Personal, Interpersonal, and Contextual Influences on Consumer Preferences for Plug-in Electric Vehicles: A Mixed-methods and Interdisciplinary Approach

by

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B.Sc. (Hons), Queen’s University, 2004
M.Sc., University of Victoria, 2010

A Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of

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Abstract

Widespread adoption of plug-in electric vehicles (PEVs) can help to achieve deep reductions in global greenhouse gas emissions; however, the degree to which this potential will be realized depends on consumers’ decisions to purchase these vehicles over conventional ones. To provide comprehensive insight into the psychological and contextual influences on consumer vehicle preferences, three studies were performed using a mixed-methods approach. Study 1 employed a survey and stated choice experiment to explore: 1) the explanatory power of the three psychological variables from Ajzen’s (1991; 2005) theory of planned behaviour in predicting PEV purchase intentions among new vehicle buyers from British Columbia, and 2) the influence of hypothetical variations in financial and non-financial incentives on estimated PEV preference, with the goal of informing the design of provincial policy measures. Vehicle preferences were most strongly influenced by purchase price and point-of-sale incentives – with a roughly 4% forecasted increase in PEV new vehicle market share under a $5,000 purchase rebate – as well as by attitudes about PEVs (especially concerning personally-relevant PEV benefits), perceived behavioural control, and social norms. In Study 2, a latent class choice model was used to integrate survey and choice experiment data to characterize
consumer classes based on vehicle preferences, demographic characteristics, and psychological variables. Findings revealed profiles of five distinct preference-based segments and demonstrated that the inclusion of psychological covariates can improve the fit of such latent class models. Study 3 extended these findings through a controlled message framing experiment that evaluated the impact of psychological distance on PEV purchase intentions. Results demonstrated that messages emphasizing both personally-relevant and societally-relevant PEV benefits increased related purchase intentions compared to the control group. Taken together, these findings may be useful in the development of PEV policies as well as targeted marketing and communications strategies aimed at supporting a transition to PEVs within Canada.
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CHAPTER 1

Background

Introduction

The G7 countries have pledged to reduce greenhouse gas (GHG) emissions to 70% below 2010 levels by 2050. In addition, as part of the 2015 Paris Climate Change Agreement – which has been lauded as a historic turning point in global consensus to minimize climate change – all 195 participating nations and the European Union pledged to limit global warming to less than 1.5 degrees Celsius above pre-industrial levels. These targets will require drastic reductions in carbon output, and road transportation will be key in achieving such reductions given that it accounts for a quarter of global carbon dioxide emissions (Sims et al., 2014). Although increased sustainable transportation (e.g., public transit and cycling) will help to reduce emissions, travel mode is notoriously difficult to change due to its habitual nature and, as such, alternative means to decrease passenger vehicle-related GHGs without requiring major changes to citizens’ transportation behaviour are required. Certainly continued improvements to the fuel efficiency of conventional gasoline vehicles (GVs) will be helpful, but substantial GHG reductions will necessitate a shift towards vehicles that use alternative fuels, such as electricity (Williams et al., 2012).

Advancements in plug-in electric vehicle (PEV) technologies – which include plug-in hybrid electric vehicles (PHEVs) that are powered by electricity for a certain distance before switching to an internal combustion engine, as well as battery electric vehicles (BEVs) that are powered exclusively by electricity – hold great potential to assist with achieving emissions reductions targets, especially when paired with renewable energy sources. Indeed, PEVs offer
only minor benefits over GVs when powered by coal-based electricity, but PEVs powered by natural gas-based electricity can reduce emissions by one third (Axsen et al., 2011) and those powered by renewable sources have the potential to totally eliminate related emissions on the road. For this reason, broader adoption of PEVs (coupled with renewable energy) is considered essential to mitigate climate change, and the International Energy Agency (2015) estimates that 40% of global new vehicle sales will need to be PEVs by 2040 to achieve stabilization of carbon dioxide concentrations.

Many governments have set ambitious short-term PEV sales targets for 2020, which translate into a roughly 500% increase in the number of new vehicles sold that are PEVs (i.e., PEV new market share; IEA, 2013). In Canada, for example, where the transportation sector is the second-largest source of domestic GHGs (Canada’s Emission Trends, 2014), the Canadian Electric Vehicle Technology Roadmap lays out a goal of 500,000 PEVs on the road by 2018 (Natural Resources Canada, 2010). Given that fossil fuels still account for 95% of national transportation (Canadian Fuels Association, 2014), several Canadian provinces have implemented policies intended to accelerate PEV market growth.

And yet, projections about the GHG-reduction impact of PEVs range widely (e.g., Duvall et al., 2007; Samaras & Meisterling, 2008), partly because of uncertainties about how consumer perceptions and preferences will influence the speed at which these vehicles diffuse into the market. Traditional consumer research in this area has focused on functional vehicle aspects (e.g., range, price, and emissions); however, for PEVs to be successfully adopted these technologies must not only meet users’ needs but consumers must also want to purchase PEVs over GVs. The class of PEVs currently available on the market tend to be predominantly small cars/sedans, as opposed to SUVs and vans. As such, consumer’s pre-existing perceptions
surrounding “required” vehicle size likely also influence perceptions of PEVs. Thus, growing evidence attests to the value of considering mental constructs, in addition to functional aspects, that underlie PEV decision-making to provide insights into how to facilitate uptake.

Towards this aim, this program of study employs an interdisciplinary approach, integrating theories and methodologies from psychology, economics, policy, and marketing into an analysis of the various influences on consumer preferences for PEVs. Specifically, a survey, stated choice experiment, latent class choice model, and randomized controlled experiment are conducted to offer comprehensive insight into the role of several factors – namely, the variables from the theory of planned behaviour (TPB; Ajzen, 1991; 2005), as well as several financial and non-financial incentives – to help account for consumer vehicle preferences. This research also aims to characterize segments of consumers with distinct vehicle preferences and examine how to best communicate the benefits of PEVs to prospective buyers. Through a series of three studies, this research program addresses both theoretical and applied objectives, such as helping to inform the design of policy measures within the province of British Columbia (BC), with the overarching goal to improve understanding of conditions that promote PEV adoption.

**Policy-related and Psychological Influences on PEV Preferences**

**PEV policies in Canada.** The percent of annual new passenger PEV sales differs widely across countries, with Norway leading (where 14% of new vehicles sold are PEVs), followed by the Netherlands (at 4%). Strong supportive policies are required to incentivize PEV purchases and thus accelerate market growth, but governments vary in the extent to which they focus on stimulating consumer demand (*demand-focused policies*) or on stimulating suppliers (*supply-focused policies*). The majority of global PEV policies are demand-focused, such as those involving financial incentives (e.g., BC’s clean energy vehicle purchase incentives) or tax
exemptions (e.g., Norway’s exemption of PEVs from a 25% vehicle tax), as well as non-financial incentives (e.g., Norway, the Netherlands, and Germany provide free downtown parking for PEVs; and California allows PEVs to use high-occupancy vehicle lanes regardless of the number of occupants). Supply-focused policies include the low-carbon fuel standard (e.g., as implemented in BC and California), which requires suppliers to decrease the carbon intensity of their fuels\(^1\) and the zero-emissions vehicle mandate (e.g., in California), which stipulates that automobile manufacturers must sell a particular proportion of PEVs or hydrogen fuel-cell vehicles.

In Canada, PEV policies vary greatly across the provinces, with Quebec, Ontario, and BC having implemented the strongest demand-focused policies. Almost half of national PEV sales (46%) occur in Quebec, with 8,456 PEVs sold in the province as of December 31, 2015 (Stevens, 2015). Quebec aims to have 25% of new light passenger vehicle sales be PEVs by 2020, and Quebec’s Drive Electric program, which began in 2012, allows consumers to receive a purchase- or lease-rebate of up to $8,000 on eligible PEVs, in addition to up to $1,000 for installing a 240V residential charging station. Quebec has also installed considerable public charging infrastructure (Level 2 and DC fast chargers).

