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Reducing meat consumption: Identifying group-specific inhibitors using latent profile analysis

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ABSTRACT

Consumption of animal products is an important greenhouse gas emitting behavior. However, perceived hindrances to incorporating more plant-based diets present challenges for the successful design of behavior-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.

1. 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 behaviors 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 behaviors, 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, Hoogland, & Boersema, 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,

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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 behavior interventions is becoming widely recognized (Maio et al., 2007; Reynolds, 2010; Stern, 2011). Relevant behavior-change theories and frameworks suggest tailoring the strategies to the perceived and actual barriers and benefits associated with specific behaviors (i.e., Schultz, 2014), to the stage of change (i.e., stage model of self-regulated change; Bamberg, 2013), to an individual's motivation, opportunity, and habit strength (e.g., the segmentation model of sustainable behavior; Verplanken, 2017), or to an individual's capability, opportunity, and motivation for change (e.g., COM-B system; Michie, van Stralen, & West, 2011). All these frameworks highlight the importance of considering the behavior 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, 2006a; Weir et al., 2000) and climate change research (see Hine et al., 2014 for a review).

1.1. 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 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.

1.2. 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 behaviors (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 behavior 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 behavior. 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.

2. Material and methods

2.1. 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.

2.2. 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 the supplementary materials.

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 behavior and prioritize efficiency over nutrition (de Boer et al., 2007, 2016; 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 behavior (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 behavioral 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 cost 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, Gatersleben, & Uzzell, 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 1. 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 the supplementary materials.

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.)

3. Results

3.1. Hypotheses testing

Segmentation. After checking that assumptions of normality were met (Kline, 2010) 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 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

Table 1
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.

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 1. 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.

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 behavioral variables (Pillai's Trace = 0.41, F (12,696) = 14.8, $p < .001$, $\eta^2 = 0.20$).

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 $d = 0.58$; $M_{diff} = 2.35$, $p < .001$, $d = -0.53$; $M_{diff} = 0.55$, $p < .001$, $d = -0.49$), and between Group 1 and Group 3 (i.e., the meat-reducers and the strong-hindrance meat eaters; $M_{diff} = -3.77$, $p < .001$, $d = 0.45$; $M_{diff} = 2.68$, $p < .001$, $d = -0.53$; $M_{diff} = 0.55$, $p < .001$, $d = -0.46$) 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 ($M_{diff} = 0.77$, $p = .01$, $d = -0.16$).

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 2.

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 $M_{diff} = 0.55$, $p < .05$, $d = -0.15$; Groups 1–2 $M_{diff} = 1.71$, $p < .001$, $d = -0.50$; Groups 1–3 $M_{diff} = 2.25$, $p < .001$, $d = -0.47$), and their willingness to incorporate new foods in their diet (Groups 2–3 $M_{diff} = 0.33$, $p < .05$, $d = -0.14$; Groups 1–2 $M_{diff} = 0.74$, $p < .001$, $d = -0.39$; Groups 1–3 $M_{diff} = 1.07$, $p < .001$, $d = -0.34$). Groups 1 and 2 (i.e., meat-reducers and moderate-hindrance meat eaters; $M_{diff} = 1.02$, $p < .001$, $d = -0.33$) and Groups 1 and 3 (i.e., meat-reducers and strong-hindrance meat eaters; $M_{diff} = 1.16$, $p < .001$, $d = -0.26$) 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; $M_{diff} = 0.14$, $p = .74$).

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.

3.2. Profiles and inhibitors

A MANOVA showed that group membership explained 47% of the variance in the set of profiling variables (Pillai's Trace = 0.94, F (46,662) = 12.7, $p < .001$, $\eta^2 = 0.47$). The analyses were followed by univariate ANOVAs to better understand group specific inhibitors (Table 3). 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 behavioral 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 $M_{diff} = 0.36$, $p < .001$, $d = -0.32$; Groups 1–3 $M_{diff} = 0.26$, $p < .01$, $d = -0.21$) and more liberal (Groups 1–2 $M_{diff} = 0.59$, $p < .001$, $d = -0.26$; Groups 1–3 $M_{diff} = -0.75$, $p < .001$, $d = 0.30$) than Groups 1 and 3 (i.e., moderate- and strong-hindrance meat eaters).

3.3. 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

Table 2
Means, standard deviations, and significance test of differences between groups.

