season has ended. However, without further repeated measures, knowing whether these increases persist over time is not possible. Perceptions of warmer-than-average winter temperatures can dissipate over time (Howe, 2018) and climate change beliefs can decrease during the winter months (Hall, Lewis, & Ellsworth, 2018). Similarly, climate change risk perception might return to its initial level during the off-season.

Our analyses focused on the hypothesis that exposure to forest fires influences climate change risk perception. However, the reverse is also conceivable: individuals with stronger climate change risk perception might be more likely to report exposure to forest fires. For example, the climate change beliefs of highly engaged individuals are more likely to influence self-reports of having personally experienced the effects of global warming (i.e., motivated reasoning), whereas for moderately engaged individuals, personal experience is more likely to influence climate change beliefs (Myers, Maibach, Roser-Renouf, Akerlof, & Leiserowitz, 2013). In addition, climate change beliefs influence self-reports of warmer-than-average temperatures and their attribution to global warming (Broomell, Winkles, & Kane, 2017; Howe, 2018; McCright, Dunlap, & Xiao, 2014). Future studies should consider the effect of motivated reasoning on personal experience of extreme weather.

Conclusions

To the best of our knowledge, this study is the first to examine the relations between exposure to extreme weather and changes in climate change risk perception using a repeated-measured quasi-experimental design. The findings provide support for the effect of exposure to forest fires on climate change risk perception, and for the effect of changes in climate change risk perception on climate policy support. However, it found important individual differences.

Coupled with tailored climate change interventions that take between-person differences in climate change beliefs into account, exposure to naturally occurring forest fires could result in increased support for climate policies and programs.

Chapter 3: Reducing Meat Consumption: Identifying Group-specific Inhibitors Using Latent Profile Analysis

with Robert Gifford

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Abstract

Consumption of animal products is an important greenhouse gas emitting behaviour. However, perceived hindrances to incorporating more plant-based diets present challenges for the successful design of behaviour-change interventions. Latent profile analysis of survey responses revealed three distinct groups. Meat-reducers perceive the fewest inhibitors and are the most willing to incorporate more meat-free days in their diets. Moderate-hindrance meat eaters perceive many more inhibitors, and are hindered by a lack of social support, attachment to meat, not wanting to change their routine, and less awareness of the health benefits of eating less meat. They are willing to incorporate new healthy foods in their diet and are somewhat willing to avoid meat on some days. Strong-hindrance meat eaters report weak self-efficacy and the most inhibitors but are somewhat willing to incorporate healthier foods in their diets. Implications for tailored meat-reduction interventions are discussed. For example, when targeting meat-attached individuals, it might be beneficial to focus on replacing red meats with less carbon-intensive protein sources.

Introduction

Agriculture has widespread impacts on water, soil, and air pollution caused by its land use change, irrigation, fertilizers, pesticides, and animal waste (Sabaté, Sranacharoenpong, Harwatt, Wien, & Soret, 2014). The extent of these impacts varies with the type of agriculture; animal protein requires more water, land, fertilizer and fuel to produce than plant-based protein because of the energy lost during the conversion (Baroni, Cenci, Tettamanti, & Berati, 2006; Pimentel & Pimentel, 2003; Sabaté et al., 2014). About 80% of global agricultural greenhouse gas (GHG) emissions are related to livestock production (McMichael, Powles, Butler, & Uauy, 2007). The environmental impacts also vary with different types of animal protein. For example, producing 1 kg of beef requires 9 times more land area than producing 1 kg of chicken (Sabaté et al., 2014).

Industrialized nations follow the most GHG-intensive dietary patterns (Pradhan, Reusser, & Kropp, 2013). For the average individual, eating fewer animal products has a larger potential for GHG reductions than, for example, switching to a more fuel-efficient car (Lacroix, 2018). The reductions associated with dietary changes become gradually larger as fewer animal products are consumed; they can amount to a reduction of up to 80% of food-related GHG compared to an average Western diet (Aleksandrowicz, Green, Joy, Smith, & Haines, 2016), or up to 22% of an individual's total (i.e., food, housing, good and services, etc.) carbon footprint (Lacroix, 2018).

Unfortunately, many individuals are unaware of the environmental impacts of meat eating (Austgulen, Skuland, Schjøll, & Alfnes, 2018; de Boer, de Witt, & Aiking, 2016; Siegrist, Visschers, & Hartmann, 2015; Tobler, Visschers, & Siegrist, 2011). Instead, meat-reducing behaviours are often motivated by health concerns (e.g., Hoek, Luning, Stafleu, & de Graaf, 2004; Mullee et al., 2017; Tobler et al., 2011), although many meat-eaters believe that vegetarian diets are nutritionally unbalanced (Lea, Crawford, & Worsley, 2006; Povey, Wellens, & Conner, 2001). Other factors impede meat-reducing behaviours, such as cultural norms (Bohm, Lindblom, Åbacka, Bengs, & Hörnell, 2015; de Boer & Aiking, 2011; Schösler, de Boer, Boersema, & Aiking, 2015), taste preferences (Corrin & Papadopoulos, 2017; de Boer et al., 2007; Graça, Calheiros, & Oliveira, 2015), and cooking skills (Corrin & Papadopoulos, 2017; Lea et al., 2006; Schüz, Sniehotta, Scholz, & Mallach, 2005).

Important differences exist between individual perceptions of benefits and limitations of plant-based diets (Corrin & Papadopoulos, 2017; Hoek et al., 2011; Lea et al., 2006) and willingness to reduce meat consumption (Graça, Calheiros, et al., 2015; Tobler et al., 2011). Noteworthy differences also exist within groups of individuals with meat-reduced diets (e.g., Fessler, Arguello, Mekdara, & Macias, 2003; Jabs, Devine, & Sobal, 1998; Povey et al., 2001; Rothgerber, 2014). For example, health-motivated individuals who identify as vegetarians tend to eat more white meat than ethically-motivated vegetarians (Fessler et al., 2003). Differences also likely exist within individuals over their lifetime as their diets gradually change (Beardsworth & Keil, 1991; Fox & Ward, 2008; Klöckner, 2017; Lea et al., 2006).

These nuances should be considered in the design of interventions aimed at changing diets. The importance of tailoring pro-environmental behaviour interventions is becoming widely recognized (Maio et al., 2007; Reynolds, 2010; Stern, 2011). Relevant behaviour-change theories and frameworks suggest tailoring the strategies to the perceived and actual barriers and benefits associated with specific behaviours (i.e., Schultz, 2014), to the stage of change (i.e., stage model of self-regulated change; Bamberg, 2013b), to an individual’s motivation, opportunity, and habit strength (i.e., the segmentation model of sustainable behaviour; Verplanken, 2018), or to an individual's capability, opportunity, and motivation for change (e.g., COM-B system; Michie et al., 2011). All these frameworks highlight the importance of considering the behaviour in context and recognizing that barriers and motivations can change over time.

Complementing these frameworks, segmentation procedures that minimize within-group differences and maximize between-group differences (e.g., cluster analysis, latent profile analysis) can help tailor interventions to groups with specific perceived inhibitors and facilitators. The idea that segmentation can inform interventions is gaining support. For example, segmentation analyses are increasingly used in the context of health (e.g., Maibach, Maxfield, Ladin, & Slater, 1996; Maibach, Weber, Massett, Hancock, & Price, 2006; Weir et al., 2000) and climate change research (see Hine et al., 2014 for a review).

Segmentation studies of dietary choice

Recently, several researchers have also used segmentation analyses to study meat consumption. Focusing on preferences for meat and meat substitute attributes (e.g., price, origin, fat content) in a discrete choice experiment, Apostolidis and McLeay (2016) identified six groups using latent class analysis: price-conscious, healthy-eating, taste-driven, green, organic, and vegetarian consumer groups.

Others, using cluster analysis, have segmented consumers according to their awareness of the environmental impact of meat and found six clusters, from individuals who are highly conscious of meat-related environmental problems to those who are resistant to this view (Pohjolainen, Tapio, Vinnari, Jokinen, & Räsänen, 2016). The more conscious groups were in favor of reducing meat consumption, whereas the resistant group strongly opposed it.

Using latent class analysis, Vainio, Niva, Jallinoja, and Latvala (2016) divided individuals into groups according to self-reported changes in consumption of beef, beans, and soy products in recent years and their expected changes in the future. They also found six clusters and examined differences in the groups' food choice motivations (e.g., visual appeal, health, sociability). Those who consumed beans and soy were more concerned about health, nature, and their weight, and were less concerned about convenience and price, compared to those who did not consume these products.

Others asked participants open-ended questions about their representations of meat (e.g., pleasure, animal death), environmental and health impacts of the meat industry, and reasons for changing (or not changing) meat consumption (Graça, Oliveira et al., 2015). They identified three groups using cluster analysis: a "meat attached and unwilling to change" cluster, a "low attachment and willing to change" cluster, and a "disgust towards meat and moral internalization" cluster.

The Present Study

As emphasized in a critical review of segmentation research (Hine et al., 2014), selecting theoretically sound profiling variables is key to conducting valuable segmentation analyses. Specifically, researchers should consider the end goal of their study during the selection of variables, and, when applicable, whether existing segmentation tools match their goal. The goal of the present study is to inform the tailoring of interventions targeting meat-eating reduction. Therefore, including a comprehensive list of the known antecedents of meat consumption and meat-reducing behaviours (e.g., facilitators and inhibitors) during the profiling is crucial.

Furthermore, the practicality of segmentation tools should be evaluated using validation analyses (i.e., does group membership significantly predict the behaviour of interest?). No attempts were made to validate the segments in previous meat segmentation studies (i.e., Apostolidis & McLeay, 2016; Graça, Oliveira, & Calheiros, 2015; Pohjolainen et al., 2016;

Vainio et al., 2016). In the present study, profiles will be validated by testing their ability to predict meat consumption behaviour. We hypothesize that segments will predict (1) current dietary patterns and (2) willingness for dietary change, and therefore will be useful for designing meat-reduction interventions.

Material and Methods

Participants

A sample of Canadians aged 18 and above was obtained using an online panel recruitment agency. Based on the anticipated number of latent groups (i.e., previous studies found 3 to 6 groups) and sample sizes required to validate the profiles, 469 participants were initially recruited. Participants completed a survey asking about their meat-specific beliefs, general food-related attitudes, food-choice frequencies, and willingness to change.

Sixty-one participants failed the attention-checking items (e.g., “Please validate your continued participation by selecting strongly disagree”) and their data were removed. Prior to reverse-coding, one participant answered “strongly disagree” to every item (i.e., straight-lining) and was also removed. Fifty-two other participants reported religious or medical (e.g., lactose intolerance, celiac disease, food allergies, etc.) dietary restrictions and were removed to control for the presumably important effect of these restrictions on their food choices.

Three hundred and fifty-five (355) participants remained. Their mean age was 31 years (SD = 10 years). The sample included 190 males (53.5%), 164 females (46.2%), and one other (0.3%). Participants were politically moderate-to-liberal on average (M = 2.43, SD = 1.04, on a 5-point scale, from “very liberal” to “very conservative”). Twenty-three percent had a high school diploma, 62% had a college or bachelor’s degree, and 15% had post-graduate degrees.

Measures

Profile variables. A literature review was conducted to identify facilitators and inhibitors to reducing meat consumption. The keywords (diet AND meat) OR (diet AND beef) OR vegetarian* OR vegan* OR “meat-reduc*” OR “meat-avoid*” OR “less meat” OR “plant-based” OR “meat*less” were entered into the Web of Science and PsycInfo databases. Hundreds of relevant articles were found. They are detailed in Appendix B.

Key variables from the literature review informed the segmentation analysis. Nineteen different constructs were measured. Unless otherwise indicated, profiling variables were measured on a 7-point Likert scale from “strongly disagree” to “strongly agree.” General dietary routine was measured using three items (e.g., “I always like to eat the same food;” Mäkiniemi & Vainio, 2014). Individuals with weaker food involvement often are more habitual in their eating behaviour and prioritize efficiency over nutrition (de Boer et al., 2016, 2007; de Boer, Schösler, & Boersema, 2013). Food involvement was measured using six items on a 6-point scale from “not like me at all” to “very much like me;” it refers to the importance individuals place on their food choices (e.g., “They eat because they have to. Meals are not important to them;” de Boer et al., 2007). Individuals who are afraid to try new foods tend to eat less vegetables and less healthy meats (Siegrist, Hartmann, & Keller, 2013). An eight-item food neophobia scale assessed open-mindedness to trying new foods (e.g., “I am afraid to eat things I have never had before;” Siegrist et al., 2013).

The healthiness of food can also be a deciding factor for certain individuals, for example those who believe that their dietary choices affect their health (e.g., locus of control; Grisolía, Longo, Hutchinson, & Kee, 2015), and those with a strong health prevention orientation (Maibach et al., 2006). A health prevention orientation scale was created. It included seven items (e.g., “What I eat is not going to affect my health”, Grisolía et al., 2015). A healthy-eater identity scale was created which included three items (e.g., “I am someone who eats in a nutritious manner;” Blake, Bell, Freedman, Colabianchi, & Liese, 2013).

Meat-specific attitudes also require special consideration. For example, meat dependence (e.g., “Meat is irreplaceable in my diet”) and meat entitlement (e.g., “Eating meat is a natural and indisputable practice”) are significant negative predictors of one’s willingness to reduce meat consumption, and each was measured using three items (Graça, Calheiros, et al., 2015). Taste is another important factor influencing food choices (Kourouniotis et al., 2016) and meat eating (Corrin & Papadopoulos, 2017; Klöckner, 2017), so a scale was created that included three items (e.g., “Vegetarian food is bland and boring;” Lea & Worsley, 2001).

Cultural norms of masculinity can also inhibit meat-reduction (Schösler et al., 2015). For example, vegetarianism is considered by some to be an effeminate behaviour (Nath, 2011), and when time or resources are not restricted, men tend to make gender-expressive food choices (Gal & Wilkie, 2010). Therefore, a five-item stereotypical masculinity scale was created (e.g., “It bothers me when a man does something I consider feminine,” Rothgerber, 2013). Social conformity correlates with alternative food practices (e.g., organic food; Robinson-O’Brien, Larson, Neumark-Sztainer, Hannan, & Story, 2009), and with vegetarianism for men (Janda & Trocchia, 2001). It was measured using four items (e.g., “When I’m in a group, I try to behave like everyone else;” Janda & Trocchia, 2001).

Many believe that they lack the cooking skills or nutritional knowledge necessary to adopt a vegetarian diet (Beardsworth & Keil, 1991; Mullee et al., 2017; Schüz et al., 2005). Therefore, a four-item self-efficacy scale was created (e.g., “Following a recommended diet is hard for me;” Weir et al., 2000). Perceived behavioural control predicts the intention to reduce meat consumption (Klöckner, 2017; Zur & Klöckner, 2014), so a three-item scale was created (e.g., "Someone else cooks and prepares meat, so I should eat it;" Mullee et al., 2017).

Yet, others are concerned about the additional time needed to prepare vegetarian meals and the lack of vegetarian options. This was measured using five items (e.g. "It takes too long to prepare plant-based meals;" Lea et al., 2006). Concerns about the cost of vegetarian food was measured using one item (i.e., "It costs too much to make vegetarian food;" Hodson & Earle, 2018).

The relevant literature provides overwhelming evidence for two meat-reduction motivations: ethical concerns, which include environmental and animal-concern motivations, and health motivations (e.g., Cooper, Wise, & Mann, 1985; Janssen, Busch, Rödiger, & Hamm, 2016; Santos & Booth, 1996). A five-item scale of health beliefs related to meat was created (e.g., "Eating meat is necessary in order to be healthy;" Piazza et al., 2015). A five-item scale to measure environmental and ethical beliefs related to meat was created (e.g., "Reducing meat consumption is better for the environment;" Tobler et al., 2011). A four-item environmental identity scale was created (e.g., "I think of myself as someone who is concerned about the environment;" Abrahamse et al., 2009).

Finally, because meat plays a central role in the Western culture and is often considered a high-status food (de Boer & Aiking, 2011; Holm et al., 2008; Köster, 2009; Schösler, de Boer, & Boersema, 2014), lack of social support may trigger a vegetarian's return to a meat-eating diet (Haverstock & Forgays, 2012; Hodson & Earle, 2018). Social influences were measured using five items, such as "Most people I know eat meat" (Piazza et al., 2015). Social support was measured using three items "Important people in my life are supportive of me eating less meat" (Hodson & Earle, 2018).

Validation variables. Six criterion variables were used to validate the segments by testing the latent groups' ability to predict current dietary patterns and willingness to reduce meat consumption. Frequency of eating animal products was measured by asking participants how often they eat red meat, white meat, fish and seafood, and eggs and dairy, on 5-point scales (1 = never, 5 = daily or almost daily). Similarly, frequency of eating vegetarian meals was measured by asking participants how often they eat meat-free meals and meat-replacers.

Willingness to change was measured by asking participants whether they were prepared to incorporate more healthy foods in their diet, whether they were prepared to abstain from eating meat or fish on specific day(s) of the week, and their willingness to change their diet instead of taking medication to control for cholesterol level, on 7-point Likert scales. They were also asked in an open-ended question if they had already made conscious efforts to reduce their meat consumption, and if yes, what motivated these efforts.

Demographic variables. Gender, age, education, political ideology, and dietary self-identity (i.e., omnivore, pescatarian, vegetarian, vegan, or other) were also measured but were not included as profile or validation variables.

Scale reliability and scoring. For ease of interpretation, some items were reverse-coded so that all profiling items reflected a Likert scale from facilitators (1 or strongly disagree) to inhibitors (7 or strongly agree) of reducing meat consumption. Each scale was analyzed for internal consistency. After two weak items were removed in the social influence and health prevention scales, all but two scales were adequately or very reliable. Scale reliability and items, including original citations for each item, are listed in Appendix B. General dietary routine and social support did not form reliable scales. Thus, their individual items were included in the profile analysis. Twenty-three variables (i.e., 16 averaged scales and 7 items) were retained as profiling variables. Correlations between profiling variables are provided in Appendix B.

Validation variables were scored as follows: food frequency items were re-coded (0 = never, 4 = daily or almost daily) and summed to create a frequency of eating animal products scale (i.e., sum for eating red meat, white meat, fish and seafood, eggs and dairy) and a frequency of eating vegetarian meals scale (i.e., sum for meat-free meals and meat-replacers). The three willingness-to-change items were scored from strongly disagree (1) to strongly agree (7). Having already made conscious efforts to reduce meat consumption was scored as yes (2) or no (1). A follow-up question asking those participants having already made conscious efforts about their motivation was content analyzed and coded by motivation type (e.g., health, financial, environmental, social, etc.)

Results

Hypotheses testing

Segmentation. After checking that assumptions of normality were met (Kline, 2012) and that there were no problems of multicollinearity (Field, 2013), Latent Profile Analysis (LPA) was conducted using the mclust package in R (Scrucca, Fop, Murphy, & Raftery, 2017). To assess model fit, Bayesian Information Criterion (BIC), Bootstrapped Likelihood Ratio Test (BLRT), and distinctiveness of the profiles were considered (Hine, Phillips, et al., 2016; McLachlan & Rathnayake, 2014; Stanley, Kellermanns, & Zellweger, 2017). The BIC penalizes for the number of parameters in the model; the smallest BIC value indicates the best model fit. The BLRT compares each model with the model with one less number of profiles, and significant *p* values indicate that the model with more profiles should be retained. Although it was not used for selecting the number of profiles, entropy indicates the accuracy of classifications of individuals into profiles and was also considered (i.e., entropy should be greater than .80; Magidson & Vermunt, 2004; Porcu & Giambona, 2017; Tein, Coxe, & Cham, 2013).

Models with increasing numbers of profiles were fitted until a non-significant BLRT value was obtained, indicating that model fit could no longer be improved by retaining additional profiles. The model fit indices are presented in Table 4. BIC favored the three-profile model and BLRT favored the four-profile model. In the four-profile model, the fourth profile had a small number of participants (< 10% of the sample) and their mean scores on the profiling variables were very similar to those of third profile, thus distinctiveness was deemed superior for the three-profile model.

Table 4

Model fit indices for latent profile analysis solutions.

Profile solution	BIC	BLRT	Entropy
1	-26041.95		
2	-26005.95	$p < .01$	0.98
3	-25979.42	$p < .01$	0.94
4	-26025.45	$p < .01$	0.93
5	-26129.59	$p = .78$	0.94

Note: BIC: Bayesian information criterion; BLRT: Bootstrap likelihood ratio test.