Ontario has the second-largest proportion of national PEV sales (at 32%), with 5,935 PEVs sold as of December 31, 2015 (Stevens, 2015), and the province aims to have 5% of new vehicle sales be PEVs by 2020. To achieve this target, starting in 2010 and running until the end of 2013, consumers of eligible PEVs received a purchase or lease rebate of up to $8,500 as well as $1,000 for the installation of a residential charging station; the recently announced new

\(^1\) If electricity is considered a low-carbon fuel, then this policy incentivizes the use of electricity for vehicles because it allows fuel refiners to purchase credits from electric utilities.
Electric Vehicle Incentive Program involves purchase incentives ranging from $8,500-$10,000, with the opportunity to receive an additional $3,000 incentive for vehicles with larger battery capabilities (but with a cap of $3,000 on PEVs priced over $75,000). Ontario has also introduced green-coloured license plates for PEV drivers, which allow single-occupant drivers to travel in high-occupancy vehicle lanes, and PEV drivers can access free charging stations at many provincially-owned parking lots.

BC currently has the third-largest proportion of Canadian PEV sales (at 18%), with 3,326 PEVs sold in the province as of December 31, 2015 (Stevens, 2015), although BC has the most comprehensive PEV policies and programs in place. The benefits associated with PEVs are especially appealing in regions such as BC, where the majority of the utility portfolio comes from renewable energy sources (see Kelly, Williams, Kerrigan, & Crawford, 2009). Controlling for the number of passenger cars sold per province, BC has the highest trailing three-month average of PEV percentage of passenger car sales, as of December 15, 2015; in particular, BC leads with roughly 2.3%, followed closely by Quebec at 2.2%, and Ontario at 0.8% (Stevens, 2015).

Passenger vehicles account for roughly 14% of provincial GHGs in BC (BC Greenhouse Gas Inventory Report, 2007), and so increased PEV adoption promises to help achieve the BC Government’s ambitious target of a 33% reduction in GHGs by 2020 (compared to 2007 levels). The Clean Energy Vehicle Program’s point-of-sale purchase or lease incentive of up to $5,000 for eligible vehicles (i.e., PEVs, fuel cell vehicles, and compressed natural gas vehicles) began in 2011 and continued through to the end of March 2014, and it was recently renewed in April 2015 to distribute additional incentives over the next three years. BC also offers rebates of up to $500 per residential Level 2 charging station and the province (in collaboration with various partners)
has recently installed hundreds of Level 2 public charging stations and dozens of DC fast-charging stations along major highways as well as launched consumer outreach efforts through the Emotive and Plug-in BC programs.

**Financial incentives and proenvironmental behaviour.** Demand-focused policies involving financial incentives offer a promising intervention approach to encourage individuals to engage in new behaviours, such as purchasing a PEV instead of a GV. According to Lewin’s (1951) classic three-stage model of change, an intervention must first *unfreeze* individuals’ current behavioural patterns by overcoming the inertia of habit. During the second stage, the *change* occurs, and then new patterns are crystallized in the final stage as behaviour *refreezes*. Therefore, financial incentives can help to interrupt pre-existing consumption patterns (e.g., purchasing GVs) by increasing the attractiveness of a competing alternative (e.g., a PEV), which can then lead to the establishment of a new behaviour, such as engaging in more sustainable transportation habits (Bamberg, 2006; Dahlstrand & Biel, 1997).

Several meta-analyses have demonstrated the positive influence of financial incentives on household energy conservation (Delmas, & Fischlein, & Asensio, 2013), recycling (Hornik, Cherian, Madasnky, & Narayana, 1995), and a range of other proenvironmental behaviours (Osbaldiston & Schott, 2012). Osbaldiston and Schott (2012) speculated that incentives may have the greatest effect on difficult behaviours. Given that sustainable transportation behaviours are perceived to be among the most difficult kinds of proenvironmental behaviour to perform (Dietz, Gardner, Gilligan, Stern, & Vandenbergh, 2009), purchase incentives may be especially effective at encouraging a shift to PEVs.

Greater financial incentives are generally more effective (Heyman & Ariely, 2004), but it is necessary to assess the influence of varying incentive amounts to optimize these interventions.
Previous research has endeavoured to forecast PEV new market share, with estimated 2020 penetration rates that range from 1-18% (Sikes et al., 2010; Sullivan et al., 2009), partly on account of variations in subsidization. However, PEV market share forecasts such as these have been criticized for not thoroughly examining the influence of government policies (see Al-Alawi & Bradley, 2013). Thus, using a stated choice experiment, the present research aims to forecast PEV new market share in BC under various purchase incentive amounts, with the goal of informing provincial policy measures.

Consumer research on vehicle preference. The recent surge of interest in consumer research related to alternative-fuel vehicles has been driven primarily by concerns about climate change and energy security. To date, research in this area has been multi-faceted, with one body of theoretical literature focusing on motivations that underlie vehicle purchase decisions, and another body of empirical literature focusing on consumer preferences related to actual and hypothetical PEV ownership (see Morton, Schuitema, & Anable, 2011). The majority of these latter studies have estimated consumer preferences and forecasted PEV market share using a technique called discrete choice modeling.

Choice modeling is based on rational choice theory – the main theoretical paradigm in economics – in that consumers are assumed to weigh vehicle attributes via deliberate cost-benefit analysis to choose products that maximize their expected personal benefit (Simon, 1997). Using this assumption, and stemming from Lancaster’s (1966) theory of value and McFadden’s (1974) random utility model, these models produce utility coefficients that reflect the value consumers associate with products and their associated attributes. Preference is most commonly represented in the economics literature by willingness-to-pay (WTP), or the extra amount a consumer would pay for one additional unit of an attribute (e.g., km of battery range), where consumer valuation
of the overall product (e.g., WTP for a PEV versus a GV) can then be represented as the sum of these valuations of individual attributes. Implicit in this approach is the assumption that consumer preferences are underpinned by psychological constructs, such as motivations and attitudes, although these variables are not often included in these models.

**Choice modeling and transportation behaviour.** Choice modeling uses hypothetical preference data from *stated choice experiments* to examine the factors that influence decision-making about discrete goods. These models assess utility by presenting respondents with a series of choice sets, each containing two or more hypothetical alternatives (e.g., vehicles), where each alternative has a set of attributes (e.g., price and battery range) with systematically varied levels (Bateman et al., 2002; Louviere et al., 2000). Respondents then choose the alternative they most prefer per choice set, thus revealing the influence of attribute variations on their subsequent choices as well as the relative impact of the attributes. Consistent with the rational actor model, consumers are assumed to select the alternative that will yield the greatest anticipated benefit. This approach lends itself well to studying new technologies, such as PEVs, where actual market choice data is currently limited (e.g., Hensher, 1994), as well as to proactive analysis about the influence of hypothetical policies (e.g., different levels of PEV purchase incentives) on consumers transportation-relevant decisions (Carson, Louviere, & Wei, 2010; see Koppelman & Bhat, 2006).

One of the earliest applications of choice modeling to examine transport mode was McFadden’s (1974) consumer demand forecast for the Bay Area Rapid Transit (BART) system. Consumer research into alternative-fuel vehicles, specifically, began following the energy crisis of 1970s (e.g., Beggs et al., 1981; Hensher, 1982; Train, 1980) and gained further momentum following the implementation of California’s zero-emission vehicle mandate in the 1990s (e.g.,
Brownstone et al., 1996, 2000; Bunch et al., 1993; Dagsvike et al., 2002; Ewing & Sarigollu, 2000; Hess, 2012; Hidrue et al., 2011; Potoglou & Kanaroglou, 2007; Tompkins et al., 1998). The majority of these previous studies have focused primarily on quantitative and functional vehicle attributes, finding, for example, that consumers are chiefly concerned about purchase price, recharge time, and battery range. And yet, underlying demographic and psychological characteristics can also exert considerable influence on consumer vehicle choices.

In an effort to include these additional individual-level variables, more recent modeling studies have interacted preference estimates with demographic variables to reveal, for instance, how WTP for alternative-fuel vehicles varies by gender, education, and household income (Brownstone et al., 2000; Bunch et al., 1993; Potoglou & Kanaroglou, 2007). And other PEV research has included interaction terms to estimate different WTP values based on mental constructs, such as environmental attitudes (Ewing & Sarigollu, 2000) as well as lifestyle variables (Axsen, Bailey, & Castro, 2015). Another choice experiment found that individuals’ purchasing responses to emissions charging schemes varied as a function of their environmental attitudes, and also that model fits were improved by incorporating this attitudinal data (Beck, Rose, & Hensher, 2011; Beck, Rose, & Greaves, 2016). The literature is scant, however, in terms of applications of behavioural theory to examine the determinants that underlie consumer PEV preferences. Thus, in addition to employing a stated choice experiment to evaluate the influence of hypothetical variations in financial and non-financial incentives on PEV preferences, the present research will also involve a survey to examine the explanatory power of Ajzen’s (1991) TPB to account for self-reported vehicle preferences.