Outcome variables	Group 1		Group 2		Group 3		Univariate
	M	*SD*	*M*	*SD*	*M*	*SD*	Welch's *F* (df)
Frequency of eating animal products	6.90	4.50	11.44	1.96	10.67	2.59	25.70 (2121)
Frequency of eating vegetarian meals	5.51	1.67	3.16	1.67	02.83	1.84	50.09 (2143)
Having already made conscious efforts to eat less meat	01.92	0.27	1.37	0.49	01.37	0.49	67.88 (2182)
Preparedness to abstain from eating meat	06.43	0.78	4.73	1.46	04.18	2.03	89.09 (2204)
Preparedness to incorporate new healthy foods	06.22	0.70	5.47	0.80	5.14	1.37	30.56 (2163)
Preference for taking medication instead of dietary change	06.43	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 $p < .001$.

Table 3
Means, standard deviations, and group differences of profiling variables.

Profiling variables	Means (SD)			Univariate
	Group 1	Group 2	Group 3	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 (2141), $p < .001$
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 (2150), $p < .001$
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 (2158), $p < .001$
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 (2147), $p < .001$
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 (2185), $p < .001$
Lack of perceived behavioral 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 (2164), $p < .001$
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 (2157), $p < .001$
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 (2163), $p < .001$
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 (2147), $p < .001$
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 (2138), $p < .001$
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 (2145), $p < .05$
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 (2139), $p < .001$
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 (2213), $p < .001$
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 (2155), $p < .001$
It costs too much to make vegetarian food	1.53* (1.07)	3.04* (1.34)	3.75* (1.90)	59.42 (2167), $p < .001$
I like to try out new recipes	1.65* (.69)	2.18* (.92)	2.82* (1.51)	29.96 (2176), $p < .001$
I always like to eat the same food	2.76† (1.26)	3.27† (1.26)	4.27 (1.54)	31.54 (2146), $p < .001$
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 (2149), $p < .01$
Demographics				
Gender (1 = male, 2 = female)	1.73 (.45)	1.4† (.49)	1.47† (.51)	13.73 (2145), $p < .001$
Education (1 = Elementary school, 6 = PhD)	3.71 (1.05)	3.61 (1.01)	3.36 (1.10)	3.29 (2145), $p < .05$
Political ideology (1 = Very liberal, 5 = Very conservative)	1.84 (.86)	2.43† (1.02)	2.60† (1.05)	13.73 (2150), $p < .001$

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.

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

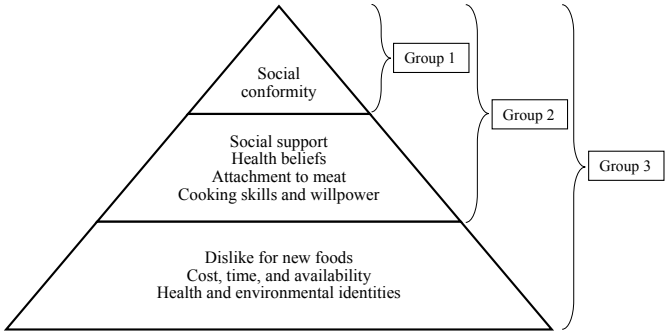

Fig. 1. Proposed hierarchy of inhibitors to changing diets. Group 1 = meat-reducers, Group 2 = moderate-hindrance meat eaters, Group 3 = strong-hindrance meat eaters.

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 (Fig. 1).

4. 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 behaviors. 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; Graça, Oliveira, et al., 2015; Pohjolainen et al., 2016; Vainio et al., 2016), only Graça, Calheiros, et al. (2015) and 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, Calheiros, et al. (2015) and Graça, Oliveira, 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, Calheiros, et al. (2015) and Graça, Oliveira, 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, Calheiros, et al. (2015) and Graça, Oliveira, 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).

4.1. Limitations and future research

A multi-scale tool was developed to measure a comprehensive set of inhibitors and facilitators to meat-reducing behaviors 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, 2017), 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.

4.2. 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, pp. 1–62).

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 behaviors 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 behavioral 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.

5. 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.

Conflicts of interest

The authors declare that no competing interests exist.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.appet.2019.04.002.