The three-profile model was retained because it was more parsimonious, interpretable, and had good entropy. Fifty-one participants (14 %) were assigned to Group 1 and were labelled “meat-reducers,” 135 participants (39 %) were assigned to Group 2 and were labelled “moderate-hindrance meat eaters,” and 169 (47 %) were assigned to Group 3 and were labelled “strong-hindrance meat eaters.”

Validation. To validate the practical use of the segmentation approach, the ability of the latent groupings to predict current diet and willingness to change was tested using MANOVA.

Group membership significantly explained 20 % of the variance in the set of behavioural variables (Pillai's Trace = 0.41, F (12,696) = 14.8, p <. 001, η^2 = .20).

This analysis was followed by univariate ANOVAs using a corrected version of the F ratio to account for heterogeneous group variances. Post hoc tests using Games-Howell revealed significant differences between Group 1 and Group 2 (i.e., the meat-reducers and the moderate-hindrance meat eaters; M_{diff} = -4.54, p < .001, Cohen's d = 0.58; M_{diff} = 2.35, p < .001, d = -0.53; M_{diff} = .55, p < .001, d = -0.49), and between Group 1 and Group 3 (i.e., the meat-reducers and the strong-hindrance meat eaters; M_{diff} = -3.77, p < .001, d = 0.45; M_{diff} = 2.68, p < .001, d = -0.53; M_{diff} = .55, p < .001, d = -0.46) in terms of frequency of eating animal products, frequency of eating vegetarian meals, and having already made conscious efforts to reduce meat consumption. Group 2 and Group 3 (i.e., moderate- and strong-hindrance meat eaters) were significantly different only for their frequency of eating animal products (M_{diff} = .77, p = .01, d = -0.16).

In sum, Hypothesis 1 was partially supported; group membership predicted differences in current diets with a medium effect size, although differences between Group 2 and Group 3 (i.e., moderate- and strong-hindrance meat eaters) were not always significant. Means and standard deviations for each group are reported in Table 5.

Table 5

Means, standard deviations, and significance test of differences between groups.

Outcome variables	Group 1 *M*	Group 1 *SD*	Group 2 *M*	Group 2 *SD*	Group 3 *M*	Group 3 *SD*	Univariate Welch's *F* (df)
Frequency of eating animal products	6.90	4.50	11.44	1.96	10.67	2.59	25.70 (2,121)
Frequency of eating vegetarian meals	5.51	1.67	3.16	1.67	2.83	1.84	50.09 (2,143)
Having already made conscious efforts to eat less meat	1.92	0.27	1.37	0.49	1.37	0.49	67.88 (2,182)
Preparedness to abstain from eating meat	6.43	0.78	4.73	1.46	4.18	2.03	89.09 (2,204)
Preparedness to incorporate new healthy foods	6.22	0.70	5.47	0.80	5.14	1.37	30.56 (2,163)
Preference for taking medication instead of dietary change	6.43	1.04	5.41	1.37	5.27	1.95	19.32 (2.170)

Notes: Group 1 = meat-reducers, Group 2 = moderate-hindrance meat eaters, Group 3 = strong-hindrance meat eaters. Frequency of eating animal products is the sum of 4 items (minimum = 0, maximum = 16). Frequency of eating vegetarian meals is the sum of 2 items (minimum = 0, maximum = 8). Having already made conscious efforts to eat less meat is scored 1 = no, 2 = yes. The last three items are scored 1 = strongly disagree, 7 = strongly agree. Reverse-coded item is listed in italics. Univariate ANOVAs are significant at $p < .001$.

All three groups were significantly different in terms of their willingness to abstain from eating meat on specific days of the week (Groups 2-3 $M_{\text{diff}} = .55$, $p < .05$, $d = -0.15$; Groups 1-2 $M_{\text{diff}} = 1.71$, $p < .001$, $d = -0.50$; Groups 1-3 $M_{\text{diff}} = 2.25$, $p < .001$, $d = -0.47$), and their willingness to incorporate new foods in their diet (Groups 2-3 $M_{\text{diff}} = .33$, $p < .05$, $d = -0.14$; Groups 1-2 $M_{\text{diff}} = .74$, $p < .001$, $d = -0.39$; Groups 1-3 $M_{\text{diff}} = 1.07$, $p <.001$, $d = -0.34$). Groups 1 and 2 (i.e., meat-reducers and moderate-hindrance meat eaters; $M_{\text{diff}} = 1.02$, $p < .001$, d = -

0.33) and Groups 1 and 3 (i.e., meat-reducers and strong-hindrance meat eaters; $M_{\text{diff}} = 1.16$, $p < .001$, $d = -0.26$) significantly differed in their willingness to change their diet instead of taking medication to control for cholesterol levels, but not Groups 2 and 3 (i.e., moderate- and strong-hindrance meat eaters; $M_{\text{diff}} = .14$, $p = .74$).

Therefore, Hypothesis 2 was generally supported; group membership predicts differences in willingness to change diet, although the differences between the moderate- and strong-hindrance meat-eater groups were not always significant. When significant, the effect sizes were smallest for these two groups.

Profiles and inhibitors

A MANOVA showed that group membership explained 47 % of the variance in the set of profiling variables (Pillai's Trace = .94, F (46,662) = 12.7, p <.001, $\eta^2 = .47$). The analyses were followed by univariate ANOVAs to better understand group specific inhibitors (Table 6). Individuals in Group 3 (i.e., strong-hindrance meat eaters) reported the lowest level of involvement with their food, the weakest beliefs that meat eating is unethical, had the weakest environmental identities, were most worried about the extra cost of preparing vegetarian meals, and reported the least interest in trying new recipes.

Group 2 (i.e., moderate-hindrance meat eaters) and Group 3 (i.e., strong-hindrance meat eaters) reported lower levels of support from their family and friends than Group 1 (i.e., meat-reducers). They also reported weaker health prevention orientations, weaker beliefs that reducing meat consumption is healthy, more dependence on and entitlement to meat, a stronger liking of the taste of meat, less self-efficacy and perceived behavioural control, were most concerned about the extra time required to prepare vegetarian meals, and most concerned about the social repercussions of not eating meat.

Compared to Group 1 (i.e., meat-reducers) and Group 2 (i.e., moderate-hindrance meat eaters), Group 3 (i.e., strong-hindrance meat eaters) individuals reported a stronger dislike for trying new foods and a weaker healthy-eater identity. Group demographics differed in some ways: Group 1 (i.e., meat-reducers) was more female (Groups 1-2 $M_{diff} = .36$, $p < .001$, $d = -0.32$; Groups 1-3 $M_{diff} = .26$, $p < .01$, $d = -0.21$) and more liberal (Groups 1-2 $M_{diff} = .59$, $p < .001$, $d = -0.26$; Groups 1-3 $M_{diff} = -.75$, $p < .001$, $d = 0.30$) than Groups 2 and 3 (i.e., moderate- and strong-hindrance meat eaters).

Table 6

Means, standard deviations, and group differences of profiling variables.

Profiling variables	Means (SD) Group 1	Group 2	Group 3	Univariate Welch's *F* (df)
Meat entitlement (3 items e.g., Eating meat is a natural and indisputable practice)	2.73 (1.28)	4.75† (1.04)	4.96† (1.58)	59.49 (2, 139), *p* < .001
Dependence on meat (3 items e.g., Meat is irreplaceable in my diet)	1.71 (.85)	4.49† (1.18)	4.68† (1.82)	193.28 (2, 178), *p* < .001
Liking the taste of meat (3 items e.g., Meat adds so much flavor to a meal it does not make sense to leave it out)	2.58 (1.01)	4.55† (.84)	4.83† (1.36)	91.84 (2,141), *p* < .001
Lack of food involvement (6 items e.g., They eat because they have to. Meals are not important to them)	2.01* (.72)	2.44* (.74)	2.95* (.99)	29.54 (2,150), *p* < .001
Health beliefs about meat (5 items e.g., Eating meat is necessary in order to be healthy)	2.17 (.78)	3.61† (.85)	3.88† (1.37)	76.90 (2,158), *p* < .001
Lack of self-efficacy and skill (4 items e.g., I lack the cooking skills to prepare meat-free meals)	2.18 (.99)	3.84† (1.05)	3.94† (1.42)	60.13 (2, 152), *p* < .001
Food neophobia (8 items e.g., I am afraid to eat things I have never had before)	2.77† (.89)	2.75† (.88)	3.25 (1.16)	9.77 (2,147), *p* < .001
Ethical beliefs about meat (3 items e.g., Cattle farming has a big impact on the planet)	1.62* (.64)	2.80* (.76)	3.37* (1.10)	98.77 (2, 170), *p* < .001
Lack of time and availability of vegetarian food (5 items e.g., It takes too long to prepare plant-based meals)	2.18 (.68)	3.44† (.86)	3.69† (1.06)	80.66 (2, 162), *p* < .001
Stereotypical masculinity (5 items e.g., It bothers me when a man does something I consider "feminine")	1.46 (.56)	2.11† (.89)	2.19† (1.18)	23.92 (2,185), *p* < .001
Lack of perceived behavioural control (3 items e.g., Someone else decides on most of the food I eat)	2.07 (1.06)	3.44† (1.46)	3.15† (1.60)	26.54 (2,164), *p* < .001
Social influences (3 items e.g., *Not eating meat is socially unacceptable*)	1.58 (.88)	2.40† (1.07)	2.50† (1.25)	19.06 (2,157), *p* < .001

(Table 6 continued)

Lack of health prevention orientation (5 items e.g., Most health issues are too complicated for me to understand)	1.91 (.56)	2.31† (.71)	2.39† (.89)	11.67 (2,163), *p* < .001
Environmental identity (4 items e.g., To engage with issues related to the environment is an important part of who I am)	2.26* (.93)	3.03* (.85)	3.65* (1.44)	33.13 (2,147), *p* < .001
Healthy-eater identity (3 items e.g., I am someone who eats in a nutritious manner)	2.68† (1.15)	2.99† (.90)	3.92 (1.41)	30.99 (2,138), *p* < .001
Conformity (4 items e.g., When I'm in a group, I try to behave like everyone else)	3.61§ (1.03)	3.96§ (.96)	4.09§ (1.32)	3.77 (2,145), *p* < .05
Important people in my life are supportive of me eating less meat	2.04 (1.36)	3.57† (1.10)	4.03† (1.68)	38.08 (2,139), *p* < .001
I have regular interactions with people who are interested in preparing vegetarian meals	1.51 (.70)	3.13† (1.45)	3.56† (2.00)	86.33 (2,213), *p* < .001
People I live with won't eat a plant-based diet so if I want to eat vegetarian, both vegetarian and non-vegetarian meals must be prepared	2.00 (1.52)	4.24† (1.78)	4.28† (2.17)	43.68 (2,155), *p* < .001
It costs too much to make vegetarian food	1.53* (1.07)	3.04* (1.34)	3.75* (1.90)	59.42 (2,167), *p* < .001
I like to try out new recipes	1.65* (.69)	2.18* (.92)	2.82* (1.51)	29.96 (2,176), *p* < .001
I always like to eat the same food	2.76† (1.26)	3.27† (1.26)	4.27 (1.54)	31.54 (2,146), *p* < .001
I do not want to change my eating habit or routine	2.89‡ (1.26)	3.70‡ (1.37)	3.38 (1.57)	5.86 (2,149), *p* < .01
<u>Demographics</u>				
Gender (1= male, 2= female)	1.73 (.45)	1.4† (.49)	1.47† (.51)	13.73 (2,145), *p* < .001
Education (1= Elementary school, 6 = PhD)	3.71 (1.05)	3.61 (1.01)	3.36 (1.10)	3.29 (2,145), *p* < .05

Political ideology (1 = Very liberal, 5 = Very conservative)	1.84 (.86)	2.43† (1.02)	2.60† (1.05)	13.73 (2,150), $p < .001$

Note: Group 1 = meat-reducers, Group 2 = moderate-hindrance meat eaters, Group 3 = strong-hindrance meat eaters. Reverse-coded items are listed in italics. Standard deviations are reported in parentheses. All profiling variables except for food involvement are measured on a 7-point Likert scale from "strongly disagree" to "strongly agree." Significance: * indicates that all three groups are significantly different at $p < .01$ using Games-Howell, ‡ indicates that only those two groups are significantly different, † indicates that those two groups are not significantly different, § indicates that none of the groups are significantly different.

Descriptive analyses

Motivation and willingness to change. Most participants in Group 2 (i.e., 94% of the moderate-hindrance meat eaters) and Group 3 (i.e., 91% of the strong-hindrance meat eaters) self-identified as omnivores. Group 1 (i.e., meat-reducers) had the largest proportion of self-identified vegans (9 out of 51 or 17.6 %), vegetarians (19.6 %), and pescatarians (13.7 %) of all three groups.

Individuals in Group 1 (i.e., meat-reducers) eat meat less frequently than the other groups and tend to eat vegetarian meals at least once per week. Most individuals (47 out of 51, or 92%) reported having already made conscious efforts to reduce their consumption of meat, and most provided at least three motives for having done so. Their most important motivator was health (66%), followed by ethics (60%) and environment (60%), financial benefits (43%), and social considerations (19%). Not surprisingly, meat-reducers are most willing to further change their diet. They are willing to incorporate new healthy foods in their diet (i.e., a mean of 6.2 on a 7-point scale, or “agree”), and to avoid meat on specific days of the week (i.e., mean 6.4, or “agree”).

Individuals in Group 2 (i.e., moderate-hindrance meat eaters) eat meat frequently and eat vegetarian meals approximately once per month. Over a third (50 out of 135, or 37%) reported having already made conscious efforts to reduce their consumption of meat, and most provided two motives for having done so. Health was the most common motivation (76%), followed by environmental (36%), financial (34%), ethical (32%), and social considerations (16 %). Moderate-hindrance meat eaters reported that they are willing to incorporate new healthy foods in their diet (i.e., mean 5.5, or “agree”) and were somewhat willing to avoid meat on specific days of the week (i.e., mean 4.7, or “somewhat agree”).

Like moderate-hindrance meat eaters, strong-hindrance meat eaters (i.e., Group 3) eat meat frequently and eat vegetarian meals approximately once per month. Similarly, over a third (63 out of 169, or 37 %) of individuals in Group 3 reported having already made conscious efforts to reduce their consumption of meat. Health was the most commonly cited motivation (68%), followed by financial benefits (41%), ethical (27%), environmental (27%), and social considerations (18%). Strong-hindrance meat eaters reported that they are somewhat willing to incorporate new healthy foods in their diet (i.e., mean 5.1, or "somewhat agree") and were uncertain about their willingness to avoid meat on specific days of the week (i.e., mean 4.1, or "neither agree or disagree").

Perceived hindrances. Descriptive statistics provide further insight into perceived hindrances. Focusing on items that are most applicable to each group (i.e., means above 3.5, which suggest agreement with the "inhibitor"), Group 1 individuals (i.e., meat-reducers) were mostly affected by inhibitors related to social conformity. Group 2 individuals (i.e., moderate-hindrance meat eaters) perceived these same social hindrances as Group 1, but also perceived additional social hindrances, specifically a lack of social support. In addition to the social inhibitors, Group 2 individuals were attached to meat for various reasons (e.g., entitlement, dependence, and taste), believed that eating meat is necessary to be healthy, and believed that they do not have the necessary attributes to prepare meat-free meals (e.g., cooking skills and willpower).

In addition to the social inhibitors perceived by Groups 1 and 2, Group 3 individuals (i.e., strong-hindrance meat eaters) reported a lack of interaction with others who are interested in preparing vegetarian meals. Furthermore, Group 3 individuals were concerned that preparing meat-free meals takes more time, that meat replacement products are not available, that meat-free meals are costlier, and disliked trying new foods.

Moving from Group 3 to Group 2 to Group 1 (i.e., from strong-hindrance meat eaters to moderate-hindrance meat eaters to meat-reducers), individuals tended to perceive fewer hindrances. Thus, we tentatively arranged the groups along a hierarchical pyramid of inhibitors according to their perceived psychological limitations to changing diets (Figure 5).

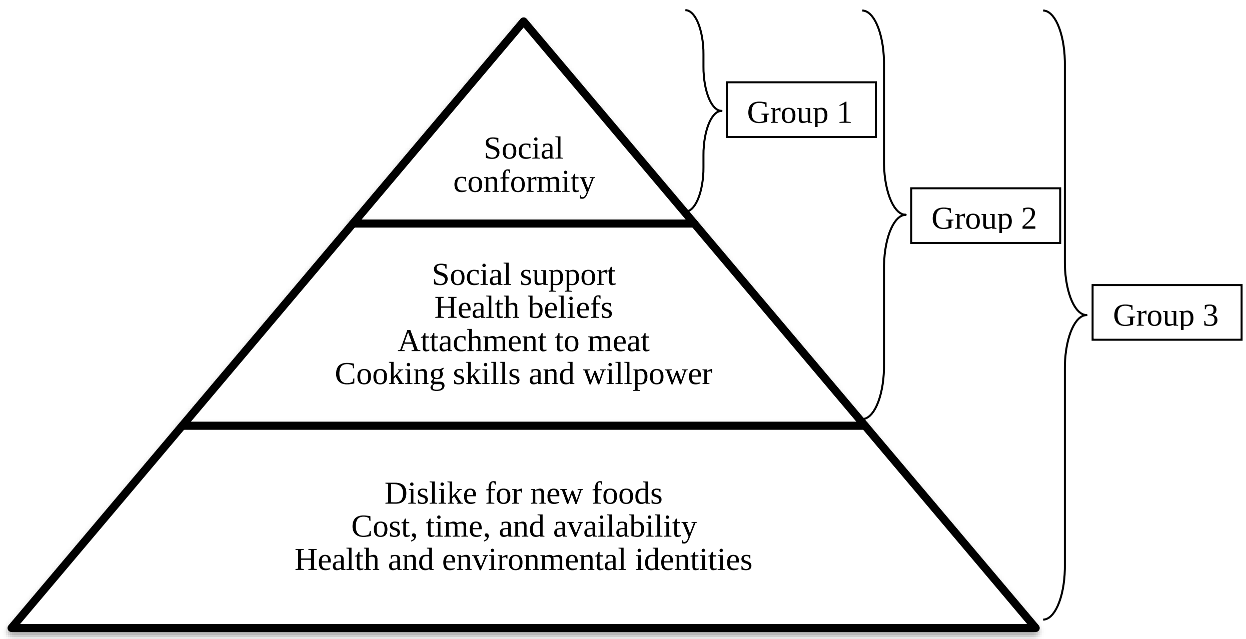

Figure 5. Proposed hierarchy of inhibitors to changing diets. Group 1 = meat-reducers, Group 2 = moderate-hindrance meat eaters, Group 3 = strong-hindrance meat eaters.

Discussion

Informed by a comprehensive literature review of food-related attitudes and influences on meat-eating, new scales were created to measure a set of inhibitors and facilitators to meat-reducing behaviours. These scales were measured in a sample of 355 Canadians and then used as profiling variables in a Latent Profile Analysis. The sample was divided into three groups: “meat-reducers,” “moderate-hindrance meat eaters,” and “strong-hindrance meat eaters.” This grouping successfully predicted meat-eating frequency and willingness to reduce meat consumption.

Of the previous segmentation analyses studying meat consumption (Apostolidis & McLeay, 2016; Pohjolainen et al., 2016; Vainio et al., 2016), only Graça, Oliveira, et al. (2015) included grouping variables that are comparable to those used in the present study (i.e., both studies measured health beliefs, environmental beliefs, ethical beliefs, attachment to meat, and willingness to reduce). However, whereas in the present study willingness to reduce meat consumption was used as a validation variable, Graça et al. (2015) included it as a segmentation variable and made no attempt to validate the segments. Nevertheless, they identified three groups, which show some resemblance to the groups identified in the present study.

While Graça et al. (2015) found only one group of meat-attached individuals, we identified two sub-groups that are hindered by their attachment to meat (i.e., moderate- and strong-hindrance meat eaters). Important distinctions between these two groups should be considered during the design of meat reduction interventions (e.g., differences in food neophobia).

On the other hand, while Graça et al. (2015) identified a small group of individuals that are disgusted by meat, no such group was found in the present study. However, one should keep in mind that model fit indices used to select the number of profiles in this study favor the most parsimonious model. Also, results may vary due to differences in the segmentation methodology (e.g., choice of profiling variables and segmentation approach; Hine et al., 2014).