**The theory of planned behaviour applied to PEVs.** The basic premise of the rational actor model has been critiqued by researchers in fields such as behavioural economics and
psychology (e.g., Peattie, 2010). Consistent with these efforts to deviate from a strictly economically rational approach to the study of vehicle purchase decisions, the TPB (Ajzen, 1991) – one of the most widely applied theories in psychology – holds promise to help explain PEV purchase intentions. Since its introduction in 1991, over 1,000 studies have applied the TPB to explain a variety of behaviours. A recent meta-analysis revealed that the TPB explained 52% of variance in general pro-environmental behavioural intention (Bamberg & Möser, 2007), and it has also effectively predicted public transport use (Heath & Gifford, 2002), intentions to carpool (Laudenslager, Holt, & Lofgren, 2004), and interest in clean energy vehicles (Lane & Potter, 2007). This theory proposes that an individual’s attitudes (or general sense of favourableness) towards a behaviour, social norms regarding that behaviour (as well as the motivation to adhere to those norms), and perceived behavioural control (i.e., one’s situation-specific sense of ability to carry out the actions necessary for the behaviour), causally predict behavioural intention. Intention, in turn, predicts the likelihood of performing the behaviour (see Ajzen, 2011 for review; Figure 1).
Figure 1. Theory of Planned Behaviour (Ajzen, 1991).

The TPB posits that the more these three variables are aligned, the more an individual will intend to engage – and thus will be more likely to engage – in the behaviour at hand. Therefore, the TPB would posit that a consumer’s reported intention to purchase a PEV would be causally determined by the three influences, as follows.

First, individuals must have a favourable attitude about purchasing a PEV as well as a belief that the consequences of the purchase will be positive. PEV adoption has been associated with various symbolic motives (e.g., Steg, Vlek, & Slotegraaf, 2001), such as environmental preservation and independence from petroleum producers (Heffner et al., 2007; Kurani et al., 2007), whereas other research suggests that vehicle purchase decisions are influenced by motivations beyond the environment (e.g., Anable et al., 2008; Thatchenkery, 2008), such as social status and identity (Dittmar, 1992; Steg, 2005). According to self-presentation theory (Schlenker, 1980), individuals strive to present themselves in a manner consistent with their self-

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2 The majority of research, to date, has assessed the ability of the TPB to predict self-reported (rather than objective) proenvironmental behaviour.
image, and vehicles can play an important role in this self-presentation. In addition, Axsen and Kurani (2012) have proposed that attitudes related to the perceived benefits of PEVs can be categorized as personal or societal, and functional or symbolic, as outlined in Table 1.

Table 1. *Categorization of perceived benefits associated with PEVs (adapted from Axsen & Kurani, 2012)*

<table>
<thead>
<tr>
<th></th>
<th>Personal</th>
<th>Societal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functional</strong></td>
<td>e.g., saving money on operating costs</td>
<td>e.g., reducing transportation-related GHG emissions</td>
</tr>
<tr>
<td><strong>Symbolic</strong></td>
<td>e.g., allowing for an expression of one’s identity</td>
<td>e.g., motivating other consumers</td>
</tr>
</tbody>
</table>

Second, individuals must believe that social norms support the behaviour; that is, that purchasing a PEV is normal and/or congruent with the expectations of important reference individuals or groups. Descriptive social norms, which refer to beliefs about how others typically behave, have been correlated with a variety of environmental behaviours (e.g., Cialdini et al., 1990), including sustainable transportation (Kormos, Gifford, & Brown, 2015); and injunctive social norms, which pertain to beliefs about how others think that people should behave, are also influential (Reno, Cialdini, & Kallgren, 1993). Furthermore, behavioural intention is typically strongest when these two types of social norms are aligned (Smith, Louis, Terry, Greenaway, Clarke, & Cheng, 2012).

Third, individuals must perceive that they have sufficient control over the action, and thus that they can successfully carry out the actions required to purchase a PEV. Indeed, research has shown that higher perceived self-efficacy is linked to increased sustainable commuting behaviour (e.g., Abrahamse, Steg, Gifford, & Vlek, 2009).
Characterizing Consumer Classes

Background to latent class modeling. Consumer vehicle preferences differ widely: some consumers may rush to purchase the latest Tesla, while others may excitedly await a lower price-point on the Nissan Leaf, and others still may deliberate over which F-series truck to buy. Market segmentation, initially proposed by Smith (1956), refers to classifying a market into separate classes of consumers who share similar preferences, perceptions, or characteristics. Latent class modeling is a statistical approach introduced by Kamakura and Russell (1989) that can be used to identify and characterize groups of similar individuals. Specifically, latent class choice models segment consumers according to differences in underlying preferences, as revealed by choice behaviour in a stated choice experiment. These models identify the probability that an individual belongs to a certain consumer segment and estimate the influence of variations in attribute levels within each segment.

The latent class approach is more sophisticated than traditional choice models (e.g., the multinomial logit model), which assume homogeneous preferences, because it incorporates preference heterogeneity by estimating separate sets of coefficients for groups of consumers with distinct patterns of preferences (e.g., Swait, 1994; Zito & Salvo, 2012). Given that latent class models are excellent at capturing preference heterogeneity (e.g., Wen & Lai, 2010), they are commonly applied in marketing research (e.g., Bhatnagar & Ghose, 2004) and less, but increasingly, applied in transportation research.

Hybrid latent class modeling: Incorporating covariates. Aside from differences in vehicle preferences, decision-makers also vary in their underlying characteristics and motivations. For instance, some consumers may wish to drive a PEV to demonstrate environmental awareness, whereas others may view their PEV as a status symbol. And yet, as
mentioned, such attitudinal data is not typically included in econometric models, likely because
y they generally assume that heterogeneity is sufficiently accounted for by demographic
covariates. Therefore, if attitudinal data is collected, it is more often used to provide context to
obtained results rather than integrated into the actual modeling. Hybrid latent class choice
models can be used to incorporate such decision-maker characteristics (e.g., demographic
variables and psychological constructs) directly into discrete choice modeling (Ben-Akiva et al.,
2002). This approach thus enables researchers to integrate behavioural theories into these
traditionally solely economic-based models, as well as to profile the characteristics of consumers
in preference-based segments (e.g., Ben-Akiva et al. 2002; see Morey, Thacher, & Breffle, 2006;
Swait, 1994). The inclusion of these individual-level variables has been shown to improve the fit
of latent class models, relative to models without such covariates (e.g., Shen, 2009), perhaps
because these additional variables reflect otherwise unobservable influences on observed
preferences (Walker & Ben-Akiva, 2002).

Previous hybrid latent class models have integrated choice data with environmental
attitudes (Boxall & Adamowicz, 2002), as well as examined the contribution of
proenvironmental consciousness and social influence in accounting for interest in low-carbon
vehicles (Daziano & Bolduc, 2011; Kim et al., 2014, respectively), and recent research
demonstrates that including attitudes in addition to choice behaviour provides improved
understanding of the motivations that underlie individuals’ PEV preferences (e.g., Axsen, Bailey,
& Castro, 2015). In addition, Hirdue et al. (2011) identified two consumer classes (GV- and
BEV-oriented), and found that the latter were generally better educated, younger, and tended to
engage in more of a proenvironmental lifestyle. With the exception of these studies, however, the
hybrid latent class approach has rarely been used to evaluate the demographic and psychological constructs that underlie consumer preferences for PEVs.

Given that consumers are, by nature, heterogeneous in their preferences, market segmentation is a critical component of strategic marketing (e.g., Boejgaard & Ellegaard, 2010). Identification of consumer preference segments, as well as the characteristics of individuals within such segments, can help to inform targeted marketing strategies (Wind, 1978). Also, from a policy perspective, the identification of segments of individuals with homogeneous characteristics allows for refinement of targeted policy analysis.