Appendix 1. Scale items

Scale	Items	Source
Entitlement to meat (3 items, α = .85)	To eat meat is an unquestionable right of every person.	Graça, Calheiros, and Oliveira (2015)
	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 = .88)	*I would feel fine with a meatless diet.*	Graça, Calheiros, et al. (2015)
	If I was forced to stop eating meat I would feel sad.	
	Meat is irreplaceable in my diet.	
Taste (3 items, α = .71)	Meat is delicious.	Piazza et al. (2015)
	Meat adds so much flavor to a meal it does not make sense to leave it out.	Lea and Worsley (2001)‡
	Vegetarian food is bland and boring.	
Self-efficacy (4 items, α = .72)	I lack the cooking skills to prepare meat-free meals.	Lea and Worsley (2001)‡
	I don't know what to eat instead of meat.	Weir et al. (2000)‡
	I don't have enough willpower to not eat meat.	
	Following a recommended diet is hard for me.	
Perceived behavioral control (3 items, α = .76)	Someone else cooks and prepares meat, so I should eat it.	Mullee et al. (2017)‡
	Someone else decides on most of the food I eat.	Lea et al. (2006)
	Someone else does the grocery shopping.	Hodson and Earle (2018)‡
Time and availability of alternatives (5 items, α = .70)	I have to go food shopping more often when making vegetarian meals.	Lea et al. (2006)‡
	It takes too long to prepare plant-based meals.	Mullee et al. (2017)‡
	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 (5 items, α = .75)	*Reducing meat consumption helps to prevent disease (e.g., heart disease, cancer).*	Lea et al. (2006)‡
	Red meat such as beef or lamb is fattening.	Lea and Worsley (2001)
	It's healthier not to frequently eat meat.	Schösler et al. (2015)
	Eating meat is necessary in order to be healthy.	Piazza et al. (2015)‡
	You cannot get all the protein, vitamins and minerals you need on an all vegetarian diet.	
Ethical and environmental beliefs (5 items, α = .79)	*Reducing meat consumption is better for the environment.*	Tobler et al. (2011)
	By reducing meat consumption, one can prevent animals suffering.	Lea et al. (2006)‡
	It is more efficient to produce plant-based foods.	Mullee et al. (2017)
	Cattle farming has a big impact on the planet.	Schösler et al. (2015)
	I think animal welfare is important.	
Food involvement (6 items, α = .77)	*They are very mindful of food. They want to eat sensibly.*	de Boer et al. (2007)‡
	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.	
Health identity (3 items, α = .89)	*I am someone who eats in a nutritious manner.*	Blake et al. (2013)
	I am someone who is careful about what I eat.	Abrahamse et al. (2009)
	I think of myself as a healthy eater.	
Environmental identity (4 items, α = .89)	*I think of myself as someone who is concerned about the environment.*	Abrahamse et al. (2009)
	To engage with issues related to the environment is an important part of who I am.	Schösler et al. (2015)
	Engaging in environmentally friendly behaviors is important to me.	
	It's important to me that my food choices are not harmful to the natural environment.	
Conformity (4 items, α = .76)	When I'm in a group, I try to behave like everyone else.	Janda and Trocchia (2001)
	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 situations, I look for the behavior of others.	

Stereotypical masculinity[§] (5 items, α = .72)	It is the woman's responsibility to keep the family healthy by serving a nutritious diet.	Hoek et al. (2004)
	Nowadays the responsibility for shopping and cooking ought to lie just as much with the husband as with the wife.	Rothgerber (2013)[‡]
	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 = .84)	I don't trust new foods.	Siegrist et al. (2013)
	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.	
Social influence (3 items, α = .70)	Not eating meat is socially unacceptable.	Piazza et al. (2015)
	Most people I know eat meat[†]	Lea and Worsley (2001)[‡]
	People would think that I am a wimp or not macho enough if I didn't eat meat.	Lea et al. (2006)
	I don't want people to think that I'm strange or a hippie	Mullee et al. (2017)[‡]
	Eating meat is how I was brought up[†]	
Health prevention (5 items, α = .69)	*I try to understand my personal health risks.*	Maibach et al. (2006)
	Most health issues are too complicated for me to understand.	Grisolía et al. (2015)
	I have difficulty understanding the health information that I read.	
	I actively try to prevent diseases and illness. [†]	
	My physical wellbeing depends on how well I take care of myself.	
	What I eat is not going to affect my health.	
	Good health is largely a matter of good luck. [†]	
Social support* (α = .29)	*I have regular interactions with people who are interested in preparing vegetarian meals.*	Hodson and Earle (2018)[‡]
	Important people in my life are supportive of me eating less meat.	Lea et al. (2006)[‡]
	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.	
Dietary routine* (α = .38)	I always like to eat the same food.	Mäkiniemi and Vainio (2014)
	I do not want to change my eating habit or routine.	
	I like to try out new recipes.	Lea and Worsley (2001)
		Hoek et al. (2004)
Cost	It costs too much to make vegetarian food.	Hodson and Earle (2018)[‡]

Note. *All items were retained for social support and dietary routine. Likert scale from strongly disagree (1) to strongly agree (7). Reverse-coded items are listed in italics. [‡] indicates items were modified slightly. [†] indicates items were removed from the scale. [§]As suggested by an anonymous reviewer, the effect of stereotypical masculinity on animal product consumption may operate differently for men and women. This was verified by including an interaction variable in multiple linear regression. The interaction was not significant (see the supplementary materials).

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