Limitations and future research

A multi-scale tool was developed to measure a comprehensive set of inhibitors and facilitators to meat-reducing behaviours identified during the literature review. However, two of the new scales were not reliable, and several single-items were used instead. Future work should attempt to improve these two scales.

Individuals self-reported their ability to understand health information. Future research should consider including objective measures of nutritional knowledge, which could better inform intervention strategies. It should also measure habit strength (Rees et al., 2018; Verplanken, 2018), which was not directly measured in this study but is likely to correlate with the food involvement and neophobia scales.

The present study included only individuals who did not report any medical or religious dietary restrictions. Individuals with dietary restrictions are likely to face additional limitations, and these may amplify existing inhibitors. Their limitations would also vary based on their specific dietary restriction. More research is needed to better understand the hindrances faced by individuals with dietary restrictions.

Although we considered some contextual factors (e.g., “Someone else decides on most of the food I eat” or “People I live with won’t eat a plant-based diet”), this study did not include other household constraints, such as having children and food affordability (de Boer & Aiking, 2019). These should be considered during the design of interventions.

Implications for interventions

This is the first study, to the best of our knowledge, to attempt to identify distinct groups based on a comprehensive survey of perceived meat-reduction facilitators and inhibitors. Significant group differences were found, for example, individuals in the three groups reported different levels of food involvement, environmental identities, and ethical beliefs about meat. Descriptive analyses suggest that individuals following different meat-related diets fall along a pyramid of psychological inhibitors to changing diets.

These results can inform group-specific meat-reduction interventions. Individuals in all groups were concerned about social conformity and perceived a strong meat-eating norm. Accordingly, all participants are likely to benefit from interventions that include a social component (e.g., joining a potluck group, sharing of recipes, family member commitment).

However, for some individuals, other inhibitors should also be considered. Moderate- and strong-hindrance groups might not be aware of the potentially harmful health impacts of frequent meat consumption. For example, Canada's New Food Guide suggests moving away from red and processed meats toward more plant-based proteins and leaner meats (Health Canada, 2019).

For members of the moderate- and strong-hindrance groups, interventions should attempt to increase their self-efficacy. As noted in previous research (e.g., Corrin & Papadopoulos, 2017), the importance of taste and openness to trying new foods should not be underestimated. Individuals in the strong-hindrance group are less open to trying new foods, so it might be beneficial to focus on modifying already familiar meal types, perhaps by incorporating meat-replacers. Realistic "fake meat" products are increasingly seen in the marketplace.

The choice of which meat-reduction behaviours to target during interventions could also benefit from group-specific tailoring. Meat-reducers in this study are very willing to incorporate meatless days into their routine. However, moderate- and strong-hindrance groups are strongly attached to meat, and an intervention focused on meatless days might well be avoided. Instead, perhaps behavioural scientists should focus on encouraging members of these groups to incorporate healthier foods to their diet, which could include replacing red meats with less carbon-intensive protein sources.

Conclusion

Important differences exist in individuals' food preferences, beliefs, and willingness to reduce meat consumption. Three distinct groups were identified in this study, and this segmentation can inform the design of meat-reduction interventions. Although most individuals who would like to reduce their meat consumption would benefit from an increase in social support, those in some groups may lack understanding of nutritional guidelines, and others would benefit from increased perceived self-efficacy for preparing healthier, less meat-centric meals.

Chapter 4: Tailoring Interventions to Distinct Meat-Eating Groups Reduces Meat Consumption

with Robert Gifford

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Author contributions: Karine Lacroix conceptualized the research, led the analysis, and prepared the manuscript. Robert Gifford advised on the research design, assisted with the acquisition of data, and provided input on the writing.

Abstract

Group-specific interventions targeted meat consumption reduction for three groups: reducer, moderate-hindrance, and strong-hindrance meat eaters. All participants were randomly assigned to one of three intervention conditions or to a control condition. Following the intervention, up to 28 days of food diaries were gathered to measure their consumption of animal products, which were weighted according to their greenhouse gas emissions. Participants as a whole reduced their animal product consumption by 20 grams of CO_2 per day on average. As hypothesized, group-matched interventions outperformed mismatched interventions. Participants in the group-matched conditions reduced their animal product consumption 40 grams of CO_2 per day on average, which is approximately equivalent to replacing one chicken-based meal with a vegetarian meal per week. The findings suggest that interventions should focus on supporting reducers' existing behaviour intentions, whereas meat substitution is a more promising approach for habitual meat eaters.

Introduction

Meat consumption has important impacts on human health and on the environment. Consumption of red (e.g., beef, pork, lamb) and processed meat is correlated with certain types of cancer, cardiovascular disease, and diabetes (Aston, Smith, & Powles, 2012; Gonzalez, 2006; Health Canada, 2019; Sutliffe, Wilson, de Heer, Foster, & Carnot, 2015; World Cancer Research Fund International, 2017). In addition, livestock production is responsible for 80% of agricultural greenhouse gas (GHG) emissions worldwide (McMichael et al., 2007).

Reducing consumption of meat and dairy has important potential for mitigating GHG emissions. Globally, a shift to healthier diets (e.g., diets modelled based on World Health Organization guidelines) can reduce food-related GHG emissions by approximately 20% (Bajželj et al., 2014; Green et al., 2015; Hallström, Carlsson-Kanyama, & Börjesson, 2015; Milner et al., 2015; van Dooren, Marinussen, Blonk, Aiking, & Vellinga, 2014) and disease by up to 16% (Aston et al., 2012; Bouvard et al., 2015; Friel et al., 2009; Milner et al., 2015; Yip, Crane, & Karnon, 2013). However, meat consumption is a difficult behaviour to change (e.g., Henson, Blandon, & Cranfield, 2010) and is hindered by a variety of factors, such as limited knowledge about health and environmental impacts, a lack of social support, and difficulties in changing habits (Chapter 3).

Meat reduction experiments

Although many correlational studies have examined predictors of meat consumption (e.g., Corrin & Papadopoulos, 2017; Weibel, Ohnmacht, Schaffner, & Kossmann, 2019), few experimental studies have been conducted. These experiments provide mixed evidence on the effectiveness of information strategies. In one study, providing information about the relative GHG emissions of different dishes resulted in fewer high-emission dishes being chosen on days when red meat dishes were offered (Brunner, Kurz, Bryngelsson, & Hedenus, 2018). In another, being presented with information about green eating (i.e., eating local, reducing food-waste, and eating plant-based proteins) resulted in larger increases in green eating behaviours than in a control group (Monroe, Lofgren, Sartini, & Greene, 2015). In a third, individuals reported a reduction in meat consumption four weeks after receiving information on the environmental, ethical, health, and social implications of meat eating (Loy, Wieber, Gollwitzer, & Oettingen, 2016).

However, other experiments provide limited or no support for information strategies. For example, an information prime that highlighted meat-free meals as environmentally friendly options (i.e., a leaf symbol on the menu and a short environmental explanation) had no effect on choosing meat-free meals in two separate studies (Campbell-Arvai & Arvai, 2015; Campbell-Arvai, Arvai, & Kalof, 2014). The authors did find support for nudging strategies; default meat-free menus increased the probability that students would select meat-free meals. The affective appeal (e.g., desirable vs. undesirable) of the different meat-free meals also influenced meat-free choices, but less than the default menu option. In another study, tailoring the information to the participant's stage of change (i.e., predecision, decision, action, and postaction from Bamberg, 2013b) increased stage progression eight weeks later (Klöckner & Osfad, 2017). However, the authors did not detect any changes in beef consumption.

Other experimental studies focused on self-regulation techniques. Individuals who received information about the maximum weekly recommended intake of red meat and daily texts reminders to self-monitor their servings significantly reduced their consumption of red meat, compared to that of a control group (Carfora, Caso, & Conner, 2017). In a different study, individuals in an implementation-intention condition reported larger reductions in meat consumption than those in an information-only condition (Loy et al., 2016). The gap between intentions to reduce meat consumption and reported meat consumption was also smaller in the implementation-intention condition. Similarly, Rees et al. (2018) demonstrated a reduction in meat consumption during an implementation intervention experiment, which was partially mediated by more frequent thoughts about the meat reduction goal.

Gaps in knowledge. In sum, more research is needed to increase the effectiveness of interventions to reduce meat consumption (Godfray et al., 2018). Informational strategies are not likely to be sufficient for reducing meat consumption, but they might be beneficial for individuals in earlier stages of change (e.g., "I am satisfied with my level of beef consumption and see no need to change it") as suggested by Klöckner and Ofstad (2017).

Some research provides support for the effectiveness of meat-free default menus in student cafeterias (Campbell-Arvai & Arvai, 2015; Campbell-Arvai et al., 2014). However, these strategies do not target the underlying factors that influence meat consumption (e.g., beliefs, social norms, habits), and thus are unlikely to change meat consumption in the home or in restaurant settings where meat-free default menus are absent.

Other studies provide support for self-regulation strategies (Carfora et al., 2017; Loy et al., 2016; Rees et al., 2018). However, one excluded individuals who did not already intend to reduce meat consumption (Rees et al., 2018), and the other found that intention strength significantly predicted meat reduction, suggesting that a moderate-to-strong intention to reduce is necessary for implementation-intentions to effect meat reduction (Loy et al., 2016). Thus, implementation-intention strategies might be effective only when targeting individuals who already intend to reduce meat consumption.

Profiles of meat eaters. Behaviour-change interventions that are tailored to the audience and to the underlying factors influencing a specific behaviour are more successful (Gifford, 2014; Osbaldiston & Schott, 2012; Reynolds, 2010). Most of the aforementioned meat experiments used a "one-size-fit- all" approach, with the exception of that by Klöckner and Ofstad (2017) in which information strategies were tailored to each stage of change. Matched interventions represent an important area of underexplored potential for reducing meat consumption.

Latent profile analysis was recently used to identify three groups of Canadians with distinct perceptions of facilitators and inhibitors of meat consumption: meat-reducers, moderate-hindrance meat eaters, and strong-hindrance meat eaters (Lacroix & Gifford, 2019; Chapter 3 of this dissertation). The groups differed in terms of their consumption of meat and animal products: strong-hindrance meat eaters ate meat most frequently, followed closely by moderate-hindrance meat eaters, and meat-reducers reported the lowest consumption of meat.

In Chapter 3, we proposed that groups are arranged in a hierarchical pyramid based on their perceptions of what inhibits reducing their meat consumption (Figure 5). At the top of the pyramid, meat-reducers perceive the fewest hindrances to reducing meat consumption. In the middle, moderate-hindrance meat eaters perceive a middle level of inhibitors, including lack of social support, low awareness of health implications, and attachment to meat. At the bottom, strong-hindrance meat eaters perceive the most hindrances, including a dislike of trying new foods, lack of time, and low availability of plant-based foods.

Behaviour-change frameworks

Interventions should be grounded in evidence and are most effective when a combination of theories and frameworks are consulted (Glanz & Bishop, 2010; Rubinstein, 2018). The following four frameworks, originally developed to guide the design of health and environmental interventions, informed the design of the interventions employed in this study:

The COM-B system associated with the Behaviour Change Wheel framework proposes three necessary conditions in a behaviour system: capability, opportunity, and motivation (Michie et al., 2011). Behaviour-change techniques are presented to address each missing component in the behaviour system (e.g., training to help increase physical capability). The COM-B model has been applied to recycling, energy-reduction, and dietary interventions (Gainforth, Sheals, Atkins, & Michie, 2016; Handley et al., 2016; McEvoy et al., 2018; Nour, Rouf, & Allman-Farinelli, 2018; Wilson & Marselle, 2016).

The stage model of self-regulated change proposes four stages of change: predecisional, preactional, actional, and postactional (Bamberg, 2013a). Three types of intentions (i.e., goal, behavioural, and implementation-intention) mark the transitions between the four stages. Behaviour-change strategies are matched to each stage and target these transition points. The stage model of self-regulated change has been used in transportation, energy-reduction, and beef consumption interventions (Bamberg, 2013a; Klöckner, 2014, 2017; Klöckner & Nayum, 2016; Klöckner & Ofstad, 2017; Olsson, Huck, & Friman, 2018; Sunio, Schmöcker, & Kim, 2018).

Community-based social marketing (CBSM) proposes that programmers should consider perceived barriers and benefits associated with a targeted behaviour during the design of interventions (Mckenzie-Mohr, 2011; Schultz, 2014). In applying CBSM principles in the context of pro-environmental behaviour, Schultz (2014) identified four quadrants: high barriers and high benefits, high barriers and low benefits, low barriers and high benefits, and low barriers and low benefits. He proposed that behaviour-change strategies should be matched to each quadrant.

The segmentation model of behaviour change proposes three fundamental drivers of sustainable behaviour: motivation, opportunity, and habit (Verplanken, 2018). This model proposes segmenting consumers into four segments based on their level of motivation and opportunity (i.e., high/low motivation, high/low opportunity). Habit is assumed to be strongest for those in the low levels and weakest for those in the high levels of motivation and opportunity. Verplanken (2018) proposed behaviour-change strategies that are relevant for each consumer segment.

The present study

The primary objective of the present study was to evaluate the effectiveness of using group-tailored interventions to reduce consumption of GHG-intensive meat and animal products. In addition, the study attempted to replicate the profiles of meat-eaters identified in Chapter 3. Critical analyses of each intervention framework were conducted to identify what seemed to be the most effective behaviour-change strategies for each group. These analyses were guided by the four behaviour-change frameworks described above.

Based on these analyses, three group-tailored interventions were designed: an implementation-intention condition (designed to match the meat-reducer group), an information-and-healthy-recipe condition (designed to match the moderate-hindrance meat eaters), and an information-and-substitution condition (designed to match the strong-hindrance meat eaters). These interventions and their rationales are described in detail in the method section and in Appendix C. All participants were randomly assigned to one of the three intervention conditions, or to a control condition.

We hypothesized that:

Hypothesis 1: Initial levels of animal product consumption will be highest for strong- and moderate-hindrance meat-eater groups, compared to the meat-reducer group.

Hypothesis 2: Changes in animal product consumption over time will be significantly greater in the treatment conditions than in the control condition.

Hypothesis 3: Changes in animal product consumption for group-matched interventions (e.g., individuals in the meat-reducer group who were randomly assigned to the implementation-intention condition) will be significantly larger than in the control and the mismatched conditions.

Method

Designing theory-based interventions

A four-step approach informed the design of theory-based interventions. First, the behavioural drivers from the four behaviour-change frameworks were summarized (Table 7). Second, using meat-specific facilitator and inhibitor variables measured in Chapter 3, analogous constructs corresponding to each behavioural driver were identified (Table 7).

Table 7

Behavioural drivers of meat consumption

	Behavioural drivers	Similar drivers measured in Lacroix and Gifford (2019), i.e., Chapter 3
COM-B (Michie et al., 2011)	Capability (physical capacity e.g., cooking skill)	Perceived behavioural control, self-efficacy.
	Capability (psychological capacity e.g., nutritional knowledge)	Health prevention, self-efficacy.
	Opportunity (physical opportunity e.g., access)	Time and availability of alternatives, cost.

	Opportunity (social opportunity e.g., cultural norms)	Social influence and support, stereotypical masculinity, entitlement
	Motivation (reflective motivation e.g., intention and planning)	Beliefs and identities, food involvement, dependence on meat, willingness to change.
	Motivation (automatic motivation e.g., habit)	Conformity, neophobia, taste, dietary routine.
Stage model of self-regulated change (Bamberg, 2013b).	Predecisional (e.g., happy with current level of meat consumption and see no reasons to reduce it) Preactional (e.g., currently thinking about reducing meat consumption, but I'm not sure how to do so) Actional (e.g., aim to reduce meat consumption and I know how to do so, but have not yet put this into practice) Postactional (e.g., I already try to reduce, and will maintain or further reduce in the future).	*Not measured.* *The stage of change can be estimated using the item "Have you already made conscious efforts to reduce meat consumption?".*
Strategies for promoting pro-environmental behaviour (Schultz, 2014)	Barriers (characteristics of the behaviour, e.g., access, cost, difficulty)	Time and availability of alternatives, cost, perceived behavioural control, self-efficacy, taste, neophobia, dependence, entitlement.
	Benefits (characteristics of the target population, e.g., monetary savings, environment, social recognition, desire to engage)	Health and environmental beliefs, health prevention, social influence and support, willingness to change.
Segmentation model of behaviour change (Verplanken, 2018)	Motivation (goals and intention to act, e.g., attitudes, social norms, and perceived behavioural control)	Entitlement, dependence, taste, health and environmental beliefs and identities, taste, neophobia, social influence and support, willingness to change, perceived behavioural control.
	Opportunity (barriers and facilitators enabling action, e.g., structural or financial, personal skills and knowledge)	Time and availability of alternatives, cost, self-efficacy, health prevention, stereotypical masculinity, social conformity.

	Habit (automatic responses to cues)	*Not measured.*

Third, each group was analyzed to determine the probable presence or absence of behavioural drivers in typical group members, their likely stage of change, or their consumer quadrant, according to the four behaviour-change frameworks. The findings from these analyses are detailed in Table 8. For example, under the COM-B framework, capability, which contains elements of physical capacity (e.g., having the necessary cooking skills) and psychological capacity (e.g., ability to understand health information), is identified as a missing component in the two meat-eater groups (i.e., moderate- and strong-hindrance groups) but not in the meat-reducer group.

Table 8

Group-matched behaviour-change strategies

		Meat-reducers	Strong- and moderate-hindrance meat eaters‡
COM-B (Michie et al., 2011)	Missing component(s)	Motivation (automatic).	Capability (physical and psychological), opportunity (physical and social), motivation (reflective and automatic).
	Matched strategies	Persuasion (e.g., discussion of benefits), incentivization (e.g., rewards), coercion (e.g., punishment or cost), environmental restructuring (e.g., prompts), modelling (e.g., inspirational examples), enablement (e.g., support).	Enablement (e.g., support), environmental restructuring (e.g., prompts), education (e.g., instructions), persuasion (e.g., discussion of benefits), incentivization (e.g., rewards), coercion (e.g., punishment or cost), training (e.g., skills), restriction (e.g., prohibiting rules), modelling (e.g., inspirational examples).
Stage model of self-regulated	Stage	Likely in the actional/ postactional stage.	Likely in the predecisional/preactional stages.

change (Bamberg, 2013b)	Matched strategies	Support behavioural planning, feedback, procedural knowledge (i.e., how-to achieve a goal), commitments, goal setting.	Social and personal norms saliency (role models /opinion leaders), enhance problem awareness, present behavioural alternatives, enhance perceived behavioural control, increase intention, effectiveness and declarative knowledge.
Strategies for promoting pro-environmental behaviour (Schultz, 2014)	Quadrant	Lower right quadrant (i.e., low barrier / high benefit).	Upper right quadrant (i.e., high barrier / mid to high benefit).
	Matched strategies	Support existing behaviour: Education, feedback, prompts, cognitive dissonance.	Decrease perception of barriers: Make it easy, commitments.
Segmentation model of behaviour change (Verplanken, 2018)	Quadrant	Upper right quadrant (high motivation / high opportunity)	Lower quadrants (middle motivation / low opportunity)
	Matched strategies	Empower (goal setting, commitment, community-based "leaders")	Choice architecture (legislation, infrastructure) and Support (Feedback, habit discontinuity, community-based "followers").
Strategic overview		Focus on supporting existing behavioural intentions. *Relevant behaviour-change strategies: Goal setting, implementation-intention plan, commitment.*	Focus on increasing perceived benefits and behavioural intentions. *Relevant behaviour-change strategies: Social norms saliency, declarative knowledge (e.g., health and environmental co-benefits), effectiveness knowledge‡ (self-efficacy and perceived feasibility).*

Note: ‡ Although these two meat-eater groups are generally similar, Chapter 3 suggests significant differences in food involvement and neophobia between moderate- and strong-hindrance meat eaters. Accordingly, different approaches were proposed in the present study to target their effectiveness knowledge (i.e., Conditions 1B and 2B).

Fourth, behaviour-change strategies were selected to target each of the missing behavioural drivers (Table 8). The four behaviour-change frameworks provided recommendations for selecting the most effective intervention strategies to target either the missing components (Michie et al., 2011), the stage of change (Bamberg, 2013b), or the consumer quadrant (Schultz, 2014; Verplanken, 2018). For example, individuals who are already making efforts to reduce meat consumption likely belong to the actional or postactional stages of change (Verplanken, 2018) and, accordingly, intervention strategies should focus on the formation of implementation-intentions.