#### Latent class analysis versus cluster analysis

Recently, there has been increased interest within psychology in using cluster analysis to achieve audience segmentation as part of efforts to develop tailored climate change communications approaches (see Hine et al., 2014 for a review of climate change studies employing a range of segmentation methodologies). Of these, perhaps the most well-known is the *Global Warming’s Six Americas* model developed by the Yale Project on Climate Change Communication (Maibach et al., 2011; Lewiserowitz et al., 2012), which found six distinct segments of the public based on attitudes and beliefs related to climate change, policy preferences for climate change mitigation, and self-reported proenvironmental behaviours. These segments range along a continuum of climate change concern and engagement, as follows: *alarmed, concerned, cautious, unconcerned, doubtful, and dismissive*. Likewise, a recent Australian study revealed five segments of *climate change interpretive communities* (Hine et al., 2013), ranging along a similar attitudinal continuum, as follows: *alarmed, concerned, uncertain, doubtful, and dismissive*. Another recent study used cluster analysis to identify six segments of the public in Wales (with distinct demographic profiles) that
relate differently to sustainability, in terms of values, perceptions and self-reported proenvironmental behaviour (Poortinga & Darnton, in press).

Domain-specific segmentation approaches have focused on specific behavioural domains, such as transportation. For example, Anable (2005) segmented travelers according to psychological factors thought to impact travel behaviour, and found that different travelers may engage in similar behaviours for different underlying motivations. These findings can inform interventions by providing insight into the motivations that underlie various segments, thus revealing the segments in which behaviour change is most likely as well as how to best approach various segments to achieve such behaviour change.

In contrast to latent class choice analysis, cluster analysis (also known as profile analysis) is a non-model-based segmentation approach that is more commonly used in environmental psychology studies, such as those described above. Cluster analysis is data-derived in that it segments consumers based on patterns that exist without assuming any model structure to the variables, and so does not include parameters, and independent or dependent variables. Thus, in cluster analysis, the goal is to uncover classes of consumers who share common response patterns; for instance, a researcher could include purchase intention, demographics, and psychological variables in a cluster analysis to assess how the data cluster together. Such an analysis may yield some distinction among the segments based on purchase intention, but it also may not. Because cluster analysis assumes no dependent variable, it is most useful as an exploratory tool. In addition, it has the advantage of involving more straightforward data set-up because it can be used solely with self-report data, compared to latent class analysis, which assumes a model structure and requires data collection from a stated choice experiment but which has the advantage of involving prediction of a dependent variable.
The present research estimates a hybrid latent class choice model to assess variations in consumer PEV preference while taking into account underlying demographic characteristics and psychological constructs from Ajzen’s (1991) TPB (i.e., attitudes, social norms, and perceived behavioural control), under the premise that a more fulsome understanding of PEV decision-making necessitates the inclusion of these additional differences among consumers. In doing so, it aims to identify and describe segments of BC new vehicle buyers with similar vehicle preferences as well as to explore the influence of including psychological variables on the fit of such decision-making models.

**Message Framing of PEV Benefits**

Informational campaigns are a common approach to encourage behaviour change, and research has begun to examine ways to most effectively communicate issues related to climate change. “Framing” refers to tailoring a message through words and/or images to guide the audience’s attention by highlighting certain motives for engaging in a behaviour (e.g., purchasing green products) through increasing the salience of related beliefs (Chong & Druckman, 2007; Nisbet & Mooney, 2007). The success of such messages hinges on their persuasiveness, and – according to Kruglanski and Sleeth-Keppler’s (2007) review of the principles of persuasion – subjective personal relevance, rather than message content, is the key factor that determines the impact of the message on attitude change. Construal level theory provides an explanation for this general finding in that it postulates that mental representations become increasingly abstract as psychological distance between the event in question and an individual’s personal experience increases (Liberman, Trope, & Stephan, 2007; Trope & Liberman, 2003).
Problematically, citizens tend to conceptualize climate change as a global, future – and thus psychologically distant – phenomenon (Leiserowitz, 2005), which can decrease receptivity to related messages and products. Therefore, one message framing approach that has shown promise in relation to climate change is that of highlighting psychological distance (or, rather, psychological proximity). Consistent with construal level theory, messages are typically most effective (i.e., persuasive) when they emphasize personal relevance (e.g., Leiserowitz, 2007; National Endowment for Science and Technology Association, 2008), perhaps because they are easier for audience members to conceptualize and process (Maio & Haddock, 2007). For instance, messages highlighting local climate change impacts cause greater climate change engagement (Scannell & Gifford, 2013) and support for local climate policies (Wiest, Raymond, & Clawson, 2014), compared to messages highlighting global impacts. Typical marketing approaches also presume that consumers are most motivated by self-interest, or personal relevance, when purchasing green products (Lanzini & Thogersen, 2014).

However, environmental appeals can sometimes be more effective than appeals to self-interest, as demonstrated, for instance, in a recent study which found that fewer customers who received an appeal to financial motives took a coupon for a free tire pressure check (i.e., to assist with ‘eco-driving’) compared to those who received an appeal to environmental motives (Bolderdijk, Steg, Geller, Lehman, & Postmes, 2013). And yet another recent field experiment found that both environmental and monetary framing conditions increased electricity conservation intentions (Steinhorst, Klockner, & Matthies, 2015). The impact of psychological distance in message framing on interest in PEVs has not yet been investigated, to my knowledge.

PEV messaging and climate change messaging face similar challenges in that they both involve environmental and financial benefits often perceived to be distant, delayed, and
uncertain. Given that framing is unavoidable when presenting PEVs to prospective buyers through advertising and promotional materials, the frame should be selected to be optimally persuasive. The research presented in this dissertation makes a novel contribution by experimentally manipulating psychological distance to emphasize either personally-relevant PEV benefits (e.g., to save money on operating costs or serve as an expression of one’s identity) or societally-relevant PEV benefits (e.g., to reduce transportation-related GHG emissions or motivate other consumers) to examine the causal impact of message frame on PEV purchase intentions.

**Rationale and Objectives**

The notoriously change-resistant nature of transportation behaviour has long plagued behavioural scientists trying to encourage sustainable transportation. PEVs offer the appealing potential to achieve substantial reductions in GHG emissions without requiring citizens to forgo the perceived benefits of private vehicle use. According to the rational actor model, consumers make conscious and systematic trade-offs among vehicle attributes to maximize their anticipated benefit; however, a growing body of literature suggests that psychological variables also exert considerable influence on vehicle choices. As such, the present program of study employs a mixed-method approach to provide comprehensive insight into the role of personal (e.g., attitudes about PEVs), interpersonal (e.g., perceived social norms), and contextual (e.g., purchase incentives) influences on consumer preferences for PEVs. Complementary methodologies from psychology and applied economics are utilized given that they function best in concert due to their respective strengths and weaknesses. In particular, choice modeling is well suited to the transportation domain because of the discrete nature of vehicle purchase decisions – unlike the majority of other proenvironmental behaviours, which are continuous in nature (e.g., electricity
consumption) – as well as its ability to assess hypothetical attribute levels (e.g., incentive amounts). And yet, survey data is most appropriate to examine the attitudes and beliefs that underlie vehicle purchase decisions and, furthermore, experiments with random assignment to conditions are necessary to evaluate causality.

A stated choice experiment and survey are performed in Study 1 to explore 1) the influence of hypothetical variations in financial and non-financial incentives on estimated PEV preference and new vehicle market share, with the goal of helping to inform the design of provincial policy measures, and 2) the explanatory power of the psychological variables from Ajzen’s (1991; 2005) TPB (i.e., attitudes, social norms, and perceived behavioural control) on PEV purchase intentions among new vehicle buyers in BC. Study 2 combines data from the choice experiment and survey using a latent class choice model to segment consumers based on vehicle preferences, profile the characteristics of each class, and explore the influence of including these psychological variables on model fit. Increased insight into the mental constructs that underpin vehicle choices and the corresponding consumer classes may be useful in the development of segment-specific targeted messaging strategies and policies aimed at promoting PEV adoption. Study 3 extends these analyses through a controlled experiment that examines the impact of psychological distance in messages about PEV benefits on related purchase intention among Canadian and American consumers. These findings may be applied to inform efforts to communicate PEV benefits in a manner that is optimally engaging for prospective buyers.
CHAPTER 2

Study 1: Stated Choice Experiment and Survey

Study Overview and Objectives

Road transportation accounts for 24% of British Columbia (BC) provincial GHG emissions (BC Greenhouse Gas Inventory Report, 2012). Although total annual emissions have decreased in recent years, more significant reductions will be needed to achieve the ambitious provincial target of a 33% GHG reduction by 2020 (compared to 2007 levels). Broader adoption of PEVs holds promise to assist with achieving this target because BC’s utility portfolio consists largely of low-carbon, renewable energy sources. As such, the Government of BC has implemented comprehensive PEV policy, including a purchase incentive of up to $5,000, through the Clean Energy Vehicle Program. This program was in effect from December 2011 to March 2014 and was renewed in April 2015 for the next three years.

Study 1 had both applied and theoretical objectives. The applied aim was to help inform the design of future provincial programs and policy measures by evaluating the influence of several financial and non-financial incentives on demand for PEVs in BC. For instance, PEV market share forecasts were estimated using simulations of vehicle market share under different purchase incentive amounts. The majority of research on consumer preferences for alternative vehicles has focused on functional elements, such as purchase price and operating cost (e.g., Adler et al., 2003; Potoglou & Kanaroglou, 2007). Study 1 extends this theoretical work by investigating the influence of non-financial factors on vehicle choice. Consistent with research attesting to the important role of attitudes towards the environment in vehicle choice (e.g., Axsen et al., 2015; Ewing & Sarigollu, 2000) – and in an effort to deviate from strictly economically
rational approaches (e.g., Lane & Potter, 2007) – Study 1 evaluated the explanatory power of psychological variables from Ajzen’s (1991; 2005) TPB in predicting PEV purchase intentions among new vehicle buyers from BC. To achieve these objectives, Study 1 employed 1) a stated choice experiment, with three vehicle options (GV, PHEV, and BEV) and ten attributes related to vehicle characteristics and incentives, and 2) a survey of attitudes, social norms, and perceived behavioural control related to PEVs, based on the TPB, as well as vehicle purchase intentions and demographic questions.

**Method**

Study 1 consisted of a stated choice experiment, used to estimate a discrete choice model, and a survey assessing psychological constructs and demographic characteristics.

**Materials**

**Stated choice experiment design.** The alternative-specific design for the choice experiment included three vehicle options (GV, PHEV, and BEV) and ten vehicle attributes, representing financial, non-financial, and environmental attributes, selected based on a review of previous studies (Bunch et al., 1993; Potoglou & Kanaroglou, 2007). The list of attributes and their levels is shown in Table 2. Purchase prices were chosen to reflect a reasonable range for the types of vehicles available in 2013 (excluding Teslas), and accompanying levels for annual fuel costs, emissions, recharge time, and battery range were based on the 2013 Fuel Consumption Guide Database published by Natural Resources Canada (http://oee.nrcan.gc.ca/transportation/tools/fuelratings/FCG2013_e.pdf). For PHEVs and BEVs, some values in the database were expressed based on 5 cycle testing as used in the U.S. Values for GVs were all based on 2 cycle testing, which is the standard testing protocol currently used in Canada. Consistent with this database, levels were based on an assumed annual driving distance of 20,000 km.

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3 For PHEVs and BEVs, some values in the database were expressed based on 5 cycle testing as used in the U.S. Values for GVs were all based on 2 cycle testing, which is the standard testing protocol currently used in Canada. Consistent with this database, levels were based on an assumed annual driving distance of 20,000 km.
emissions, the three levels for estimated annual fuel costs were first converted into kWh, and then into GWh.\textsuperscript{4} Next, a range of carbon intensities was applied to these three levels.\textsuperscript{5} Last, resulting tonnes of CO\textsubscript{2} were converted into values for kg CO\textsubscript{2}. For the GV, CO\textsubscript{2} levels were selected to represent the most common GVs on the market in 2013, again based on data from the Fuel Consumption Database. Values for the incentive-related attributes were chosen in consultation with contacts at the Government of BC.

The attributes and levels were then combined into profiles, which were, in turn, combined into choice sets. Of the ten attributes outlined in Table 2, three had three different levels for all vehicle options, and two had three different levels for the PHEV and BEV options. Of the remaining five attributes, two had common levels between the two PEV options, leaving seven attributes that were fixed for the GV. This design resulted in \(3^{23} \times (94,143,178,827)\) potential profiles. A set of 54 choice sets was the smallest orthogonal main-effects plan (OMEP) design required to obtain orthogonality.\textsuperscript{6} To allocate the profiles to choice sets, a \(L^{MA}\) customized design (with \(M\) choice options, \(A\) attributes, and \(L\) levels) was obtained from the SAS catalogue. A design that segmented the 54 profiles into three blocks of equal size (i.e., with 18 choice sets presented to each respondent) was selected to reduce participant cognitive fatigue, and alternate columns were then adjusted to avoid all low-level or all high-level feature combinations. In the choice experiment, each participant was presented with 18 choice sets with systematically varied

\textsuperscript{4} Based on an assumed electricity cost per kWh of $0.12.
\textsuperscript{5} Values used for calculations: 20 t CO\textsubscript{2}/GWh to represent BC for the first level, 650 t CO\textsubscript{2}/GWh to represent Alberta for the third level, and 335 t CO\textsubscript{2}/GWh for the mid-point value to use for the middle level.
\textsuperscript{6} Although it may be argued that the orthogonal profile design strategy for creating the choice sets limits the external validity of the resulting findings, given that these vehicle attributes are correlated in reality, a key advantage of the orthogonal design is that it serves to disentangle choice experiment attributes. In turn, this allows for the subsequent examination of the individual (and thus relative and combined) impact of attributes on choice, which is a more accurate depiction of the real-world correlation among attributes.
levels of vehicle attributes (see Figure 2 and Figure 3). A 18 x 18 Latin square was used to
determine the order of presentation of choice sets, with sequential assignment to block according
to the order in which participants initiated the survey.
Table 2. List of attributes and levels used in the choice experiment

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gasoline vehicles</td>
</tr>
<tr>
<td>Purchase price</td>
<td>$16,500</td>
</tr>
<tr>
<td></td>
<td>$20,500</td>
</tr>
<tr>
<td></td>
<td>$24,500</td>
</tr>
<tr>
<td>Estimated annual fuel costs(^7)</td>
<td>$1,500</td>
</tr>
<tr>
<td></td>
<td>$2,300</td>
</tr>
<tr>
<td></td>
<td>$3,100</td>
</tr>
<tr>
<td>Estimated annual emissions(^8)</td>
<td>2,800 kg CO(_2)</td>
</tr>
<tr>
<td></td>
<td>3,100 kg CO(_2)</td>
</tr>
<tr>
<td></td>
<td>3,400 kg CO(_2)</td>
</tr>
<tr>
<td>Standard recharge time/refuel</td>
<td>10 min.</td>
</tr>
<tr>
<td></td>
<td>1.5 hr.</td>
</tr>
<tr>
<td></td>
<td>2.5 hr.</td>
</tr>
<tr>
<td></td>
<td>3.5 hr.</td>
</tr>
<tr>
<td></td>
<td>4 hr.</td>
</tr>
<tr>
<td></td>
<td>10 hr.</td>
</tr>
<tr>
<td>Range on battery only(^9)</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Incentive for purchase or lease</td>
<td>$0</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Other financial incentives</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Home charging station rebate</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional incentive</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Fast charging station availability</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^7\) Assuming 20,000 km driven/year, and based on forecast prices of $1.29/L for regular gasoline and $0.12/kWh for electricity.

\(^8\) Assuming 20,000 km driven/year, and 2.3 kg of CO\(_2\)/L of regular gasoline.

\(^9\) Note: Given that purchase price and battery range are linked in the real world, variation in the levels of these two attributes was intentionally correlated in the experimental design, \( r = .26, p < .01 \).
Figure 2. Sample choice set – first selection.

Figure 3. Sample choice set – second selection.
Survey design. A survey was developed involving scales to assess psychological constructs, intended vehicle purchase, and demographic characteristics (see Appendix A).