Steps three and four were repeated for the three groups identified in Chapter 3. Combined, the four behaviour-change frameworks suggest that interventions should focus on supporting existing behavioural intentions for the meat-reducer group and on increasing behavioural intentions for the two meat-eater groups.

Intervention materials. Three interventions conditions were designed to match the group-specific strategic overview of theory-based recommendations (Table 8). For strong- and moderate-hindrance meat eater groups, an overview of behaviour-change frameworks (see Table 8) suggested a focus on increasing the perceived benefits of reducing meat consumption, especially red and processed meats, and the formation of behavioural intentions. Thus, in treatment conditions 1A and 2A, participants were first presented with a news story, which was comprised of pieced-together segments of authentic news articles discussing Canada’s new Food Guide (Howard & Culbert, 2018; Hui, 2017; Sagan, 2017). The news story aimed to inform participants of the health and environmental consequences of red and processed meat consumption. Recognizing the traditional role that meat plays in Canadian diets, it highlighted a "reducetarian" approach. These two treatment conditions (i.e., conditions 1A and 2A) also included a descriptive social norm (i.e., that 45% of Canadians are already making efforts to reduce their consumption of meat).

Strong- and moderate-hindrance meat eaters differed on certain food preferences, such as their levels of food neophobia, food involvement, and healthy eater identities. Moderate-hindrance meat eaters reported the same level of food neophobia than the meat-reducer group (i.e., they tend to be open to trying new foods), but strong-hindrance meat eaters preferred to eat familiar foods. Moderate-hindrance meat eaters also tended to attach more importance to the nutritional quality of their food compared to strong-hindrance meat eaters. Thus, different approaches were used to target effectiveness knowledge in conditions 1B and 2B. To match the preferences of strong-hindrance meat eaters, treatment condition 1B included efficacy-building information framed around substituting red meat in already familiar meals (i.e., the substitute condition). To match the preferences of moderate-hindrance meat eaters, treatment condition 2B instead included efficacy-building information framed around incorporating new healthy recipes that featured lean meats and plant-based proteins (i.e., the recipe condition).

The vast majority (92%) of individuals in the meat-reducer group had already made efforts to reduce their consumption of meat. Together, the behaviour-change frameworks suggest that intervention strategies for meat-reducers should focus on supporting existing behavioural intentions. In treatment condition 3 (i.e., implementation plan) participants were first asked to write down a specific behavioural goal. They were then guided through a series of steps leading to the formation of implementation plans (e.g., "If chicken is not available in a restaurant, then I will order fish;" Adriaanse & Verhoeven, 2018). Finally, participants were invited to make a behavioural commitment by sharing their goal with a friend or family member. In the control condition, participants were asked to complete an unrelated survey. The intervention conditions are described in more detail in Appendix C.

Procedure

The study consisted of up to 16 online surveys completed by participants over three study phases: a profiling phase, a baseline food diary and intervention phase, and a follow-up food diary phase. During the first phase of the study, participants completed the profiling survey which asked about their food preferences. Upon completing the profiling survey, they were eligible to begin phase two of the study. During this phase, they reported their baseline (i.e., current) consumption of animal products (meat, dairy, eggs) and meat-substitutes. To encourage more accurate recall of food consumption, we limited self-reporting to the day before, with an option to complete a food diary for two-days prior if they could remember what they ate. The participants were randomly assigned to, and guided through, one of four conditions (i.e., three interventions and one control condition).

Participants were eligible to complete phase three two days after they had completed the baseline food diary and intervention phase. During it, they were invited to complete semi-daily diaries (i.e., every two days) to self-report their consumption of animal products, using the same procedure as for the baseline food survey in phase two. A maximum of 14 semi-daily diaries (28 diary days if they could remember what they ate two-days prior) were collected over a period of up to 60 days.

Recruitment. A sample of 471 Canadians were initially recruited using Turk Prime. Participants who failed the validation questions (e.g., “To validate your continued participation please select ‘agree’ for this question”, n = 34) were excluded from the analyses. We excluded participants who reported dietary restrictions (*n* = 60) from the profiling analysis, because these restrictions were likely to create additional barriers. After these participants were removed, 377 remained for the profiling analysis in phase one.

Two-hundred fifty-two participants of the original total participated in phase two of the study and were retained for hypothesis testing. Sixty-three (63) were randomly assigned to condition 1, 64 to condition 2, 72 to condition 3, and 53 were assigned to the control condition. One hundred sixty-five participants of the original total participated in phase three of the study by completing at least one follow-up food diary. Of these, 90 completed at least seven days of follow-up food diaries, 61 completed at least 14 days of follow-up food diaries, 34 completed at least 21 days of follow-up diaries, and 14 completed all 28 days of follow-up food diaries. Logistic regression revealed that the data are assumed to be missing at random; missingness was related to other observed variables (e.g., age) but not to the outcome variable (Nicholson, Deboeck, & Howard, 2015).

Profiling measures. During the first phase of the study, the same profiling variables as those used in Chapter 3 were measured (e.g., entitlement to meat, food involvement, etc.). Additional items were included to improve measures of meat-eating habits and social support, that did not result in reliable scales in the previous study: five items were added to measures meat-eating habit strength (e.g., “Eating meat is something that I do automatically;” Rees et al., 2018), and six items were included to measure social support for healthy diets and meat-reduced diets (e.g., “Friends and family offer me healthy foods when I visit their home” and “My friends and family will support me if I choose to change my diet so that it includes less meat;” Sallis, Grossman, Pinski, Patterson, & Nader, 1987; Steptoe, Perkins-Porras, Rink, Hilton, & Cappuccio, 2004; Zur & Klöckner, 2014).

These attempts to improve the meat-eating habits scale were successful. The new meat-eating habit strength scale was reliable (Cronbach's alpha = .86). We factor analyzed the social support items (i.e., 6 items from the original study and 6 new items). After two weak items were removed, principal axis factor analysis with oblimin rotation suggested two factors: social support for eating less meat (e.g., "Important people in my life are supportive of me eating less meat") and social support for eating a healthy diet (e.g., "People around me encourage me not to give up on my healthy eating goals"). Reliability for the social support scales was weak (i.e., Cronbach's alphas of .63 and .60), but the scales were retained because this was deemed preferable to using single items. All other scales were adequately reliable (see Appendix C for items and scale reliability).

The profiling scales were used to separate participants into the groups post hoc and to verify the replicability of the meat-eater profiles. Validation items were measured to verify the practicality of the segmentation tool: one item measured past efforts to reduce meat consumption and three items measured willingness for dietary change. Age, gender, income, education, and political ideology were also measured.

Outcome measure. Reported animal product consumption was repeatedly measured using food diaries during the second and third phase of the study. Using conditional survey questions (i.e., branch or skip logic) to minimise participant fatigue, portions of beef, pork, chicken, fish, cheese, eggs, yogurt, milk, tofu, meat-replacement products (e.g., vegetarian burger), and legumes were measured (e.g., "Did you eat beef yesterday?" If yes, "How many portions of beef did you eat yesterday?"). Examples were provided to help participants estimate the number of portions (e.g., one portion of meat is about the size of a deck of cards; American

Heart Association, 2017; Dieticians of Canada, 2017; Eat Right Ontario, 2015). Self-reported number of portions were converted to kg of product post hoc.

Because not all types of animal products are equal in terms of GHG emissions (Table 9), self-reported consumption of each type of animal product was weighted according to its GHG emissions (e.g., 85 g of beef multiplied by 26.61 kg of CO_2e per kg of beef = 2.26 kg of CO_2e). The resulting weighted values for each type of animal product were summed to calculate a total daily animal product consumption score for each individual. This weighted daily animal product consumption score was used during hypotheses testing.

Table 9

Greenhouse gas emissions for different animal products

Food category	kg CO_2e / kg product	Number of studies included in meta-analysis	Emissions ratio (compared to beef)	Portion size (g)
Beef	26.61	49	1	85
Lamb	25.58	22	0.96	85
Cheese	8.55	22	0.32	43
Turkey	7.17	3	0.27	85
Pork	5.77	38	0.22	85
Chicken	3.65	29	0.14	85
Fish (all species)	3.49	47	0.13	85
Eggs	3.46	19	0.13	56
Yogurt	1.31	7	0.05	175
Milk	1.29	77	0.05	245
Meat-replacement	1.20	-	0.05	100
Tofu	0.98	-	0.04	150
Legumes	0.51	15	0.02	139

Note: Legumes include beans, peas, chickpeas, lentils, soybeans, peanuts and ground nuts. kg CO_2e / kg product estimates are median values from a meta-analysis (Clune, Crossin, & Verghese, 2017), except for meat-replacement and tofu estimates which were not included in the meta-analysis. The meat-replacement estimate is from Blonk, Kool, Luske, and de Waarf (2008) and Zhu and Ierland (2004), and the tofu estimate is from Mejia et al. (2018).

Results

Segmentation

Nineteen profiling variables were retained: meat entitlement, dependence on meat, liking the taste of meat, lack of perceived behavioural control, lack of time and availability of vegetarian food, health beliefs about meat, ethical beliefs about meat, lack of food involvement, healthy-eater identity, environmental identity, conformity, stereotypical masculinity, food neophobia, lack of health prevention orientation, lack of self-efficacy, cost, meat-eating habit strength, social support for meat reduction, and social support for healthy eating.

A Latent Profile Analysis (LPA) was conducted using the mclust package in R (Scrucca et al., 2017). Model fit was assessed using Bayesian Information Criterion (BIC) and Bootstrapped Likelihood Ratio Test (BLRT). The two-profile solution appeared slightly preferable to the three-profile solution based on BIC (Table 10). Significant BLRT values indicate that the model with more profiles is a better fit (Stanley et al., 2017), and it was significant for the three-profile model (Table 10). Although the two- and three-profile solutions seemed appropriate, the three-profile model was deemed more practical for the purpose of this study because the intervention materials were designed to match the three distinct groups. Thus, the three-profile model was retained.

Table 10

Model fit indices

Profile solution	BIC	BLRT
1	-20968.39	
2	-20968.34	83.22 (.001)
3	-21035.09	99.23 (.001)

Note: BIC: Bayesian information criterion; BLRT: Bootstrap likelihood ratio test and *p* value.

Forty participants (11%) were thereby assigned to the meat-reducer group, 151 (40%) to the moderate-hindrance meat eater group, and 186 (49%) to the strong-hindrance meat eater group. The demographic profiles of each group are shown in Table 11. These profiles replicated the meat-eater groups identified in Chapter 3. Univariate ANOVAs were conducted to compare the three groups and are detailed in Appendix C.

Table 11

Group demographics

	Meat-reducers	Moderate-hindrance	Strong-hindrance
% of total sample	11%	40%	49%
% of males	35%	54%	54%
Political ideology	2.13 (0.85)	2.38 (0.99)	2.59 (1.04)
Education	3.85 (1.03)	3.43 (1.00)	3.19 (1.08)
Age	35 (10)	32 (9)	31 (11)
Baseline consumption	2.99 (3.92)	4.23 (7.3)	5.04 (5.6)

Note: Standard deviations are included in parentheses. Political ideology scale: 1 = very liberal to 5 = very conservative. Education scale: 1 = elementary school diploma to 6 = PhD. Baseline consumption scale: baseline GHG-weighted animal product consumption.

Hypothesis testing

Group differences. To test hypothesis 1, that initial levels of animal product consumption (i.e., GHG-weighted animal product consumption score at baseline) were larger for the strong- and moderate-hindrance meat eating groups than for the meat-reducer group, a one-way analysis of variance was conducted. Means for the strong-hindrance group were almost significantly larger than for the meat-reducer group ($MD = 2.05$, $d = 0.42$, $p = .10$), a small-to-medium effect size. Means for the moderate-hindrance group were not significantly different than for the meat-reducer group ($MD = 0.8$, $d = 0.21$, $p = 0.63$) or the strong-hindrance group ($MD = -1.2$, $d = -0.12$, $p = 0.49$). Hypothesis 1 was only partially supported; initial levels were highest for the strong-hindrance group and were lowest for the meat-reducer group.

Multilevel models. Prior to testing the next hypotheses, an unconditional means model was used to decompose the total variance into within- and between-person components (Singer & Willett, 2003). The intraclass correlation (ICC) was .63, indicating that about two-thirds of the variation in GHG-weighted animal product consumption could be accounted for by within-person variance. The equation for this model is:

$$(1)\ Y_{ij} = y_{00} + u_{0i} + E_{ij}$$

where subscript i represents the participants (i.e., $i = 1 \ldots 252$), subscript j represents the measurement occasions (i.e., $j = 0, 1, 2, \ldots 60$), y_{00} represents the population average intercept, u_{0i} represents the person-specific intercept, and E_{ij} represents the residual variance. This model was estimated using the nlme package in R (Pinheiro, Bates, DebRoy, Sarkar, & R Core Team, 2019). The R code for the multilevel models is included in Appendix C.

Next, an unconditional growth model was estimated, which includes time as a predictor of GHG-weighted animal product consumption and allows for the intercept and the slope to vary between individuals. The equation for this model is:

$$(2)\ Y_{ij} = y_{00} + y_{10}\mathrm{TIME}_{ij} + u_{0i} + u_{1ij}\mathrm{TIME}_{ij} + E_{ij}$$

where $y_{10}\mathrm{TIME}_{ij}$ represents the population average slope and $u_{1ij}\mathrm{TIME}_{ij}$ represents the person-specific slope.

The likelihood ratio test statistic for comparing the unconditional means model and the unconditional growth model was significant (L.Ratio = 52.49, p <.001), indicating that individuals vary in their rate of change. Comparing the residual variance between these two nested models revealed that time explains about 4% of the within-person variance (Singer & Willett, 2003). On average, GHG-weighted animal product consumption at the first time of measurement was 3.81 kg of CO_2e and decreased at a rate of -0.02 kg of CO_2e per day (i.e., y_{00} and y_{10} for Model 2; Table 12). In more concrete terms, a reduction of 20g of CO_2e per day would be the equivalent of replacing a chicken-salad sandwich with an egg-salad sandwich once per day or of replacing one portion of pork with chicken once per week (more details in Appendix C).

Table 12

Multilevel analyses of animal product consumption

Variable	Model 1	Model 2	Model 3	Model 4
Fixed Effects				
Intercept (y_{00})	3.73 (0.27)***	3.81 (0.28)***	3.23 (0.61)***	3.65 (0.32)***
Time (y_{10})		-0.02 (0.01)**	-0.01 (0.01)	-0.01 (0.01)
Treatment (y_{01})			0.73 (0.69)	
Treatment*Time (y_{11})			-0.01 (0.02)	
Matching (y_{02})				0.62 (0.64)
Matching*Time (y_{12})				-0.03 (0.01)*
Random Effects				
Intercept variance (u_{0i})	16.33***	17.59***	17.49***	17.54***

Time variance (u_{1ij})		0.004***	0.004***	0.004***
Residual variance (E_{ij})	5.47	5.25	5.25	5.24
Deviance (loglik)	-5481.321	-5455.076	-5454.462	-5452.975
AIC	10968.64	10922.15	10924.92	10921.95
BIC	10985.81	10956.49	10970.71	10967.74

Note: Standard errors of fixed effects included in parentheses. Significance: *p < .05. **p < .01. ***p < .001.

To test Hypothesis 2, that the changes in GHG-weighted animal product consumption over time would be larger in the treatment conditions than in the control condition, a variable named Treatment was created (control = 0, treatment = 1). A cross-level interaction between this treatment variable and time was included as a fixed effect in the multilevel model. The equation for this model is:

$$(3)\ Y_{ij} = y_{00} + y_{01}\text{TREATMENT}_i + y_{10}\text{TIME}_{ij} + y_{11}\text{TREATMENT}_i{*}\text{TIME}_{ij} + u_{0i} + u_{1j}\text{TIME}_{ij} + E_{ij}$$

where y_{00} represents the intercept for the average participant in the control condition, $y_{01}\text{TREATMENT}_i$ represents the difference in the intercept between the average control and treatment participants, $y_{10}\text{TIME}_{ij}$ represents the slope for the average control participant, $y_{11}\text{TREATMENT}_i{*}\text{TIME}_{ij}$ represents the difference in the rate of change between the average control and treatment participants, u_{0i} represents the person-specific intercept, $u_{1ij}\text{TIME}_{ij}$ represents the person-specific slope, and E_{ij} represents the residual variance.

No significant difference in the initial GHG-weighted animal product consumption (y_{02}) was found between the average control and treatment participants (b = 0.73, p = 0.69). The cross-level interaction between time and treatment (y_{11}) was not significant, indicating that there was no significant difference in the rate of change between the average control and treatment participant. Hypothesis 2 was not supported.

Hypothesis 3 predicted that changes in GHG-weighted animal product consumption would be larger in group-matched conditions than in the control and the group-mismatched conditions. This was tested by creating a variable named Matching (mismatched = 0, matched = 1). A cross-level interaction between time and matching was included as a fixed effect in the multilevel model. The equation for this model is:

$$(4)\ Y_{ij} = y_{00} + y_{02}\text{MATCHING}_i + y_{10}\text{TIME}_{ij} + y_{12}\text{MATCHING}_i{*}\text{TIME}_{ij} + u_{0j} + u_{1j}\text{TIME}_{ij} + E_{ij}$$

where y_{00} represents the intercept for the average mismatched participant, $y_{02}\text{MATCHING}_i$ represents the difference in the intercept between the average mismatched and matched participants, $y_{10}\text{TIME}_{ij}$ represents the slope for the average mismatched participant, $y_{12}\text{MATCHING}_i{*}\text{TIME}_{ij}$ represents the difference in the rate of change between the average mismatched and matched participants, u_{0i} represents the person-specific intercept, $u_{1ij}\text{TIME}_{ij}$ represents the person-specific slope, and E_{ij} represents the residual variance.

No significant difference in the initial (i.e., intercept) GHG-weighted animal product consumption (y_{02}) was found between the average mismatched and matched participants (b = 0.62, p = 0.64). The slope (y_{10}) for the average mismatched participant was not significant (b = -0.01, p =.09). However, the cross-level interaction between time and matching (y_{12}) was significant (b = -0.03, p =.04), indicating that the rate of the change for the average matched participant was -0.03 units per day larger than for the average mismatched participant. In other words, reductions in GHG-weighted animal product consumption were 10 grams of CO_2e per day on average for the mismatched participants, and 40 grams of CO_2e per day on average for the matched participants. The difference in slopes between those who were matched and mismatched to their treatment condition is illustrated in Figure 6. Therefore, Hypothesis 3 was supported; rates of change (i.e., slope) in GHG-weighted animal product consumption were larger in group-matched than in group-mismatched conditions.

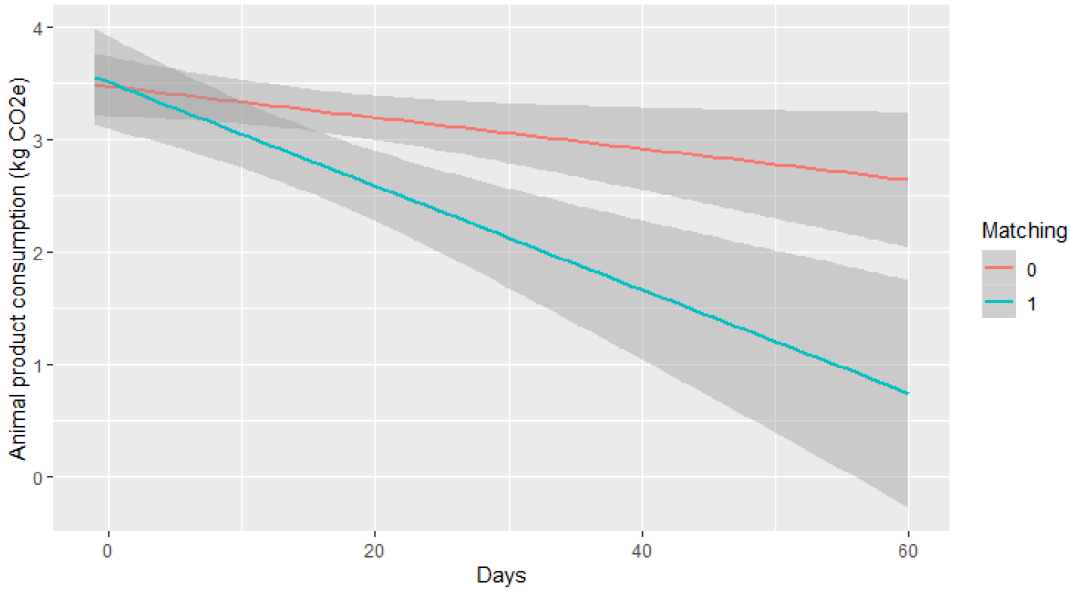

Figure 6. Comparing change in animal product consumption for matched and mismatched groups.