Three scales, based on Ajzen’s (1991; 2005) TPB, were used to assess psychological constructs. For each of the following three scales, participants indicated the extent to which they agreed with each item, on a scale from 1 (Strongly disagree) to 7 (Strongly agree):

i. **Attitudes about PEVs** were measured using a 15-item scale adapted from the following categories proposed by Axsen and Kurani (2012): functional-personal (e.g., “The purchase price of an electric vehicle is too high”); functional-societal (e.g., “Purchasing one of these vehicles would be an effective way to help fight climate change by reducing greenhouse gas emissions”); symbolic-personal (e.g., “Driving an electric vehicle would allow me to express my identity, values, and beliefs”); and symbolic-societal (e.g., “Individuals who choose to drive electric vehicles are an inspiration to others”). Additional items related to hedonic aspects (e.g., “Electric vehicles can be as pleasurable to drive as a conventional vehicle”) were included in this measure (e.g., Turrentine & Kurani, 2007).

ii. **Social norm beliefs** were measured on a 5-item scale, where two items assessed descriptive social norms (e.g., “Many of the people who are important to me would consider purchasing an electric vehicle”) and three items evaluated injunctive social norms (e.g., “In general, those closest to me think that more people should buy electric vehicles”).

iii. **Perceived behavioural control**, referring to general control over the vehicle purchase as well as the ease and financial feasibility of purchasing a PEV, was measured using a 5-item scale developed for the study.
The behavioural intention scale (also based on the TPB) was created to evaluate participants’ intentions to purchase a GV, hybrid, PHEV, and BEV as their next vehicle; the scale ranged from 1 (Very unlikely) to 7 (Very likely). Participants were also asked about the budget for their next vehicle (including taxes).

The demographic scale recorded participants’ gender, age, education level, and income, as well as the type of area in which they live and other household characteristics (e.g., single versus two-parent, household size, type of principal residence, rent or own, and number of registered vehicles). And, finally, participants entered their average number of kilometers driven per weekday and per day on the weekend, as well as the number of extra kilometers driven annually as part of occasional or unusual trips (e.g., vacations).

**Procedure**

Participants were referred to the web-based choice experiment and survey by a panel company. Respondents read the letter of information for implied consent, followed by an introduction to the study and basic information about different vehicle types. Next, respondents read instructions about the choice experiment; specifically, that they would be presented with 18 sets of three hypothetical vehicles, with each set consisting of a GV, a PHEV, and a BEV, and that each set would describe a different combination of vehicle attributes that might influence their purchase decisions. Participants were told that vehicle features would change with each choice set, but that the details presented would be based on plausible assumptions about yearly driving distance, costs, and emissions. Furthermore, participants were asked to imagine that the vehicles differ only in how they are powered (i.e., and not in terms of styling, cargo space, and performance).
For each choice set, participants selected their most preferred vehicle and their second-most preferred vehicle. They were then given a no-choice option through which they could indicate whether they would not purchase any of the vehicles in that set (thus allowing for the assessment of unconditional demand). Next, participants responded to the survey, with the order of scale items scrambled across participants and two quality control questions inserted, followed by questions related to vehicle purchase intention and demographic characteristics.

Data Collection

Data collection occurred between March 18, 2014, and April 6, 2014 (see Appendix B for ethics approval). Participants from BC were recruited by a web panel company (Survey Sampling International) and invited to participate if they were 18 years of age or older and planned to purchase a new vehicle in the next 12 months. An initial pilot test of 50 participants was conducted, after which some substantive modifications were made to the survey, necessitating the exclusion of these participants from the final analyses. A subsequent pilot test of 46 participants was followed by minor survey adjustments, and 399 additional respondents were sampled during the main data collection period, resulting in a sample size of 445. Participant demographic characteristics are shown in Table 3. The attrition rate was 31% given that 203 additional individuals initiated but did not complete the survey. Thus, sampling continued until 445 participants had completed the survey.
Table 3. *Summary of demographic characteristics of the sample (N = 445)*

<table>
<thead>
<tr>
<th>Individual characteristics</th>
<th>Percentage&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Household type</th>
<th>Percentage&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gender</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>46% (206)</td>
<td>Single-person</td>
<td>29% (127)</td>
</tr>
<tr>
<td>Female</td>
<td>52% (230)</td>
<td>Couple with no children</td>
<td>23% (103)</td>
</tr>
<tr>
<td>Other</td>
<td>0% (2)</td>
<td>One-parent family with children</td>
<td>7% (30)</td>
</tr>
<tr>
<td><strong>Age category</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 29</td>
<td>26% (115)</td>
<td>Couple with children</td>
<td>34% (151)</td>
</tr>
<tr>
<td>30-39</td>
<td>19% (84)</td>
<td>Group household</td>
<td>7% (33)</td>
</tr>
<tr>
<td>40-49</td>
<td>21% (93)</td>
<td>Single-family detached</td>
<td>56% (249)</td>
</tr>
<tr>
<td>50-59</td>
<td>16% (72)</td>
<td>Semi-detached</td>
<td>9% (39)</td>
</tr>
<tr>
<td>60-69</td>
<td>12% (53)</td>
<td>Apartment or condominium</td>
<td>32% (140)</td>
</tr>
<tr>
<td>≥ 70</td>
<td>6% (28)</td>
<td>Other</td>
<td>4% (17)</td>
</tr>
<tr>
<td><strong>Household income (before taxes)</strong></td>
<td></td>
<td>Rent/own</td>
<td></td>
</tr>
<tr>
<td>&lt; $25,000</td>
<td>18% (79)</td>
<td>Rent</td>
<td>47% (209)</td>
</tr>
<tr>
<td>$25,000-$50,000</td>
<td>27% (122)</td>
<td>Own</td>
<td>53% (236)</td>
</tr>
<tr>
<td>$50,000-$75,000</td>
<td>20% (89)</td>
<td>Area of residence</td>
<td></td>
</tr>
<tr>
<td>$75,000-$100,000</td>
<td>18% (79)</td>
<td>Downtown</td>
<td>12% (52)</td>
</tr>
<tr>
<td>$100,000-$125,000</td>
<td>9% (42)</td>
<td>Suburban (&lt; 2 km to city core)</td>
<td>35% (156)</td>
</tr>
<tr>
<td>&gt; $125,000</td>
<td>7% (32)</td>
<td>Suburban (&gt; 2 km to city core)</td>
<td>38% (167)</td>
</tr>
<tr>
<td><strong>Education</strong></td>
<td></td>
<td>Numbered registered vehicles</td>
<td></td>
</tr>
<tr>
<td>Elementary, middle school</td>
<td>1% (5)</td>
<td>Rural</td>
<td>16% (70)</td>
</tr>
<tr>
<td>High school graduate</td>
<td>21% (92)</td>
<td>0</td>
<td>11% (48)</td>
</tr>
<tr>
<td>Some post-secondary</td>
<td>19% (85)</td>
<td>1</td>
<td>45% (201)</td>
</tr>
<tr>
<td>College, diploma, or trade certification</td>
<td>30% (133)</td>
<td>2</td>
<td>34% (151)</td>
</tr>
<tr>
<td>Bachelor’s degree</td>
<td>21% (95)</td>
<td>3</td>
<td>7% (32)</td>
</tr>
<tr>
<td>Graduate or professional degree</td>
<td>8% (35)</td>
<td>4 or more</td>
<td>3% (13)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Rounded to the nearest whole percentage.

Note: Budget for next vehicle: \( M = \$26,185.13, \) \( SD = \$17,184.16. \) km driven per weekday/weekend day: \( M = 72.69 \) km, \( SD = 181.98; \) \( M = 48.07 \) km, \( SD = 85.67. \) Total distance driven for unusual trips: \( M = 4,652.88 \) km, \( SD = 10451.94. \)

Data Analysis

Descriptive analysis of variable means and multiple regression analysis were performed for the “most preferred” choices using IBM SPSS<sup>©</sup> Statistics 22. To estimate a multinomial logit (MNL) model, the data were first restructured and effects coded using Excel, and then Latent
GOLD Choice 5.0 was employed to fit the model (see Appendix G). MNL analysis, which is the most popular technique for discrete choice modeling, statistically quantifies consumer preferences and, specifically, how participants make trade-offs among various attributes in the choice experiment. The MNL model estimates a set of coefficients for the whole sample and, based on random utility theory, presupposes that perceived utility is based on observable and unobservable portions (McFadden, 1974; Train, 1980). It is assumed that the observable (deterministic) part of the utility is represented by a sum of estimated weighted coefficients that pertain to the attributes of the product (e.g., purchase price) and that the probability of an individual choosing one alternative over another in a given choice set is based on its (relative) attractiveness as well as on the unobservable (random) component of each alternative.