Note. The shaded area represents the 95% confidence interval.

Discussion

After improvements were made to two of the profiling scales from the previous study (Chapter 3), the present study successfully replicated the grouping structure and associated willingness for dietary change. Participants reduced their GHG-weighted animal product consumption by 20 g of CO_2e per day on average, equivalent to about replacing one portion of pork with chicken once per week. Compared to those who were assigned to a mismatched condition, participants who were assigned to a treatment condition that was designed specifically to address their group's meat consumption inhibitors presented significantly larger reductions in GHG-weighted animal product consumption (i.e., reduction of 40 g of CO_2e per day), equivalent to about replacing one chicken-based meal with a vegetarian meal every week.

To the best of our knowledge, this is the first study to account for the variability in GHG emissions for different types of meat by using a weighted measure of animal product consumption. Past experimental studies of meat reduction are scarce, and those that use a comparable meat consumption measure are even scarcer. Nevertheless, the degree of change over time in the present study resembles that from one previous study, which found a reduction of about 1.5 portions of red meat per week (Carfora et al., 2017). Similarly, the reduction in GHG in the present study is equivalent to approximately one less portion of red meat (i.e., pork) per week for the average participant, or two portions for participants in the group-matched condition. This reduction may seem small, but it can amount to large reductions in GHG emissions if many individuals make these changes, and would also help increase the perception of social support for reducing meat consumption, which was an inhibitor for all three meat-eater groups in the present study.

In Chapter 3, we found that frequency of animal product consumption for the strong- and moderate-hindrance meat-eater groups significantly differed from the meat-reducer group. In the present study, no significant differences were found between the three groups (Hypothesis 1). These discrepancies are most likely caused by variations in measurement. In the previous study, items were summed (i.e., consumption of red meat, white meat, fish, and eggs and dairy) to measure frequency of animal product consumption. When comparing between the groups, variations in the types of animal products (i.e., red meat vs. white meat) consumed were not accounted for because all four types were given equal weight. However, these nuances are reflected in the present study's outcome measure because each type of animal product is weighted according to their GHG emissions.

The grouping structure varied slightly between the previous study and the present one. Strong-hindrance meat eaters tended to be more food neophobic than the moderate-hindrance and the meat-reducer groups in the original study, but no significant differences were found in the present study. Also, moderate-hindrance meat eaters tended to feel less entitled and dependent on meat compared to the strong-hindrance meat eaters in the present study, but they did not significantly differ in the original study. Nevertheless, these variations are minor and we see no reason to question the design of group-tailored intervention conditions in the present study. However, they do highlight some key considerations for conducting latent profile analyses, namely the importance of using theory-based profiling variables and of using validated scales as often as possible.

Previous findings provided support for the use of self-regulation strategies, moderated by intentions to reduce (e.g., Loy et al., 2016), but provided limited support for information strategies (Brunner et al., 2018; Campbell-Arvai & Arvai, 2015; Campbell-Arvai et al., 2014; Monroe et al., 2015). These mixed findings may be partly attributed to their use of one-size-fits-all approaches, as opposed to a more tailored approach. In the present study, no significant differences were found in the rate of change between the three treatment conditions and the control condition, but significant differences occurred between group-matched (i.e., tailored) and group-mismatched conditions. Future research could increase understanding of the effect of individual preferences on dietary change by designing tailored interventions and by using multilevel models.

The behaviour-change frameworks suggested key differences in intervention strategies for each meat-eater group. For individuals in the meat-reducer group, tailored interventions should focus on supporting existing behavioural intentions. Supported by previous research

(Carfora et al., 2017; Loy et al., 2016; Rees et al., 2018), the present findings suggest that implementation-intention planning is a promising approach for targeting individuals who intend to reduce. For individuals in the meat-eater groups, interventions should focus on increasing their perception of the benefits of reducing meat consumption and on increasing their behavioural intentions. The present findings suggest that promoting small dietary changes within already-familiar meal formats (i.e., substitution) is a promising approach for strong-hindrance meat eaters, who make up the largest segment of the sample. Building on previous findings (Elzerman, Hoek, van Boekel, & Luning, 2011; Hoek et al., 2013; Schösler, Boer, & Boersema, 2012), future research should continue to explore the potential of using meat substitutes to help habitual meat-eaters reduce meat consumption.

Some limitations apply to the present study. As is common in longitudinal research, approximately one-third of participants were lost at each study phase. A larger sample would allow for a better understanding of the differences between groups and types of interventions. Special consideration should be given to strategies for increasing retention rates (Booker, Harding, & Benzeval, 2011). Attempts were made to reduce recall error by limiting each food diary to the past two days. Nevertheless, this study focused on self-reported food consumption and is susceptible to social desirability response bias. Furthermore, the meat-eater profiles were developed with Canadian samples, and their applicability to other cultures should be examined.

Conclusion

Consumption of meat and dairy is responsible for a large portion of global GHG emissions and is linked to higher incidences of cancer, cardiovascular disease, and diabetes (e.g., Aston et al., 2012; Gonzalez, 2006). By designing theory-based interventions tailored to different meat-eater profiles, this study demonstrated that group-matched interventions represent an important area of underexplored potential for reducing meat consumption, thereby contributing in a substantive way to the mitigation of climate change.

Chapter 5: General Discussion

Previous researchers have evaluated the effectiveness of intervention strategies to promote PEB (e.g., Campbell-Arvai et al., 2014; Loy et al., 2016), and reviews of such work conclude that choice architecture and social comparison messages are most promising for changing PEB (Byerli et al., 2018; Nisa, Bélanger, Schumpe, & Faller, 2019). However, most of these interventions use one-size-fits-all approaches, other than a few interventions tailored to the stage of change (Bamberg, 2013a; Klöckner & Osftad, 2017) or to home energy audits (Abrahamse, Steg, Vlek, & Rothengatter, 2007). This dissertation focuses on how individual differences in beliefs, motivations, and perceptions of barriers can inform the tailoring of PEB interventions. Furthermore, this dissertation uses behaviour-change frameworks (e.g., Behaviour Change Wheel) to diagnose key influencing factors for a specific behaviour and to select behaviour-change techniques that are most appropriate to address these factors.

Summary

Chapter 2 (Study 1) used longitudinal data to examine changes in climate change risk perception and in climate policy support over the course of a forest fire season. Predictor variables from the Climate change risk perception model (CCRPM) were measured at phase 1 (e.g., values, norms, knowledge) and were used to test a replication of the model. Indirect exposure to forest fire, direct exposure to forest fire, direct exposure to other types of extreme weather, climate change risk perception, and climate policy support were measured at all 3 phases and were entered in our longitudinal growth models. Whereas the CCRPM was originally used in a British sample and included personal experience with floods as a predictor, the cross-sectional analyses in Study 1 demonstrated support for the model in a new context: Canadian residents' experience with forest fires. CCRPM predictors in both studies had a large effect on climate change risk perception. Longitudinal growth analyses demonstrated the importance of individual differences in climate change beliefs: perception of scientific agreement had a medium-to-large effect (r = .43) on initial levels of climate change risk perception and small-to-medium effect on (r = .26) the rate of change.

Chapter 3 (Study 2) included a comprehensive literature review of the underlying factors influencing meat consumption (i.e., 97 relevant studies were retained), which suggested 19 key factors. These factors were measured in a Canadian sample and latent profile analysis (LPA) was used to identify groups of individuals with similar patterns of underlying influences to meat consumption (e.g., similar levels of food involvement, ethical beliefs about meat, or dependence on meat). Three groups were identified: strong-hindrance meat eaters, moderate-hindrance meat eaters, and reducers. The grouping structure was successfully validated to ensure that it predicted the behaviour of interest: groups were significantly different in their frequency of eating meat, vegetarian meals, and willingness for dietary change. The end goal of Study 2 was to inform the tailoring of interventions targeting meat consumption.

Chapter 4 (Study 3) designed and tested three interventions based on group-specific underlying influences of meat eating, using findings from the previous study. Prior to data collection, I applied four behaviour-change frameworks to design interventions specifically matched to each group. Study participants were randomly assigned to one of four conditions: information-and-substitution condition designed to match the strong-hindrance meat eaters, information-and-recipe condition designed to match the moderate-hindrance meat eaters, implementation-intention condition designed to match the reducers, and a control condition. The main hypothesis was supported: group-matched conditions resulted in significantly larger decreases in consumption of animal product over time, compared to group-mismatched conditions.

Advancement in Knowledge

These three studies highlight the importance of considering individual differences when designing PEB interventions. Using a naturalistic quasi-experiment, Study 1 provided evidence for the moderating effect of the perception of scientific agreement on climate change risk perception, both in terms of the initial group differences and in terms of the rates of change over time (Figure 4). Study 2 provided evidence that grouping individuals with similar preferences, beliefs, and habits predicts differences in consumption of animal products. Study 3 showed that interventions can be up to four times more effective when they are designed to match group-specific characteristics (i.e., group-matched vs. group-mismatched slopes, Table 12).

Behavioural scientists have access to a wealth of empirical evidence about the underlying influences of PEBs. However, the literature includes a variety of models and accounts for a variety of underlying factors, often with limited overlap between studies, making it difficult to incorporate them in practice. LPA allows intervention designer to succinctly combine this comprehensive knowledge to identify similar groups of individuals within a population of interest. This profile-specific understanding can then be used to tailor interventions. To the best of my knowledge, Study 3 is the first study to combine LPA and behaviour-change frameworks to explicitly inform the design of PEB intervention. Importantly, as emphasized by Hine et al. (2014) during their review of audience segmentation in the context of climate change, if a program aims to “facilitate behaviour change, segmentation should be focused on key drivers and barriers associated with desired behaviours.” Thus, the selection of theory-based profiling variables is central to maximising the practicality of this LPA approach.

Two of three studies collected longitudinal data which, combined with growth models, help provide more nuanced insights into the factors that influence behaviour change. For example, cross-sectional studies, including part of the analyses in Study 1 (Table 1), generally suggest that experience with extreme weather events correlates with stronger perception of climate change risk (e.g., Akerlof et al., 2013; Spence et al., 2011), although the evidence is mixed (e.g., Whitmarsh, 2008). This could lead to the conclusion that as extreme weather events become more frequent (Barros et al., 2014; Romero-Lankao et al., 2014), climate change risk perception will naturally increase. However, Study 1 shows no significant effect of personal experience with forest fires on climate change risk perception during the peak forest fire period. Thus, analyses that ignore individual change over time can hide valuable nuances.

This study found no effect of direct exposure to forest fires on climate change risk perception, and only a modest effect of indirect exposure at the beginning of the forest fire season. In light of recent findings by Zannoco et al. (2018; 2019) who suggest that the relation between personal experience and climate change concern is moderated by personal harm and political ideology, the relative impact of direct and indirect exposure in Study 1 was likely influenced by the degree of personal harm. Experiencing extreme weather can impact levels of concern when it causes personal harm – this is more likely for individuals with direct experience, but proximity does not necessarily correspond to personal harm. On the other hand, Zanocco and colleagues suggest that motivated reasoning can impact levels of concern in the absence of personal harm – this is more likely for individuals with indirect experience.

In addition, these studies offer a clearer picture of effective intervention design, which make use of empirical evidence and rigorous behaviour-change frameworks. Study 3 provides support for using diagnostic tools from multiple behaviour-change frameworks to identify the most relevant strategies for a given audience. Using multiple frameworks allows for more flexibility, because a given framework's strategic recommendations are not always feasible within a particular project scope. For example, one framework recommended using legislative and infrastructure change strategies to address structural barriers (e.g., cost and availability of meat-free alternatives) perceived by moderate- and strong-hindrance meat eaters in Study 3, which was not possible given our operational constraints (see Table 8).

Environmental psychologists argue that research should focus on advancing knowledge about high-impact PEB (e.g., Clayton, Litchfield, & Geller, 2013; Clayton & Myers, 2015; Schultz & Kaiser, 2012; Wolske & Stern, 2018), such as personal transportation (i.e., vehicle and air travel; Wynes & Nicholas, 2017), consumption of animal-based food (Aleksandrowicz et al., 2016), or energy (i.e., weatherization and renewable energy; Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009). This dissertation focused on reducing animal-product consumption as a high-impact private-sphere behaviour because this behaviour is understudied in previous research and it has a large potential for change (e.g., health and environmental benefits, fewer structural barriers), and on climate policy support as a potentially high-impact public-sphere behaviour.

Behavioural impact is given special consideration in these dissertation studies. When possible, efforts have been made to measure the potential of behaviour-change interventions in terms of actual GHG emissions reductions. Intervention designers should also consider non-environmental implications of PEB, for example, reducing consumption of GHG-intensive animal-based foods (i.e., red meat) also results in considerable health co-benefits (e.g., Health Canada, 2019; World Cancer Research Fund International, 2017).

Limitations and Future Research

Some of the scales used in the present studies had low reliability. In the future, researchers should attempt to use validated scales when possible, and to improve new scales during pilot studies. Furthermore, the profiling tool used in Study 2 and Study 3 was developed in Canadian context and should be tested in other countries.

To evaluate the effectiveness of interventions, researchers should not only measure changes to the targeted behaviour, they should also include measurements of their key influencing factors to provide a better understanding of the underlying processes of change (Darnton, 2008a; Glanz & Bishop, 2010). These studies could have been improved by including a real measure of climate policy support in Study 1 (e.g., signing a petition), and by measuring more mediating and moderating factors in Study 1 and 3. Unfortunately, attrition is an ongoing challenge of longitudinal research, and smaller sample sizes limit the number of variables that can be included in the statistical analyses. More research is needed on effective ways to reduce attrition during longitudinal research (e.g., reminders, rewards, use of mobile applications).

The finding that perception of scientific agreement on climate change moderates initial levels and growth of climate change risk perception (Figure 4) is suggestive of motivated reasoning. This should be further examined. Furthermore, when evaluating the potential for belief-consistent interpretations of extreme weather events, researchers should consider the degree of personal harm caused by the event (Zanocco, 2018; 2019) and the level of engagement with climate change (Myers, 2013).

More research is needed on the design of effective behaviour-change interventions targeting specific audiences. The present studies were limited to online surveys, and as such, could not fully address all social and contextual barriers. Researcher should consider using more interactive tools to address these barriers, such as social networks for sharing family-friendly vegetarian recipes (e.g., online communities) and mobile apps targeting habitual behaviour change (e.g., smart phone intervention to reduce excessive drinking; Garnett, Crane, West, Brown, & Michie, 2019). The potential use of time-saving appliances (e.g., pressure cookers) to target perceived efficacy and time constraints should also be evaluated.

Conclusion

Environmental psychologists and behavioural scientists have an important role to play in the discovery, implementation, and uptake of climate change solutions. Using a naturalistic quasi-experiment and a randomized control trial, these studies demonstrate support for the use of tailored interventions when targeting climate-relevant behaviour changes. The findings from this dissertation contribute to climate change mitigation efforts by informing climate change communication surrounding extreme weather events and by providing concrete and replicable examples of behaviour-change interventions.

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Appendix

Appendix A: Chapter 2 – Supplementary materials

Measures

Climate change risk perception, climate change knowledge, values, social norms, and affect were measured using items from the Climate change risk perception model (van der Linden, 2015).

Climate change risk perception

1. How concerned are you about climate change?

(1 = Not concerned at all, 5 = Very concerned)

2. In your judgment, how likely are you, sometime during your life, to experience serious threats to your health or overall well-being, as a result of climate change?

3. In your judgment, how likely do you think it is that climate change will have very harmful, long-term impacts on our society?

(1 = Very unlikely, 5 = Very likely)

4. How serious of a threat do you think climate change is to the natural environment?

5. How serious would you rate current impacts of climate change around the world?

6. How serious of a threat do you believe climate change is, to you personally?

7. How serious would you estimate the impacts of climate change for Canada?

(1 = Not serious at all, 5 = Very serious)

8. How often do you worry about the potentially negative consequences of climate change?

(1 = Very rarely, 5 = Very frequently)

Climate change cause knowledge

How much do you think each of the following contribute to climate change?

Driving a car / The sun / Burning fossil fuels (coal, oil, gas) for heat and electricity / The hole in the ozone layer / Flying and commercial air travel / Toxic waste / Steadily rising CO2 emissions (carbon dioxide) / Aerosol spray cans (containing CFC's) / Nuclear power plants / Agricultural activities such as cattle breeding (cows raised for meat consumption) / Deforestation (e.g., destruction of rain forests) / Smoking cigarettes

(1 = Major contribution to climate change, 2 = Minor contribution to climate change, 3 = No contribution to climate change, 4 = Don't know)

Climate change impact knowledge

How likely are each of the following to change because of climate change?

Global sea level / Acid rain / Melting of glaciers and polar ice caps / Areas in the world experiencing drought / Global spread of infectious diseases / Forest fires[1] / Air pollution / Global average temperature / Extreme weather events (e.g., flooding, hurricanes, etc.) / Global biodiversity (i.e., variety of plants and animals) / Volcanic eruptions / The hole in the ozone layer / Frequency of hot days and nights / Global fresh water supply

(1 = Likely to decrease, 2 = No change, 3 = Likely to increase, 4 = Don't know)

Climate change response knowledge[2]

How will each of the following contribute to addressing climate change?

Switching from fossil fuels to renewable energy (wind, solar, geothermal) / Generating less toxic waste (nuclear, chemical) / Recycling paper, glass and plastic / Insulating buildings / Reducing (commercial) airline flights / Conserving energy / Purchasing only organic products / Fixing the

[1] A forest fire item was added to the measure of climate change impact knowledge.

[2] The item "becoming a member of an environmental group" was coded as correct if participants answered "not going to reduce climate change at all" in the original study (van der Linden, 2015) – this item was deemed ambiguous because it can have indirect impacts on climate change, and was thus removed from the scale in the present study.

hole in the ozone layer / Switching from petrol to electric cars / Eating less meat / Using more public transportation / Planting trees

(1 = Reduce climate change a lot, 2 = Reduce climate change a little, 3 = Not going to reduce at all, 4 = Don’t know)

Social norms

Please indicate the extent to which you agree or disagree with the following.

1. Most people who are important to me, are personally doing something to help reduce the risk of climate change.
2. It is generally expected of me that I do my part to help reduce the risk of climate change.
3. People that are important to me, would support me if I decided to help reduce climate change.
4. Business and industry should reduce their emissions to help prevent climate change.
5. People whose opinion I value, think that I should personally act to reduce climate change.
6. Most people I care about are doing their part to help slow climate change.
7. I feel that helping to tackle climate change is something that is NOT expected of me (reversed item)
8. The government should take strong action to reduce emissions and prevent climate change.
9. I feel a personal obligation to do whatever I can to prevent climate change.
10. People close to me are taking personal action to address climate change.

(1 = Strongly disagree, 7 = Strongly agree)

Values

How do each of the following align with your values?

1. Respecting the Earth (harmony with other species)
2. Wealth (material possessions, money)

3. Protecting the environment (preserving nature)

4. Peace (a world free of war and conflict)

5. Equality (equal opportunity for all)

6. Preventing pollution (protecting natural resources)

7. Influential (having an impact on people or events)

8. Helpful (working for the welfare of others)

9. Social justice (correcting injustice, care for the weak)

10. Authority (the right to lead or command)

11. Unity with nature (fitting into nature)

12. Social power (control over others, dominance)

(1 = Opposed to my values, 7 = Of supreme importance)

Affect

1. I see climate change as something that is (1 = Very pleasant, 7 = Very unpleasant)

2. Overall, I feel that climate change is (1 = Very favourable, 7 = Very unfavourable)

3. To me, climate change is (1 = Very positive, 7 = Very negative)

Climate change beliefs

1. What percentage of climate scientists have concluded that human-caused climate change is happening? (1-100%)

2. Climate change plays a role in the frequency and intensity of forest fires.

(1 = Strongly disagree, 7 = Strongly agree)

Climate policy support

Do you generally oppose or favour the following proposals?

1. A carbon tax (e.g., a tax on carbon pollution from burning gasoline)?

2. Setting more strict auto emissions standards for automobiles (fuel efficiency)?

3. Gas guzzler tax upon purchase of vehicles that use more than 11.3 L/100 km (or less than 25 mpg)?

4. Clean electricity regulation (a requirement that at least 20% of the electricity produced be generated from zero-emission sources, such as hydro, solar, or wind)?

5. An emissions cap (setting a limit to how much carbon businesses are allowed to emit, i.e., emissions permit. If permit trading is allowed, this is called cap-and-trade)?

6. Setting higher emissions and pollutions standards for business and industry?

7. Setting higher energy-efficiency regulations for new buildings?

8. Shifting government subsidies away from the fossil fuel industry to the renewable energy industry?

9. Providing tax rebates for people who use solar or wind energy?

10. Providing tax rebates for people who purchase fuel-efficient vehicles?

11. Providing tax rebates for businesses who use solar or wind energy?

12. Providing tax rebates for businesses who purchase fuel-efficient vehicles?

13. Government funding more research into renewable energy sources, such as solar and wind power?

14. Signing an international treaty to cut greenhouse gas emissions?

(1 = Definitely oppose, 4 = Definitely favour)

Past exposure to extreme weather

For the following questions, please consider your experience over the last 5 years, without including year 2016.

1. How often (in total) have you personally experienced any type of extreme weather event (other than forest fires) in your local area? (e.g., severe heat waves, flooding, storms, hurricanes, etc.)

Past exposure to forest fires

For the following questions, please consider your experience over the last 5 years, without including year 2016.

1. How often have you personally seen smoke, ash, or flames from a forest fire?

2. How often have you personally been relocated because of a forest fire?

(1= Never, 4 = Three times or more)

3. How serious, if at all, was your property damage as a result of a forest fire?

(1= Did not suffer property damage, 5 = Very serious property damage)

Direct exposure to extreme weather

The previous questions asked you about your experiences over the last 5 years, not including 2016. Now we would like you to consider your experience so far in 2016 only.

1. How many times have you personally experienced any type of extreme weather event (other than forest fires) in your local area? (e.g., severe heat waves, flooding, storms, hurricanes, etc.)

Direct exposure to forest fires

The previous questions asked you about your experiences over the last 5 years, not including 2016. Now we would like you to consider your experience so far in 2016 only.

1. How many days have you personally seen smoke, ash, or flames from a forest fire?

2. How many days have you personally been relocated because of a forest fire?

(1= Never, 4 = Three times or more)

3. In 2016, how serious, if at all, was your property damage as a result of a forest fire?

(1= Did not suffer property damage, 5 = Very serious property damage)

Indirect exposure to forest fires

For the following, please consider your day-to-day experiences.

1. How often do you hear about forest fires in the media (Radio, TV, newspaper, online news)?

2. How often do you hear about forest fires on social media (Facebook, Twitter, etc.)?

3. How often do your friends and family talk about forest fires?

4. How often do your co-workers talk about forest fires?

(1= Never, 5 = Very frequently)

Scales, means, and reliability

The climate change knowledge scales had low reliability (i.e., from .51 to .67) and were consequently scored based on the sum of correct answers. All other scales from the CCRPM were acceptable.

Scales, reliability, and descriptives.

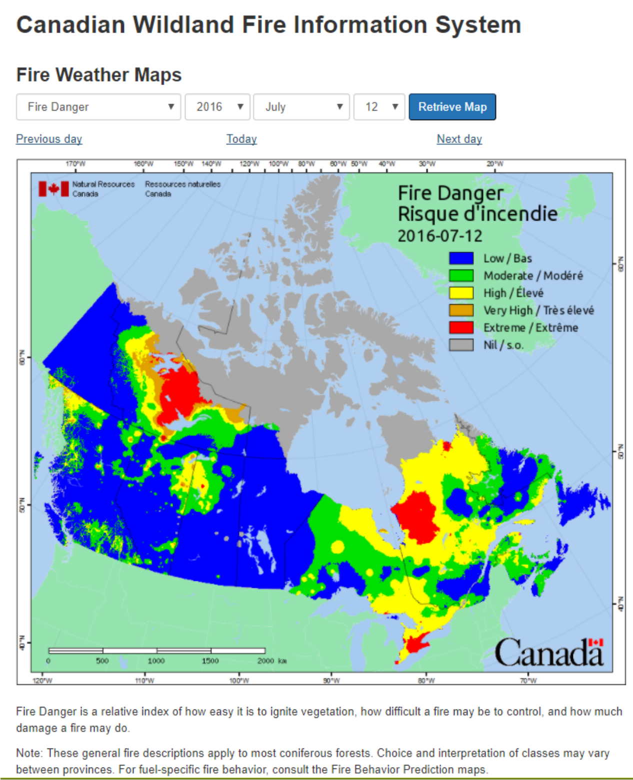
Scales	Number of items	Cronbach's alpha	Scale range	Mean	Standard deviation
Prescriptive norms	4	.70	1 to 7	4.63	1.05
Descriptive norms	3	.89	1 to 7	3.72	1.32
Biospheric values	4	.84	1 to 9	5.43	.86
Altruistic values	4	.78	1 to 9	5.67	.90
Egoistic values	4	.71	1 to 9	3.91	1.01
Affect	3	.90	1 to 7	5.85	.88

Perceived scientific consensus	1	-	1 to 100 %	82.61	20.07
Link climate change and forest fires	1	-	1 to 7	5.23	1.27
Cause knowledge	13	.57	Correct/ incorrect	7.40	1.7
Impact knowledge	14	.64	Correct/ incorrect	9.15	2.25
Response knowledge	12	.51	Correct/ incorrect	7.74	1.63
Past exposure to extreme weather	1	-	Yes/no	1.70	.50
Past exposure to forest fire	3	-	Yes/no	1.40	.50
Climate change risk perception	8	.94	1 to 5	3.53; 3.56; 3.69	.92; .93; .96
Climate policy support	14	.90	1 to 4	3.38; 3.39; 3.39	.49; .49; .58
Indirect exposure to forest fire	4	.89	1 to 5	2.50; 2.79; 1.98	.91; .84; .86
Recent direct exposure other extreme weather	1	-	Yes/no	1.26; 1.62; 1.50	.44; .49; .50
Recent direct exposure forest fire	3	-	Yes/no	1.06; 1.21; 1.22	.24; .41; .42

Note. Cronbach's alpha measured at time 1. Knowledge questions were coded as correct/incorrect and correct answers were summed. Exposure is dichotomized no =1, yes = 2. The last five scales are repeated measures; the means for each phase are provided.

Map of fire danger risk forecasts

Peak forest fire activity was estimated by daily monitoring of fire danger forecasts provided by Natural Resources Canada (Natural Resources Canada, n.d.)



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Appendix B: Chapter 3 – Supplementary materials

Literature review of meat-eating influences

Source	Relevant findings
Abrahamse, Gatersleben, & Uzzell (2009)	Current meat consumption, meat identity, and health identity predict attitudes toward meat. Positive meat beliefs: nutrition, taste, versatility, filling, texture, ease of preparation, social aspects. Negative meat beliefs: bad: fatty, animal welfare, safety, cost, environmental.
Apostolidis & McLeay (2016)	Six major factors influence meat substitute choices: fat content, carbon footprint, type of mince meat (e.g., turkey, beef, pork, meat-free), method of production (e.g., organic), price, origin.
Audebert, Deiss, & Rousset (2006)	General eating hedonism is negatively correlated with ethical consideration.
Beardsworth & Keil (1991)	Most self-identified vegetarians have more than one motivation for converting to a vegetarian diet. Listed first more often were moral motives, followed by health, and taste and texture. Vegetarianism requires nutritional knowledge.
Berndsen & Pligt (2004)	Meat consumption is predicted by attitude, subjective norm, and ambivalence. Positive hedonic and health beliefs (e.g., meat is healthy) correlates with increased meat consumption. More ambivalence correlates with less positive attitudes towards meat.
Blake, Bell, Freedman, Colabianchi, & Liese (2013)	Four eating types: healthy, picky, meat, emotional.
Bohm, Lindblom, Åbacka, Bengs, & Hörnell (2015, 2016); Bohm, Lindblom, Åbacka, & Hörnell (2016)	Meat is seen as central to nutritional health, sensory experience, culture and social relationships. Vegetarianism is seen as deviant and nutritionally deficient.
Cherry (2015)	Social support and identity are important factors affecting the retention of veganism.
Chin, Jr, & Sims (2002)	Attitudes toward vegetarians are generally positive. Males have more negative attitudes.
Cooper, Wise, & Mann (1985)	Vegetarians are motivated by health, animal cruelty, and taste preferences.
Corrin & Papadopoulos (2017)	Concerns about meat-free diet: health, enjoyment of meat, time concerns, lack of options, partner, and social perception. Vegetarian men are perceived as less masculine. Veganism is perceived more negatively than vegetarianism. More nutritional knowledge correlates with a vegetarian lifestyle.

Cramer et al. (2017)	General wellness or disease prevention is a motivator for vegetarian diets (e.g., feeling better, a sense of control over their health).
de Boer & Aiking (2011)	Meat is valued for tradition and health beliefs.
de Boer, de Witt, & Aiking (2016); de Boer, Hoogland, & Boersema (2007); de Boer, Schösler, & Boersema (2013b); Schösler, Boer, & Boersema (2012)	de Boer et al. (2007): Develop the food choice motive (later called the food involvement and focus questionnaire or FIFQ). Those with a low degree of involvement with food tend to be more habitual in their eating behaviour. Schösler et al. (2012): Suggest two distinct meal formats; meat-replacers (similar to more conventional meal format) and non-meat replacers vegetarian meals (e.g., lentil dish). The less conventional meal format may require more cooking skills. de Boer et al. (2013b): FIFQ and choice of snacks. Familiarity is likely more important for lowly involved individuals. de Boer et al. (2016): Consumers with low levels of food involvement often prioritize efficiency and time saving.
de Boer, de Witt, & Aiking (2016)	Most are unaware of the mitigation potential of reducing meat consumption. Willingness to reduce is higher for those that are most aware.
de Boer, Schösler, & Boersema (2013)	The link between meat and climate is not well understood.
de Boer, Schösler, & Aiking (2014)	Compares preferences for two strategies to reduce meat - meatless days or less but better (portion sizes).
Dhont & Hodson (2014)	Right-wing ideology related to more meat eating.
Dyett, Sabaté, Haddad, Rajaram, & Shavlik (2013)	Veganism is often health-motivated.
Feldman & Mayhew (1984)	Meat eating is explained by habit, lack of social acceptance, and inconvenience.
Fessler, Arguello, Mekdara, & Macias (2003)	Different motivations for meat avoidance correlate with different dietary choices. Ethical and environmental motivations correlate with eating less meat. Health-motivated individuals eat more white meat. Taste-motivated meat-avoiders eat the most meat overall.
Fox & Ward (2008)	Vegetarian motivations change over time.
Gal & Wilkie (2010)	Gender-expressive choices about food. When time or attention is not restricted, men tend to make more gender-based choices.
Gifford & Chen (2017)	Social factors and tokenism are important barriers to climate-friendly food choices.
Golan, Schwarzfuchs, Stampfer, Shai, & DIRECT group (2010)	Spouses attending support meetings tend to also benefit from weight-loss programs.
Graça, Calheiros, & Oliveira (2015)	Meat attachment correlates with attitudes toward meat, subjective norm, human supremacy beliefs, eating habits, and dietary identity. Lower attached people might be more open to a shift in diet. Higher attached people are subject to identity reinforcement.

Graça, Oliveira, & Calheiros (2015)	Cluster analysis of willingness to switch to plant-based diet. Find three clusters: meat attached and unwilling to change; low attachment and willingness to change; disgust towards meat and moral internalization.
Grisolía, Longo, Hutchinson, & Kee (2015)	Health locus of control varies from internal control, to control by powerful others (e.g., doctors), to chance control.
Haverstock & Forgays (2012)	Compares current and former meat-avoiders. Lack of social support and health concerns lead to re-incorporating animal products in the diet. Individuals that gradually reduce animal products, self-identify as vegetarian/vegan, and have a social support system are more likely to maintain their meat-avoider diet.
Henson, Blandon, & Cranfield (2010)	Limiting the consumption of red meat is voted the most difficult health promoting behaviour.
Hodson & Earle (2018)	Right-wing ideology explains vegetarians returning to meat through lower social support and lesser justice concerns. Peer influence and meat cravings also significantly explain lapsing.
Hoek et al. (2011)	Non-users of meat substitute are more food neophobic.
Hoek, Luning, Stafleu, & de Graaf (2004)	Compares lifestyles of vegetarians and meat eaters. Vegetarians value health, product information labels, and social aspects in eating (e.g., eating with friends).
Hoek, Pearson, James, Lawrence, & Friel (2017)	The environmental impact of food is rarely considered during food choices. Health is an important motivator.
Hoffman, Stallings, Bessinger, & Brooks (2013)	Ethically motivated vegetarians have high convictions, more meat restrictive diets, and have been vegetarian for longer, compared to health motivated vegetarians.
Jabs, Devine, & Sobal (1998)	Identifies two types of vegetarians: health- and ethically-motivated.
Jabs, Devine, & Sobal (1998a)	Personal factors (animal rights and health beliefs, skills, habits), social networks, and availability of alternative foods support the maintenance of vegetarian diets.
Janda & Trocchia (2001)	Strong concern for animals and nutrition correlates with a vegetarian orientation. Concern with fitness is negatively correlated for men. Social conformity is only related to vegetarian orientation for men.
Janssen, Busch, Rödiger, & Hamm (2016)	Three main motives for veganism: animal, health, environment.
Jaspal, Nerlich, & Cinnirella (2014)	Behaviours that are important to self-esteem or identity can be harder to change. Suggest that meat eating is possibly one of those behaviours.
Kalof, Dietz, Stern, & Guagnano (1999)	Strongest predictor of vegetarian diet is the belief that it is environmentally beneficial.
Keller & Siegrist (2015)	Agreeableness and openness negatively relate to meat eating.
Klöckner (2017)	Four stages of food change progression (pre-decision, decision, action, post-action). Dietary influences vary at different stages.

Köster (2009)	Past behaviour, habit, and hedonism are good predictors of food choices.
Kourouniotis et al. (2016)	Taste is rated as the most important factor in food purchases.
Lacroix, Gifford, & Chen (2019)	Conflicting goals and aspirations (e.g., limited time, difficulty changing habits) and lacking knowledge (e.g., not knowing how to change) are important psychological barriers for eating less meat.
Larsson, Rönnlund, Johansson, & Dahlgren (2003)	Three types of vegans, from less committed to more committed. Motivations vary based on level of commitment.
Lazzarini, Zimmermann, Visschers, & Siegrist (2016)	Most underestimate environmental impact of meat, are unaware of the impacts of different types of meat (e.g., beef vs. chicken), and overestimate the impact of meat transport.
Lea, Crawford, & Worsley (2006)	Stages of change and plant-based diet.
Lea & Worsley (2001)	Perceived difficulties with vegetarian diets: health concerns, appreciation for meat, lack of knowledge/skill and convenience, social concerns. Number of vegetarian friends is positively correlated.
Levi, Chan, & Pence (2006)	Females often more involved than males in food decisions. One possible avenue is challenging the masculine ideals associated with food.
Lindeman & Väänänen (2000); Markovina et al. (2015); Pula, Parks, & Ross (2014); Steptoe, Pollard, & Wardle (1995)	Steptoe et al. (1995): Developed a food choice questionnaire which includes nine factors: health, mood, convenience, sensory appeal, natural content, price, weight control, familiarity, ethical concern. Lindeman & Väänänen (2000): Suggest adding ecological welfare, political values, and religion. Pula et al. (2014): Suggest removing the weight control factor and add an impression management factor (e.g., portrays positive image). Markovina et al. (2015): Find support for original scale but the importance of factors differs between European countries.
Lund, McKeegan, Cribbin, & Sandøe (2016)	Concerns about animal rights is an important motivation for vegans. But some vegetarians are not concerned about animal rights, they are instead health motivated.
MacInnis & Hodson (2017)	Attitudes towards vegetarians are generally negative. Vegetarian men are evaluated more negatively than vegetarian women. Vegans are evaluated more negatively than vegetarians. Attitudes vary based on motivation for veg*ism (i.e., animal concern or ethical motivations more negative than health motivations).
Maibach, Maxfield, Ladin, & Slater, (1996); Maibach, Weber, Massett, Hancock, &	Segmentation studies in the domain of health behaviour. Relevant measures include self-efficacy, perceived social support, health prevention orientation, etc.

Price, (2006); Weir et al. (2000)	
Mäkiniemi & Vainio, (2014)	Cost is perceived as the most relevant barrier to buying climate-friendly food, but habit and disbelief that it will have an impact are more closely related to food choice.
McCarthy, O'Reilly, Cotter, & de Boer (2004)	Attitudes and important others influence intentions to consume pork and poultry. Health, safety, and taste are important. Advice from doctors and dieticians influence consumption.
McDonald (2000)	Both logic and emotions play a role in decisions to become vegan. Two types of learning: communicative (animal rights) and instrumental learning (skills needed to be vegan).
Minson & Monin (2012)	Perceptions of vegetarians are more negative when individuals expect to be judged by vegetarians.
Mullee et al. (2017)	Taste, habit, lack of options, and cooking skills are most often reported as reasons for eating meat.
Nath (2011)	Explores discourses and meat eating as a social norm. Meat eating is seen as a masculine behaviour.
Niehues & Klockner (2016)	Social influences (e.g., norms and ambitions) and meat consumption. Proposes a typology of reactions to conflicting norms, from confrontational to defensive.
Ogden, Karim, Choudry, & Brown (2007)	Vegetarian diets correlate with less positive attitudes (e.g., tasty) toward meat.
Paisley, Beanlands, Goldman, Evers, & Chappell (2008)	Dietary changes are facilitated by health concerns and cooperative partners. More difficult for picky eaters, those with less nutritional knowledge, those valuing taste over health, and those with unsupportive partners.
Pfeiler & Egloff (2018)	Higher score on the openness personality trait positively correlates to vegetarianism.
Piazza et al. (2015)	Commons justifications for meat eating are that it is natural, normal, necessary, and enjoyable. Most believe vegetarianism is morally admirable.
Pohjolainen, Tapio, Vinnari, Jokinen, & Räsänen (2016)	Consumer support for efficiency (efficient production) and sufficiency (less consumption) solutions to meat production. Identify six groups.
Povey, Wellens, & Conner (2001)	Some meat eaters consider the vegetarian diet healthy, others consider it nutritionally unbalanced. Healthy eaters are more likely to consider reducing meat consumption.
Richardson, Shepherd, & Elliman (1993)	Health, taste, value for money, and ethics are predictors of meat consumption.
Robinson-O'Brien, Larson, Neumark-Sztainer, Hannan, & Story (2009)	Those supporting alternative food practices (e.g., organic, non-GMO) are more likely to have a healthy diet.
Rosenfeld & Burrow (2017)	Departing from social norms can result in a strong vegetarian identity. Proposes a Unified Model of Vegetarian Identity.

Rothgerber (2013)	More meat consumption is related to higher masculinity. Men use more direct tragedies for justification of meat consumption (e.g., deny animal suffering, animal hierarchy, human destiny) while women use more indirect strategies (e.g., avoid thinking about it).
Rothgerber (2014)	Proposes that meat eaters face dissonance but that meat eating is resistant to behavioural change because of justification strategies: avoidance (e.g., information or situation), dissociation (e.g., using language like bacon instead of pork), perceived behavioural change (e.g., underclaim meat eating), denial of animal pain, denial of animal mind, pro-meat justification (e.g., taste statements), and reduced perceived choice (e.g., health justifications).
Rothgerber (2014a)	Semi-vegetarians differ from vegetarians in their evaluation of meat. Semi-vegetarians are more likely to express liking meat and not being disgusted by meat, or to have emotional resistance consuming it. Strict vegetarians are motivated by ethical concern more than semi-vegetarians. Vegetarianism should be characterized on a continuum.
Rothgerber (2014b)	Intergroup judgments between different groups of meat-avoiders (e.g., health vegetarians, ethical vegetarians, etc.). Motives influence intergroup relations.
Rothgerber (2015b, 2015a)	Differences between vegetarians and conscientious omnivores. Conscientious omnivores have less strict diets, less guilt when eat meat, less disgust, and lower ingroup identification.
Rozin, Markwith, & Stoess (1997)	Compares attitudes of moral and health vegetarians.
Rozin, Bauer, & Catanese (2003)	Proposes a six-factor structure of food attitudes (weight, diet and health, diet-health link, pleasure, eating disorder, natural food preference).
Ruby (2012)	Suggest that reasons for becoming vegetarians impact the process, diet, and ideology.
Ruby et al. (2016)	Attitudes toward vegetarians in four countries Argentina, Brazil, France, United States. Generally neutral attitude toward vegetarians. Admiration of vegetarians is highest in Brazil and U.S. The French were most bothered by vegetarians (i.e., threat to identity).
Ruby & Heine (2011)	Vegetarians are perceived as more virtuous than omnivores by both vegetarians and omnivores. Vegetarian men are perceived as less masculine.
Rydén & Mattsson Sydner (2011)	Switching to a Mediterranean diet for patients with arthritis is more difficult if their spouse is not supportive.
Santos & Booth (1996)	Meat avoiders have multiple reasons for avoiding meat: ethics, health, sensory factors, influence of friends. Those that are fully vegetarian are mostly concerned with ethics.