Results

Descriptive Statistics

Descriptive statistics for the psychological scales are shown in Table 4. Participants indicated the greatest agreement with items in the attitudes scale ($M = 4.35$, $SD = 1.03$), followed by the social norms ($M = 3.53$, $SD = 1.18$) and perceived behavioural control scales ($M = 3.23$, $SD = 1.39$). In particular, for the attitude scale, respondents expressed the greatest agreement with items stating that PEVs are too expensive ($M = 5.54$, $SD = 1.40$), as well as that owning a PEV would help to reduce dependence on petroleum ($M = 5.22$, $SD = 1.43$). For the social norms scale, participants indicated greatest agreement with the statements that people who are important to them would approve of them purchasing a PEV ($M = 4.51$, $SD = 1.61$) and also that these individuals think that more consumers should buy PEVs ($M = 3.74$, $SD = 1.59$). Last, for the perceived behavioural control items, respondents expressed the most agreement with items
stating that the type of vehicle they purchase is within their control \((M = 5.22, SD = 1.56)\) and also that it would be more difficult to purchase a PEV than a GV \((M = 5.05, SD = 1.64)\).
Table 4. Descriptive statistics for three psychological scales and five attitude subscales

<table>
<thead>
<tr>
<th>Items</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Attitude scale</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hedonic</strong></td>
<td>4.35</td>
<td>1.03</td>
</tr>
<tr>
<td>Electric vehicles can be as visually appealing as a conventional vehicle.</td>
<td>4.97</td>
<td>1.66</td>
</tr>
<tr>
<td>Electric vehicles can be as pleasurable to drive as a conventional vehicle.</td>
<td>4.71</td>
<td>1.50</td>
</tr>
<tr>
<td><strong>Functional-societal</strong></td>
<td>4.65</td>
<td>.94</td>
</tr>
<tr>
<td>Purchasing an electric vehicle would be an effective way to help fight climate change by reducing greenhouse gas emissions.</td>
<td>4.94</td>
<td>1.63</td>
</tr>
<tr>
<td>Purchasing an electric vehicle would NOT be an effective way to improve air quality.*</td>
<td>2.92</td>
<td>1.54</td>
</tr>
<tr>
<td>Owning an electric vehicle would help reduce our dependence on petroleum.</td>
<td>5.22</td>
<td>1.43</td>
</tr>
<tr>
<td>I am concerned about the environmental impact of the batteries in electric vehicles, including manufacturing and disposal.*</td>
<td>4.67</td>
<td>1.57</td>
</tr>
<tr>
<td><strong>Symbolic-societal</strong></td>
<td>4.36</td>
<td>1.45</td>
</tr>
<tr>
<td>Individuals who choose to drive electric vehicles are an inspiration to others.</td>
<td>4.24</td>
<td>1.57</td>
</tr>
<tr>
<td>People who drive electric vehicles are sending a message to the government, as well as to automotive and oil companies.</td>
<td>4.48</td>
<td>1.62</td>
</tr>
<tr>
<td><strong>Functional-personal</strong></td>
<td>3.82</td>
<td>1.00</td>
</tr>
<tr>
<td>The purchase price of electric vehicles is too high.*</td>
<td>5.54</td>
<td>1.40</td>
</tr>
<tr>
<td>I find the idea of reduced operating costs (due to decreased fuel use) very appealing.</td>
<td>5.15</td>
<td>1.38</td>
</tr>
<tr>
<td>The types of electric vehicles currently available do NOT suit my transportation needs.*</td>
<td>4.48</td>
<td>1.71</td>
</tr>
<tr>
<td>Owning an electric vehicle would suit my daily life and routine.</td>
<td>4.13</td>
<td>1.82</td>
</tr>
<tr>
<td><strong>Symbolic-personal</strong></td>
<td>3.67</td>
<td>1.30</td>
</tr>
<tr>
<td>Driving an electric vehicle would allow me to express my identity, values, and beliefs.</td>
<td>3.76</td>
<td>1.60</td>
</tr>
<tr>
<td>Owning an electric vehicle is a status symbol.</td>
<td>3.73</td>
<td>1.68</td>
</tr>
<tr>
<td>Driving an electric vehicle would help me to connect with other like-minded people.</td>
<td>3.54</td>
<td>1.58</td>
</tr>
<tr>
<td><strong>Social norms scale</strong></td>
<td>3.53</td>
<td>1.18</td>
</tr>
<tr>
<td>In general, those closest to me would approve of me purchasing an electric vehicle.</td>
<td>4.51</td>
<td>1.61</td>
</tr>
<tr>
<td>In general, those closest to me think that more people should buy an electric vehicle.</td>
<td>3.74</td>
<td>1.59</td>
</tr>
<tr>
<td>Many of the people who are important to me would consider purchasing an electric vehicle.</td>
<td>3.66</td>
<td>1.54</td>
</tr>
<tr>
<td>Many of my family and friends own a fuel-efficient vehicle.</td>
<td>3.31</td>
<td>1.80</td>
</tr>
<tr>
<td>Many of my family and friends expect me to buy an electric vehicle.</td>
<td>2.45</td>
<td>1.64</td>
</tr>
<tr>
<td><strong>Perceived behavioural control scale</strong></td>
<td>3.23</td>
<td>1.39</td>
</tr>
<tr>
<td>The type of vehicle I purchase is mostly within my control.</td>
<td>5.22</td>
<td>1.56</td>
</tr>
<tr>
<td>It would be more difficult for me to buy an electric vehicle than a conventional one.*</td>
<td>5.05</td>
<td>1.64</td>
</tr>
<tr>
<td>It would be too confusing to figure out which type of electric vehicle to purchase.*</td>
<td>3.66</td>
<td>1.63</td>
</tr>
<tr>
<td>It would be financially feasible for me to purchase an electric vehicle.</td>
<td>3.51</td>
<td>1.78</td>
</tr>
<tr>
<td>If I wanted to, I could easily purchase an electric vehicle.</td>
<td>3.23</td>
<td>1.84</td>
</tr>
</tbody>
</table>

Note: Scales ranged from 1 (Strongly disagree) to 7 (Strongly agree). Items indicated with italics and an asterix (*) were later reverse-coded. Means are ordered from largest to smallest.
Further analysis of the five attitude subscales revealed that participants expressed the greatest agreement with items in the hedonic subscale, followed by the functional-societal and symbolic-societal subscales (Table 4). Paired-sample *t*-tests demonstrated that participants indicated higher levels of agreement with items in the functional-societal subscale (*M* = 4.65, *SD* = .94) compared to the functional-personal subscale (*M* = 3.82, *SD* = 1.00), *t*(440) = -15.73, *p* < .001, as well as with items in the symbolic-societal subscale (*M* = 4.36, *SD* = 1.45) compared to the symbolic-personal subscale (*M* = 3.67, *SD* = 1.30), *t*(433) = -11.82, *p* < .001. In short, participants expressed greater perceived societally-relevant, versus personally-relevant, benefits of PEVs.

Participants reported the highest likelihood of purchasing a GV (*M* = 5.39, *SD* = 1.63), followed by a hybrid (*M* = 3.69, *SD* = 1.70), PHEV (*M* = 3.27, *SD* = 1.66), and BEV (*M* = 2.75, *SD* = 1.74). Consistent with these findings, 69% of participants (*n* = 307) indicated an intention to purchase a GV within the next 12 months, 15% (*n* = 67) intend to buy a hybrid, 12% (*n* = 54) a PHEV, 5% (*n* = 23) a BEV, and 2% (*n* = 9) indicated no intention to purchase a vehicle in the next 12 months.