Sautron et al. (2015)	Health, ethics, environment, production, taste, price, convenience, innovation, and absence of contaminants influence food purchasing decisions.
Schösler, de Boer, Boersema, & Aiking (2015)	Cultural notions of masculinity can be a barrier to reducing meat consumption.
Schüz, Sniehotta, Scholz, & Mallach (2005)	Self-efficacy predicts preventive nutrition.
Šedová, Slovák, & Ježková (2016)	Attitudes toward meat eating in a group of environmental studies students. They perceive a stronger social norm to avoid meat than in the general population. Price and availability as a barrier.
Siegrist, Hartmann, & Keller (2013)	Food neophobia (fear of trying new foods) correlates with eating less vegetables, white meat, and fish consumption.
Siegrist, Visschers, & Hartmann (2015)	Beliefs that reducing meat consumption is healthy and can prevent animal suffering correlate with the belief that it is better for the environment (i.e., halo effect).
Sparks, Conner, James, Shepherd, & Povey (2001)	Food choice attitudes and intentions. Higher attitude ambivalence correlates with weaker attitude-intention relation.
Tobler, Visschers, & Siegrist (2011)	Many are unaware of the environmental impact of food choices. Willingness to reduce meat consumption is influenced by health and ethical motives.
Turrell, Hewitt, Patterson, Oldenburg, & Gould (2002)	Food purchases vary by socio-economic status. Low income individuals buy less fruits and vegetables, more low fibre and high fat products.
Vainio, Niva, Jallinoja, & Latvala (2016)	Eating motivation scale and healthy diets. Fifteen eating motives.
Verain, Dagevos, & Antonides (2015); Verain, Sijtsema, & Antonides (2016)	Verain et al., (2015): Using mean sample split, identifies four segments that differ in terms of sustainable food consumption and behaviour type (sustainable product choice vs. curtailment): Unsustainers, curtailers, product oriented, sustainers. Verain et al. (2016): Identify three clusters using cluster analysis: pro-self, average, and conscious consumers.
Wansink, Shimizu, & Brumberg (2014)	To increase consumption of healthy food (e.g., tofu), it is better to correct misconceptions (e.g., expensive, difficult to prepare, spoils easy) than to focus on health benefits.
Yen, Lin, & Davis (2008)	More dietary knowledge correlates with eating less red meat.
Zur & Klöckner (2014)	Habits are an important predictor of meat consumption.

Correlations between profiling variables.

Variables and items	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1. Entitlement to meat	.63	.62	.24	.22	.23	.65	.48	.18	*.07*	.35	*.02*	.23	*.04*	.26	*.10*	.22	.21	.19	.21	.20	*.05*	.31
2. Dependence on meat		.79	.42	.24	.30	.68	.51	.21	.17	.38	*-.02*	.25	*.05*	.32	.17	.28	.35	.14	.23	.17	*.10*	.35
3. Taste			.51	.27	.40	.63	.48	.28	.21	.36	*.01*	.26	*.10*	.36	.20	.27	.27	.12	.30	.21	.15	.45
4. Self-efficacy				.33	.59	.23	.15	.40	.43	.21	.20	.12	.20	.32	.41	.17	.16	.21	.30	*-.04*	.29	.55
5. Perceived behavioural control					.27	.14	*.08*	.19	.12	.12	.20	.21	*-.00*	.32	.22	.15	.12	.25	.22	*.06*	.14	.19
6. Time and availability of alternatives						.23	.13	.23	.17	*.10*	.14	.25	.23	.46	.36	.18	.11	.25	.21	*.01*	.17[*]	.55
7. Health beliefs							.66	.18	.13	.39	*-.01*	.31	.11	.29	.22	.32	.36	*.06*	.25	.22	.14	.30
8. Ethical and environmental beliefs								.27	.24	.50	*-.07*	.34	.18	.32	.34	.37	.40	*-.05*	.29	.14	.20	.24
9. Food involvement									.63	.49	*.05*	*0.05*	.44	.14	.40	.16	.18	*-.04*	.48	*.00*	.56	.30
10. Health identity										.49	*-.01*	-.11	.19	*.07*	.43	.12	.15	*-.00*	.27	-.16	.32	.27
11. Environmental identity											*-.03*	.14	*.09*	.23	.31	.27	.26	*.04*	.27	*.04*	.23	.24
12. Conformity												.18	.15	.17	.19	*.04*	*.03*	.14	.13	*.02*	*.04*	.12
13. Stereotypical masculinity													.30	.50	.32	.22	.15	*.09*	.17	.14	*.05*	.20
14. Food neophobia														.23	.37	.18	*.08*	*.02*	.51	*.07*	.43	.15
15. Social influence															.41	.20	.17	.11	.24	*.03*	.15	.35
16. Health prevention																.24	.16	*.00*	.31	*.05*	.28	.31
17. I have regular interactions with…[‡]																	.28	*.06*	*.10*	.12	.13	.17
18. Important people in my life are supportive… [‡]																		*.05*	.15	*.07*	.14	.15
19. People I live with won't eat a plant-based…																			*.02*	*.01*	*.04*	.20
20. I always like to eat the same food																				*.09*	.41	.26
21. I do not want to change my routine…																					*.02*	*.04*
22. I like to try out new recipes[‡]																						.19
23. It costs too much to make vegetarian food																						

Notes. N = 355. Non-significant correlations are listed in italics, [‡] indicates items were reversed-coded.

Interaction between gender and stereotypical masculinity.

Predictors	β	*p*
Stereotypical masculinity	-.18	.27
Gender	-.405	<.001
Stereotypical masculinity X Gender	.33	.07
F	8.51	<.001
R^2	.07	

Notes. Dependent variable is frequency of eating animal products. Gender is score as 1= male, 2= female. One participant answered “other” for gender and was excluded from this analysis (N = 354).

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Appendix C: Chapter 4 – Supplementary materials

Condition 1A and 2A (news story)

New Food Guide recommends eating less red meat, a diet that is good for people and the planet

What is a healthy diet? That's a question Health Canada had to tackle as it worked to revamp Canada's Food Guide. In updating the guide, Health Canada had to address concerns from doctors and nutritionists who say it has not changed enough over its 75 years. Specifically, they argued it had done a poor job of adapting to changing health concerns, away from the malnutrition and wartime rationing the guide was originally intended to address, and toward more pressing, current concerns of obesity and diet-related chronic illness.

The new Canada Food Guide recommends eating less red meat, instead pointing Canadians to leaner animal cuts and plant-based proteins. (Shutterstock image)

Released in January 2019, the new Canada Food Guide encourages Canadians to consume less red meat and processed foods, and less foods high in saturated fat like butter and certain cheeses, but it’s not urging they be ruled out altogether from one’s diet.

Plant-rich, low-meat diets have been shown to have modest benefits in terms of all-cause mortality, to decrease our risk of colorectal cancer and cardiovascular disease, and to improve glycemic control in people with diabetes.

Low-meat diets also reduce greenhouse gases, land use and water consumption by a median of 20-30 per cent across studies, which is critical to maintaining planetary health and sustaining our ability to feed ourselves as we move through the 21st century.

There are good reasons why many people choose to include animal products in their diet. It allows for the continuation of family food traditions, particularly on special occasions; supports Indigenous land-based food gathering; and enables us to take advantage of agroecology and to enhance food security in particular environments, including Canada's North.

Increasingly, however, people are incorporating these elements in a "reducetarian" approach — by simply eating less meat and more plants.

Condition 1B (i.e., substitute condition)

Did you know that 45% of Canadians are already making efforts to reduce their meat consumption? Most of them do so because of the health benefits.
These people are not giving up meat altogether – instead, they choose leaner meats and plant-based proteins, and eat red (beef, pork, lamb, goat) and processed meats on occasion.

Red meat and processed meats can be replaced quite easily. Check out these healthy twists on popular meals.

Pizza. Choose non-processed meats or meat-free toppings – popular examples include grilled chicken, spinach and cheese, margherita, or vegetable pizzas.

Burgers. Try a chicken or turkey burger. Many brands of vegetarian burger patties are also available in grocery stores.

Pasta. So many options to choose from. For example, spaghetti with turkey meatballs, spaghetti with lentils and marinara sauce, chicken stroganoff, or linguine with pesto and pine nuts...

Tacos. Try fish, chicken, or tofu tacos.

Sandwiches. Choose lean meats, non-processed, or non-meat alternatives, like leftover chicken, tuna, egg salad, or hummus.

Burritos. Available in most restaurants and frozen food sections, bean burritos are a protein-packed alternative.

Soup. Minestrone soup – this hearty Italian soup is already a favourite among many. Other favourites are lentil harvest, bean and barley, or chicken noodle.

Stew. Why not try a turkey and rice, potato and chicken, or a Moroccan chickpea and vegetables stew? Many popular brand names carry these if you are short on time.

Chili. Simply add more beans (black beans, kidney beans, or pinto beans) or use chicken instead of beef for a healthier spin on this classic meal.

You can download (insert link to pdf) and print all these suggestions or carry them with you on your mobile, for easy access while shopping.

Condition 2B (i.e., recipe condition)

Did you know that 45% of Canadians are already making efforts to reduce their meat consumption? Most of them do so because of the health benefits.
These people are not giving up meat altogether – instead, they choose leaner meats and plant-based proteins, and eat red (beef, pork, lamb, goat) and processed meats on occasion.

Check out these healthy and delicious recipes.

- Curried vegetable lentil stew
- Turkey and veggie stuffed pita
- Vegetable frittata
- Spaghetti and turkey meatballs
- Quinoa and veggie casserole
- Greek-style chicken sandwiches
- The ultimate mixed bean salad
- Turkey chili
- Orange soy tofu pockets
- Hearty chicken noodle soup

You can download (insert link to pdf) and print all these recipes or carry them with you on your mobile, for easy access while shopping.

More recipes are available at Eat well recipes – Canada.ca

Condition 3 (i.e., implementation intention)

We will guide you along a series of steps, which have been known to help individuals achieve their own personal dietary goals.

1. First, please identify your goal. Try to be specific, for example, if your goal is to eat healthier, include specific ways how you plan to eat healthier.
For example:
"I intend to replace beef with chicken"
"I intend to eat more vegetarian meals"
"I intend to try healthier recipes"

Write down your own goal, starting with "I intend to…"

2. Now think of concrete situations where you can implement this goal. Specifically, think about *where*, *when*, and *how* you intend on doing this.
For example:
"I intend to order chicken instead of beef in restaurants"
"I intend to prepare vegetarian meals for lunch every day"
"I intend to cook a healthy recipe every Sunday"

Write down your goal including *where*, *when*, and *how* you can implement this goal. Start with "I intend to…"

3. Now that you have identified a concrete goal, can you think of things that might stand in the way of achieving your goal?
For example:
"I intend to order chicken instead of beef in restaurants"
Possible obstacle: Chicken is not available in the restaurant.
"I intend to eat vegetarian meals every Monday"
Possible obstacle: I am invited to have dinner at someone's house on Monday.
"I intend to cook a healthy recipe every Sunday"
Possible obstacle: My kids do not like the new recipes.

Write down possible obstacles related to your own personal goal.

4. For each possible obstacle, think of a desirable alternative response or a possible strategy to overcome the obstacle.
For example:
Possible obstacle: Chicken is not available in the restaurant.
Strategy: Order fish instead.

Possible obstacle: I am invited to have dinner at someone's house on Monday
Strategy: Ask the host for a meat-free option.
Possible obstacle: My kids do not like the new recipes.
Strategy: Ask a friend for their children's favourite healthy meals.

Write down possible strategies related to each obstacle you identified.

5. Now that you have identified obstacles and strategies, take a few minutes to formulate concrete plans for ways to overcome each obstacle. Your plans should follow the "if-then" format illustrated in the examples below.
For example:

"If chicken not available in a restaurant, then I will have fish"

"If I am invited to have dinner at a friend's house on Monday, then I will ask if we can have a meat-free option"

"If my kids do not like the healthy meals that I prepare, then I will ask a friend/family member for their children's favourite healthy dish."

Write down if-then plans for each anticipated obstacle and strategies to overcome the obstacle.
"If (obstacle), then (strategy to overcome the obstacle)"

6. To reinforce your "if-then" plans, we suggest that you say them out load, write them down again, or vividly imagine enacting the plans. Please take a moment to do so now.

7. Making a commitment to reaching your goal will increase your chances of success. We invite you to tell a family member or a friend about your goal.

Profiling items, scales, and reliability

Meat entitlement (3 items, α = .81)
 To eat meat is an unquestionable right of every person.
 According to our position in the food chain, we have the right to eat meat.
 Eating meat is a natural and indisputable practice.
Dependence on meat (3 items, α = .85)
 I would feel fine with a meatless diet.
 If I was forced to stop eating meat, I would feel sad.
 Meat is irreplaceable in my diet.
Liking the taste of meat (3 items, α = .72)
 Meat is delicious.
 Meat adds so much flavor to a meal it does not make sense to leave it out.
 Vegetarian food is bland and boring.
Lack of perceived behavioural control (3 items, α = .72)
 Someone else cooks and prepares meat, so I should eat it.
 Someone else decides on most of the food I eat.
 Someone else does the grocery shopping.
Lack of time and availability of vegetarian food (5 items, α = .66)
 I have to go food shopping more often when making vegetarian meals.
 It takes too long to prepare plant-based meals.
 Plant-based meals are not available when I eat out.
 The plant foods I would need to eat meat-free meals are not available where I shop.
 The availability of meat-replacement products is insufficient.
Health beliefs about meat (5 items, α = .76)
 Reducing meat consumption helps to prevent disease (e.g., heart disease, cancer).
 Red meat such as beef or lamb is fattening.
 It's healthier not to frequently eat meat.
 Eating meat is necessary in order to be healthy.
 You cannot get all the protein, vitamins and minerals you need on an all vegetarian diet.
Ethical beliefs about meat (5 items, α = .80)
 Reducing meat consumption is better for the environment.
 By reducing meat consumption, one can prevent animals suffering.
 It is more efficient to produce plant-based foods.
 Cattle farming has a big impact on the planet.
 I think animal welfare is important.
Lack of food involvement (6 items, α = .77)
 They are very mindful of food. They want to eat sensibly.
 They like to vary her meal. They are curious about new tastes.
 They prefer natural products. They would really like their food fresh from the garden.
 They don't care much about cooking. They use a lot of ready-made products in their meals.
 Food is not very important to them. They have no special food requirements.
 They eat because they have to. Meals are not important to them.
Healthy-eater identity (3 items, α = .90)

I am someone who eats in a nutritious manner.
I am someone who is careful about what I eat.
I think of myself as a healthy eater.

Environmental identity (4 items, α = .88)

I think of myself as someone who is concerned about the environment.
To engage with issues related to the environment is an important part of who I am.
Engaging in environmentally friendly behaviours is important to me.
It's important to me that my food choices are not harmful to the natural environment.

Conformity (4 items, α = .78)

When I'm in a group, I try to behave like everyone else.
At parties, I usually try to behave in a manner that makes me fit in.
The slightest look of disapproval in the eyes of a person with whom I am interacting is enough to make me change my approach.
If I am the least bit uncertain as to how to act in a social situation, I look for the behaviour of others.

Stereotypical masculinity (5 items, α = .78)

It is the woman's responsibility to keep the family healthy by serving a nutritious diet.
Nowadays the responsibility for shopping and cooking ought to lie just as much with the husband as with the wife.
If I heard about a man who was a hairdresser and a gourmet cook, I might wonder how masculine he was.
I would not make an effort to engage with a man whose hobbies are cooking, sewing, and going to the ballet.
It bothers me when a man does something I consider "feminine".

Food neophobia (8 items, α = .83)

I don't trust new foods.
If I don't know what is in a food, I won't try it.
I like foods from different countries.
Ethnic food looks too weird to eat.
I am afraid to eat things I have never had before.
I am very particular about the foods I will eat.
I will eat almost anything.
I am constantly sampling new and different foods.

Lack of health prevention orientation (5 items, α = .69)

I try to understand my personal health risks.
Most health issues are too complicated for me to understand.
I have difficulty understanding the health information that I read.
My physical wellbeing depends on how well I take care of myself.
What I eat is not going to affect my health.

Lack of self-efficacy (4 items, α = .70)

I lack the cooking skills to prepare meat-free meals.
I don't know what to eat instead of meat.
I don't have enough willpower to not eat meat.
Following a recommended diet is hard for me.

Meat-eating habit strength (5 items, α = .86)

Eating meat is something that I do automatically
Eating meat is something that I do without having to consciously remember
Eating meat is something that I do without thinking
Eating meat is something that I have no need to think about doing
Eating meat is something that is typically me

Social support for meat reduction (5 items, α = .63)

I have regular interactions with people who are interested in preparing vegetarian meals.
Important people in my life are supportive of me eating less meat.
Not eating meat is socially unacceptable.
People would think that I am a wimp or not macho enough if I didn't eat meat.
My friends and family will support me if I choose to change my diet so that it includes less meat

Social support for healthy eating (5 items, α = .60)

Friends encourage me not to eat unhealthy foods when I am tempted to
Friends and family offer me healthy foods when I visit their home
Friends and family ask me for ideas on how they can eat healthier diets
My family helps me make changes in my diet
People around me encourage me not to give up on my healthy eating goals

Cost

It costs too much to make vegetarian food.

Note. Items in italics are reverse-coded. Weak items "I don't want people to think that I'm strange or a hippie because of what I eat" and "People I live with won't eat a plant-based diet so if I want to eat vegetarian, both vegetarian and non-vegetarian meals must be prepared" were removed after factor analysis of the social items.

Profiles

Group 1 = Strong-hindrance meat eaters (*n* =186)
Group 2 = Moderate-hindrance meat eaters (*n* = 151)
Group 3 = Meat-reducers (*n* = 40)

<u>Inhibitors to reducing meat consumption</u>

Profiling variables	Groups	Mean	Std. Deviation
Meat entitlement	1	**5.14**	1.31
	2	**4.37**	1.08
	3	2.17	1.20
Dependence on meat	1	**4.63**	1.62
	2	**3.87**	1.17
	3	1.58	0.99
Liking the taste of meat	1	**5.94**	0.96
	2	**5.09**	0.86
	3	3.36	1.12
Lack of perceived behavioural control	1	**3.62**	1.59
	2	3.05	1.20
	3	1.55	0.61
Lack of time and availability of vegetarian food	1	**3.77**	1.08
	2	**3.57**	0.80
	3	2.45	0.97
Health beliefs about meat	1	**3.98**	1.21
	2	3.29	0.83
	3	2.06	0.75
Ethical beliefs about meat	1	2.97	1.17
	2	2.81	0.82
	3	1.67	0.72
Lack of food involvement	1	2.80	0.90
	2	2.56	0.70
	3	2.11	0.76
Healthy-eater identity	1	3.40	1.44
	2	3.34	0.99
	3	2.53	1.33
Environmental identity	1	3.26	1.30
	2	2.94	0.85
	3	2.18	1.14
Social conformity	1	**3.87**	1.39
	2	**4.03**	0.99
	3	**3.74**	1.14
Stereotypical masculinity	1	2.32	1.17
	2	2.17	1.04
	3	1.79	0.86
Food neophobia	1	3.22	1.11
	2	3.14	0.89

	3	3.23	1.11
Lack of health prevention orientation	1	2.36	0.82
	2	2.58	0.78
	3	1.92	0.55
It cost too much to make vegetarian food	1	**3.59**	1.82
	2	3.32	1.45
	3	2.10	1.72
Meat-eating habit	1	**5.43**	1.12
	2	**4.70**	0.91
	3	2.24	1.11
Lack of self-efficacy and skill	1	**5.46**	1.75
	2	**4.88**	1.31
	3	2.31	0.93
Lack of social support for healthy eating	1	2.78	0.98
	2	2.94	0.76
	3	1.92	0.64
Lack of social support for reducing meat	1	**4.27**	1.03
	2	**3.82**	0.74
	3	**3.78**	0.97

ANOVAS

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
Meat entitlement	1	2	0.77	0.13	<.001
	1	3	2.97	0.21	<.001
	2	3	2.20	0.21	<.001
Dependence on meat	1	2	0.76	0.15	<.001
	1	3	3.05	0.20	<.001
	2	3	2.29	0.18	<.001
Liking the taste of meat	1	2	0.86	0.10	<.001
	1	3	2.58	0.19	<.001
	2	3	1.73	0.19	<.001
Lack of perceived behavioural control	1	2	0.57	0.15	<.001
	1	3	2.07	0.15	<.001
	2	3	1.50	0.14	<.001
Lack of time…	1	2	0.20	0.10	0.12
	1	3	1.32	0.17	<.001
	2	3	1.12	0.17	<.001
Health beliefs about meat	1	2	0.69	0.11	<.001
	1	3	1.93	0.15	<.001
	2	3	1.24	0.14	<.001
Ethical beliefs about meat	1	2	0.16	0.11	0.30
	1	3	1.30	0.14	<.001
	2	3	1.14	0.13	<.001

Lack of food involvement	1	2	0.23	0.09	0.02
	1	3	0.69	0.14	<.001
	2	3	0.45	0.13	<.001
Healthy-eater identity	1	2	0.06	0.13	0.90
	1	3	0.87	0.24	<.001
	2	3	0.81	0.23	<.001
Environmental identity	1	2	0.32	0.12	0.02
	1	3	1.09	0.20	<.001
	2	3	0.77	0.19	<.001
Social conformity	1	2	-0.15	0.13	0.46
	1	3	0.13	0.21	0.81
	2	3	0.28	0.20	0.33
Stereotypical masculinity	1	2	0.15	0.12	0.42
	1	3	0.53	0.16	<.001
	2	3	0.38	0.16	0.06
Food neophobia	1	2	0.09	0.11	0.71
	1	3	-0.01	0.19	1.00
	2	3	-0.10	0.19	0.87
Lack of health prevention orientation	1	2	-0.22	0.09	0.03
	1	3	0.44	0.11	<.001
	2	3	0.67	0.11	<.001
It cost too much to make vegetarian…	1	2	0.27	0.18	0.29
	1	3	1.49	0.30	<.001
	2	3	1.22	0.30	<.001
Meat-eating habit	1	2	0.73	0.11	<.001
	1	3	3.19	0.19	<.001
	2	3	2.46	0.19	<.001
Lack of self-efficacy and skill	1	2	0.58	0.17	<.001
	1	3	3.15	0.19	<.001
	2	3	2.57	0.18	<.001
Lack of social support for healthy eating	1	2	-0.16	0.10	0.20
	1	3	0.86	0.12	<.001
	2	3	1.02	0.12	<.001
Lack of social support for reducing meat	1	2	0.46	0.10	<.001
	1	3	0.49	0.17	0.01
	2	3	0.04	0.16	0.97

Willingness to change

Validation variables	Groups	Mean	Std. Deviation
I am prepared to incorporate new foods in my diet, to eat as healthily as possible.	1	5.41	1.32
	2	5.39	0.93

	3	6.13	0.88
I am prepared to abstain from eating meat or fish on one or more specific days of the week.	1	4.33	2.05
	2	4.97	1.43
	3	5.78	1.83
If I could control my cholesterol level with diet or medication, I would choose to take medication.	1	2.58	1.74
	2	2.75	1.48
	3	1.45	1.08
Have you already made conscious efforts to reduce your consumption of meat?	1	1.58	0.49
	2	1.48	0.50
	3	1.05	0.22

ANOVAS

Dependent Variable	(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
I am prepared to incorporate new foods in my diet, to eat as healthily as possible.	1	2	0.02	0.12	0.99
	1	3	-0.72	0.17	< .001
	2	3	-0.73	0.16	< .001
I am prepared to abstain from eating meat or fish on one or more specific days of the week.	1	2	-0.63	0.19	< .001
	1	3	-1.44	0.33	< .001
	2	3	-0.81	0.31	0.03
If I could control my cholesterol level with diet or medication, I would choose to take medication.	1	2	-0.17	0.18	0.61
	1	3	1.13	0.21	< .001
	2	3	1.30	0.21	< .001
Have you already made conscious efforts to reduce your consumption of meat?	1	2	0.10	0.05	0.18
	1	3	0.53	0.05	< .001
	2	3	0.43	0.05	< .001

Comparisons of group differences across studies.

Significant differences between meat-reducer and strong-hindrance groups

Lacroix and Gifford (2019)	Present study
Profiling variables:	*Profiling variables:*
Meat entitlement	**Meat entitlement**
Dependence on meat	**Dependence on meat**
Liking the taste of meat	**Liking the taste of meat**
Lack of food involvement	**Lack of food involvement**
Health beliefs about meat	**Health beliefs about meat**
Lack of health prevention orientation	**Lack of health prevention orientation**
Healthy-eater identity	**Healthy-eater identity**
Ethical beliefs about meat	**Ethical beliefs about meat**
Environmental identity	**Environmental identity**
Lack of self-efficacy and skill	**Lack of self-efficacy and skill**
Lack of perceived behavioural control	**Lack of perceived behavioural control**
Cost	**Cost**
Lack of time	**Lack of time**
Stereotypical masculinity	**Stereotypical masculinity**
Social influences †	**Social support for reducing meat** †
Important people in my life are supportive of me eating less meat †	**Social support for healthy eating** †
I have regular interactions with people who are interested in preparing vegetarian meals †	**Meat eating habit strength ***
People I live with won't eat a plant-based diet… †	
I like to try out new recipes *	
I always like to eat the same food*	
Food neophobia	
Conformity	
Willingness to change variables:	*Willingness to change variables:*
Have already made efforts to reduce	**Have already made efforts to reduce**
Preparedness to abstain from eating meat on certain days	**Preparedness to abstain from eating meat on certain days**
Preparedness to incorporate new healthy foods	**Preparedness to incorporate new healthy foods**
Preparedness for taking medication instead of dietary change	**Preparedness for taking medication instead of dietary change**

Significant differences between meat-reducer and moderate-hindrance groups

Lacroix and Gifford (2019)	Present study

Profiling variables: **Meat entitlement** **Dependence on meat** **Liking the taste of meat** **Lack of food involvement** **Health beliefs about meat** **Lack of health prevention orientation** **Ethical beliefs about meat** **Environmental identity** **Lack of self-efficacy and skill** **Lack of perceived behavioural control** **Cost** **Lack of time** **Social influences** † **Important people in my life are supportive of me eating less meat** † **I have regular interactions with people who are interested in preparing vegetarian meals** † **People I live with won't eat a plant-based diet…** † **I do not want to change my eating habit or routine*** **I like to try out new recipes*** **I always like to eat the same food*** Stereotypical masculinity	*Profiling variables:* **Meat entitlement** **Dependence on meat** **Liking the taste of meat** **Lack of food involvement** **Health beliefs about meat** **Lack of health prevention orientation** **Ethical beliefs about meat** **Environmental identity** **Lack of self-efficacy and skill** **Lack of perceived behavioural control** **Cost** **Lack of time** **Social support for healthy eating** † **Meat eating habit strength*** Health-eater identity
Willingness to change variables: **Have already made efforts to reduce** **Preparedness to abstain from eating meat on certain days** **Preparedness to incorporate new healthy foods** **Preparedness for taking medication instead of dietary change**	*Willingness to change variables:* **Have already made efforts to reduce** **Preparedness to abstain from eating meat on certain days** **Preparedness to incorporate new healthy foods** **Preparedness for taking medication instead of dietary change**
Significant differences between moderate- and strong-hindrance groups	
<u>Lacroix and Gifford (2019)</u>	<u>Present study</u>
Profiling variables: **Lack of food involvement** **Environmental identity** **Important people in my life are supportive of me eating less meat**†	*Profiling variables:* **Lack of food involvement** **Environmental identity** **Social support for reducing meat** † **Meat eating habit strength***

I like to try out new recipes*	Meat entitlement
I always like to eat the same food*	Dependence on meat
Ethical beliefs about meat	Liking the taste of meat
Health-eater identity	Lack of perceived behavioural control
Food neophobia	Health beliefs about meat
Cost	Lack of self-efficacy and skill
Lack of time	Lack of health prevention orientation ‡
Willingness to change variables:	*Willingness to change variables:*
Preparedness to abstain from eating meat on certain days	**Preparedness to abstain from eating meat on certain days**
Preparedness to incorporate new healthy foods	

Note: Significant group differences at p <.05 using Games-Howell. Constructs that are similarly different between the two studies are shown in bold. Although the habit and social support items are not identical across studies, items with * measure habit strength constructs, and items with † measure social support constructs. ‡Lack of health prevention orientation was a larger inhibitor for moderate-hindrance than for the strong-hindrance group (all other group differences are in the expected direction).

Food diary questionnaire

Try to remember what you ate for meals and snacks ***yesterday.***

	Yes (1)	No (2)	Unsure (3)
Did you eat mixed-meats (e.g., hot-dog, bologna, pepperoni)? (9)	❍	❍	❍

Other than these mixed-meats, did you...

	Yes (1)	No (2)	Unsure (3)
... eat beef? (1)	❍	❍	❍
... eat pork? (2)	❍	❍	❍
... eat chicken? (3)	❍	❍	❍
... eat turkey? (4)	❍	❍	❍
... eat lamb? (5)	❍	❍	❍
... eat fish? (6)	❍	❍	❍
... eat eggs? (7)	❍	❍	❍
... drink milk? (8)	❍	❍	❍
... eat yogurt or cottage cheese? (11)	❍	❍	❍
... eat other types of cheese? (12)	❍	❍	❍

Display This Question:

If Try to remember what you ate for meals and snacks yesterday. = Did you eat mixed-meats (e.g., hot-dog, bologna, pepperoni)? [Yes or unsure]

How many portions of mixed-meats did you eat yesterday (including meals and snacks)? Here are examples to help you estimate the number of portions. *One portion is about two regular hot-dogs, about one jumbo hot-dog, or about 3 slices of bologna. A small 10-inch pepperoni pizza is about half a portion. A small 10-inch meat pizza is about two portions.*

0 1 2 3 4 5 6 7 8 9 10

How many portions of mixed-meats did you eat yesterday?	

Display This Question:

If Other than these mixed-meats, did you... = ... eat beef? [Yes or unsure]

How many portions of beef did you eat yesterday (including meals and snacks)? Here are examples to help you estimate beef portions. *One portion of beef is about the size of a deck of cards or a bar of soap. For strips of beef (e.g., in a stir fry, soup, or stew), one portion is about the size of 9 standard dice. For ground beef, one portion is about the size of a 1 cup serving of meat spaghetti sauce, or about 6 meatballs, or about a 1.5 cup serving of shepherd's pie. A frozen hamburger patty is about 1.5 portions of beef.*

0 1 2 3 4 5 6 7 8 9 10

How many portions of beef did you eat yesterday?	

Display This Question:

If Other than these mixed-meats, did you... = ... eat pork? [Yes or unsure]

How many portions of pork did you eat yesterday (including meals and snacks)? Here are examples to help you estimate pork portions. *One portion of pork is about the size of a deck of cards or a bar of soap, about 2 breakfast sausages, about 3 slices of bacon, or about 1 Italian sausage. For strips of pork (e.g., in a stir fry, soup, or stew), one portion is about the size of 9 standard dice. For meatballs, one portion is about six meatballs. A small 10-inch Hawaiian pizza is about one portion of pork.*

0 1 2 3 4 5 6 7 8 9 10

How many portions of pork did you eat yesterday?	

Display This Question:

If Other than these mixed-meats, did you... = ... eat chicken? [Yes or unsure]

How many portions of chicken did you eat yesterday (including meals and snacks)? Here are examples to help you estimate chicken portions. *One portion of chicken is about the size of a deck of cards or a bar of soap, about 1 frozen chicken burger patty, about 2 chicken strips, or about 4 chicken wings or nuggets. For strips of chicken (e.g., in a stir fry, soup, or stew), one portion is about the size of 9 standard dice. For meatballs, one portion is about six meatballs.*

0 1 2 3 4 5 6 7 8 9 10

How many portions of chicken did you eat yesterday?	

Display This Question:

If Other than these mixed-meats, did you... = ... eat turkey? [Yes or unsure]

How many portions of turkey did you eat yesterday (including meals and snacks)? Here are examples to help you estimate turkey portions. *One portion of turkey is about the size of a deck of cards or a bar of soap, or about 3 slices of turkey bacon. For strips of turkey (e.g., in a stir fry, soup, or stew), one portion is about the size of 9 standard dice. For meatballs, one portion is about six meatballs. A frozen turkey burger patty is about 1.5 portions.*

0 1 2 3 4 5 6 7 8 9 10

How many portions of turkey did you eat yesterday?	

Display This Question:

If Other than these mixed-meats, did you... = ... eat lamb? [Yes or unsure]

How many portions of lamb did you eat yesterday (including meals and snacks)? Here are examples to help you estimate lamb portions. *One portion of lamb is about the size of a deck of cards or a bar of soap. For strips of lamb (e.g., in a stir fry, soup, or stew), one portion is about the size of 9 standard dice.*

0 1 2 3 4 5 6 7 8 9 10

How many portions of lamb did you eat yesterday?	

Display This Question:

If Other than these mixed-meats, did you... = ... eat fish? [Yes or unsure]

How many portions of fish did you eat yesterday (including meals and snacks)? *One portion of fish is about the size of a check book or half a can of fish.*

0 1 2 3 4 5 6 7 8 9 10

How many portions of fish did you eat yesterday?	

Display This Question:

If Other than these mixed-meats, did you... = ... eat eggs? [Yes or unsure]

How many eggs did you eat yesterday (including meals and snacks)?

	0 1 2 3 4 5 6 7 8 9 10
How many eggs?	

How many portions of dairy did you eat or drink yesterday (including meals and snacks)? Here are examples to help you estimate dairy portions.

Display This Question:

If Other than these mixed-meats, did you... = ... drink milk? [Yes or unsure]

Milk: *One portion is about 1 cup or 250 mL.*

	0 1 2 3 4 5 6 7 8 9 10
How many portions of milk did you drink yesterday?	

Display This Question:

If Other than these mixed-meats, did you... = ... eat yogurt or cottage cheese? [Yes or unsure]

Yogurt or cottage cheese: *One portion is about 3/4 cup, 180 mL, or 175g.*

	0 1 2 3 4 5 6 7 8 9 10
How many portions of yogurt or cottage cheese did you eat yesterday?	

Display This Question:

If Other than these mixed-meats, did you... = ... eat other types of cheese? [Yes or unsure]

Cheese: *One portion of firm cheese is about the size of 4 standard dice or the size of two thumbs. One portion of ricotta cheese is about 1/4 cup. One portion of pre-sliced sandwich cheese is about 2 slices. One piece of lasagna is about 2.5 portions. One small 10-inch pizza is about 2 portions of cheese or 3 portions of cheese for an extra-cheese or cheese-only pizza.*

0 1 2 3 4 5 6 7 8 9 10

How many portions of cheese did you eat yesterday?	

Try to remember what you ate for meals and snacks yesterday.

	Yes (1)	No (2)	Unsure (3)
Did you eat legumes (e.g., beans, lentils, chickpeas)? (1)	❍	❍	❍
Did you eat tofu? (2)	❍	❍	❍
Did you eat meat-replacement products (e.g., veggie burger, vegetarian meatballs)? (3)	❍	❍	❍

Display This Question:

If Try to remember what you ate for meals and snacks yesterday. = Did you eat legumes (e.g., beans, lentils, chickpeas)? [Yes or unsure]

How many portions of legumes (e.g., beans, lentils, chickpeas) did you eat yesterday (including meals and snacks)? *One portion of legumes is about 3/4 cup, 175 mL, or about the size of one fist.*

0 1 2 3 4 5 6 7 8 9 10

How many portions of legumes?	

Display This Question:

If Try to remember what you ate for meals and snacks yesterday. = Did you eat tofu? [Yes or unsure]

How many portions of tofu did you eat yesterday (including meals and snacks)? *One portion of tofu is about 3/4 cup, 175 mL, or 150g.*

0 1 2 3 4 5 6 7 8 9 10

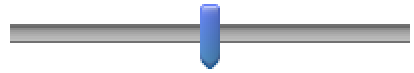
How many portions of tofu?	

Display This Question:

If Try to remember what you ate for meals and snacks yesterday. = Did you eat meat-replacement products (e.g., veggie burger, vegetarian meatballs)? [Yes or unsure]

How many portions of meat-replacement products did you eat yesterday (including meals and snacks)?

One portion of meat-replacement is about 1 vegetarian burger or chicken breast or Italian sausage, 2 veggie dogs, 3 vegetarian meatballs, 4 vegetarian chicken strips, or 8 slices of vegetarian ham or bologna.

	0 1 2 3 4 5 6 7 8 9 10
How many portions of meat-replacement products?	

Do you remember what you ate for meals and snacks two days ago?

- ❍ Yes (1)
- ❍ No (2)

If they answered yes, participants were asked the same questions as above but for *two days ago* instead of *yesterday*.

Examples of GHG in meals

1 beef portion = 2260 g CO_2e
1 pork portion = 490 g CO_2e
1 chicken portion = 310 g CO_2e
1 meat-replacement portion = 120 g CO_2e
1 portion of legumes = 70 g CO_2e

Burgers:
Beef burger (on average 113g of beef per burger) = 3004 g CO_2e
Chicken burger (on average 100g of chicken per burger) = 365 g CO_2e
Veggie burger (on average 75g of meat-substitute per burger) = 90 g CO_2e

Pizza:
Small meat pizza (90g beef, 90g pork, 99g cheese) = 3634 g CO_2e
Small chicken pizza (71g chicken, 99g cheese) = 1111 g CO_2e
Small vegetarian pizza (99g cheese) = 852 g CO_2e

Sandwiches:
Roast beef (85g beef, 8g egg for mayonnaise) = 2289 g CO_2e
Ham and cheese (25g ham, 45g cheese) = 531 g CO_2e
Chicken-salad (85g chicken, 8g egg for mayonnaise) = 339 g CO_2e
Egg-salad (92g eggs) = 314 g CO_2e

Breakfast:
Bacon and eggs (56g pork, 112g eggs) = 703 g CO_2e
Yogurt (175g) = 230 g CO_2e

R code (nlme package)

Unconditional means model:
$Y_{ij} = y_{00} + u_{0i} + E_{ij}$
R code: Mod1<- lme (ghg ~ 1, random = ~ 1|ID, data = mydata, na.action = na.omit, method = "ML")

Unconditional growth model:
$Y_{ij} = y_{00} + y_{10}\mathrm{TIME}_{ij} + u_{0i} + u_{1ij}\mathrm{TIME}_{ij} + E_{ij}$
R code: Mod2<- lme (ghg ~ 1 + time, random = ~ time|ID, data = mydata, na.action = na.omit, method = "ML")

Treatment interaction model:
$Y_{ij} = y_{00} + y_{02}\mathrm{TREATMENT}_{i} + y_{10}\mathrm{TIME}_{ij} + y_{12}\mathrm{TREATMENT}_{i}{*}\mathrm{TIME}_{ij} + u_{0j} + u_{1j}\mathrm{TIME}_{ij} + E_{ij}$
R code: Mod4<- lme (ghg ~ 1 + time + treatment + time:treatment, random = ~ time|ID, data = mydata, na.action = na.omit, method = "ML")

Matching interaction model:
$Y_{ij} = y_{00} + y_{02}\mathrm{MATCHING}_{i} + y_{10}\mathrm{TIME}_{ij} + y_{12}\mathrm{MATCHING}_{i}{*}\mathrm{TIME}_{ij} + u_{0j} + u_{1j}\mathrm{TIME}_{ij} + E_{ij}$
R code: Mod4<- lme (ghg ~ 1 + time + matching + time:matching, random = ~ time|ID, data = mydata, na.action = na.omit, method = "ML")