**Scale Reliability**

The internal consistency of the psychological scales was assessed (Table 5), and poor-performing items with item-total correlation values less than .3 were removed (see Field, 2005). For the attitude scale, the initial reliability was good (Cronbach’s *α* = .83), although it was further improved following the deletion of three poor-performing items (Cronbach’s *α* = .87). The reliability of the social norms scale was also deemed to be good (Cronbach’s *α* = .77), with all items yielding acceptable item-total correlation values. The reliability of the perceived
behavioural control scale, however, was initially poor (Cronbach’s $\alpha = .58$) but was improved following the removal of two poor-performing items (Cronbach’s $\alpha = .70$).

The psychometric properties of the attitude subscales were also assessed, and the internal consistency of all subscales was found to be acceptable or good (Kline, 2000). In particular, the reliability of the functional-societal, symbolic-personal, and symbolic-societal subscales were all good (Cronbach’s $\alpha = .71$, .71, and .78, respectively), and the hedonic and functional-personal subscales had acceptable reliability (Cronbach’s $\alpha = .66$ and .60, respectively). Given that these scales were developed for use in this study, the construct validity – or degree to which the attitude subscales assess what they are intended to measure – remains somewhat unknown. However, the internal consistency of the attitude subscales was deemed to be reasonable considering the relatively low number of items per subscale. Additional items would have likely increased the alpha values but, given time restrictions, we were limited to a low number of items per scale, which may partly account for the acceptable (but not good) alphas two of the five attitude subscales.

**Intercorrelations**

The three psychological variables were significantly correlated such that the attitude scale was positively associated with the social norms and perceived behavioural control scales ($r = .62$, $p < .001$ and $r = .23$, $p < .001$, respectively), as were the social norms and perceived behavioural control scales ($r = .41$, $p < .001$). Therefore, participants who indicated more prevalent social norms tended to hold favourable attitudes about PEVs and perceive high levels of behavioural

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10 Excluding the poor-performing items that were previously deleted.
11 Future research may employ factor analysis to examine whether the items currently included in the attitude scale, as well as additional items per subscale, fall into the five proposed attitude subscales.
control. In addition, the five attitude subscales were all significantly correlated with one another (all $ps < .001$).
Table 5. Reliability statistics for the psychological scales

<table>
<thead>
<tr>
<th>Items</th>
<th>Initial Scale Reliability</th>
<th>Final Scale Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corrected item-total</td>
<td>Cronbach's $\alpha$</td>
</tr>
<tr>
<td></td>
<td>correlation</td>
<td>if item deleted</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Attitude Scale</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The purchase price of electric vehicles is too high.*</td>
<td>0.03</td>
<td>0.84</td>
</tr>
<tr>
<td>Owning an electric vehicle would help reduce our dependence on</td>
<td>0.50</td>
<td>0.81</td>
</tr>
<tr>
<td>petroleum.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I find the idea of reduced operating costs (due to decreased fuel</td>
<td>0.59</td>
<td>0.81</td>
</tr>
<tr>
<td>use with an electric vehicle) very appealing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric vehicles can be as visually appealing as a conventional</td>
<td>0.53</td>
<td>0.81</td>
</tr>
<tr>
<td>vehicle.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchasing an electric vehicle would be an effective way to help</td>
<td>0.63</td>
<td>0.80</td>
</tr>
<tr>
<td>fight climate change by reducing greenhouse gas emissions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electric vehicles can be as pleasurable to drive as a conventional</td>
<td>0.57</td>
<td>0.81</td>
</tr>
<tr>
<td>vehicle.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I am concerned about the environmental impact of the batteries in</td>
<td>-0.19</td>
<td>0.85</td>
</tr>
<tr>
<td>electric vehicles, including manufacturing and disposal.*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The types of electric vehicles currently available do NOT suit my</td>
<td>0.30</td>
<td>0.83</td>
</tr>
<tr>
<td>transportation needs.*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>People who drive electric vehicles are sending a message to the</td>
<td>0.61</td>
<td>0.80</td>
</tr>
<tr>
<td>government, as well as to automotive and oil companies.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individuals who choose to drive electric vehicles are an inspiration</td>
<td>0.69</td>
<td>0.80</td>
</tr>
<tr>
<td>to others.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owning an electric vehicle would suit my daily life and routine.</td>
<td>0.64</td>
<td>0.80</td>
</tr>
<tr>
<td>Driving an electric vehicle would allow me to express my identity,</td>
<td>0.70</td>
<td>0.80</td>
</tr>
<tr>
<td>values, and beliefs.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Owning an electric vehicle is a status symbol.</td>
<td>0.31</td>
<td>0.82</td>
</tr>
<tr>
<td>Driving an electric vehicle would help me to connect with other like-</td>
<td>0.55</td>
<td>0.81</td>
</tr>
<tr>
<td>minded people.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Purchasing an electric vehicle would NOT be an effective way to</td>
<td>0.27</td>
<td>0.83</td>
</tr>
<tr>
<td>improve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social Norms Scale</td>
<td>Cronbach’s α = .77; No. of items = 5</td>
<td>Same as initial scale</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------</td>
</tr>
<tr>
<td>In general, those closest to me would approve of me purchasing an electric vehicle.</td>
<td>.46</td>
<td>.75</td>
</tr>
<tr>
<td>In general, those closest to me think that more people should buy an electric vehicle.</td>
<td>.71</td>
<td>.66</td>
</tr>
<tr>
<td>Many of the people who are important to me would consider purchasing an electric vehicle.</td>
<td>.68</td>
<td>.67</td>
</tr>
<tr>
<td>Many of my family and friends own a fuel-efficient vehicle (i.e., either an efficient internal combustion engine, hybrid, or electric vehicle).</td>
<td>.32</td>
<td>.80</td>
</tr>
<tr>
<td>Many of my family and friends expect me to buy an electric vehicle.</td>
<td>.56</td>
<td>.71</td>
</tr>
<tr>
<td>Perceived Behavioural Control Scale</td>
<td>Cronbach’s α = .58; No. of items = 5</td>
<td>Cronbach’s α = .70; No. of items = 3</td>
</tr>
<tr>
<td>The type of vehicle I purchase is mostly within my control.</td>
<td>.20</td>
<td>.59</td>
</tr>
<tr>
<td>It would be more difficult for me to buy an electric vehicle than a conventional vehicle.*</td>
<td>.40</td>
<td>.49</td>
</tr>
<tr>
<td>It would be too confusing to figure out which type of electric vehicle to purchase.*</td>
<td>.13</td>
<td>.63</td>
</tr>
<tr>
<td>It would be financially feasible for me to purchase an electric vehicle.</td>
<td>.44</td>
<td>.46</td>
</tr>
<tr>
<td>If I wanted to, I could easily purchase an electric vehicle.</td>
<td>.53</td>
<td>.40</td>
</tr>
</tbody>
</table>

*Note: Scales ranged from 1 (Strongly disagree) to 7 (Strongly agree). Items indicated with italics and an asterix (*) were reverse-coded for the purpose of analysis.
Multiple Regression Analyses

A multiple regression analysis revealed that the linear combination of the three psychological variables predicted PEV purchase intention, $F(3,417) = 109.42, p < .001$, accounting for 44% of the adjusted variance in intention (Table 6). Further analysis showed that each scale positively and uniquely predicted purchase intention, such that higher scale values were associated with increased intention; specifically, attitudes, $t(417) = 5.27, p < .001$, explained 4% of variance, social norms, $t(417) = 5.79, p < .001$, explained 5% of variance, and perceived behavioural control, $t(417) = 7.85, p < .001$, explained 8% of variance in purchase intention.\(^\text{12}\)

Table 6. *PEV purchase intention regressed on the psychological variables*

<table>
<thead>
<tr>
<th>Scale</th>
<th>$B^a$</th>
<th>SE</th>
<th>$\beta^b$</th>
<th>$t$</th>
<th>$p$</th>
<th>$sr^2$ (unique)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitude scale</td>
<td>.36</td>
<td>.07</td>
<td>.25</td>
<td>5.27</td>
<td>&lt;.001</td>
<td>.04</td>
</tr>
<tr>
<td>Social norms scale</td>
<td>.38</td>
<td>.07</td>
<td>.29</td>
<td>5.79</td>
<td>&lt;.001</td>
<td>.05</td>
</tr>
<tr>
<td>Perceived behavioural control scale</td>
<td>.34</td>
<td>.04</td>
<td>.32</td>
<td>7.85</td>
<td>&lt;.001</td>
<td>.08</td>
</tr>
</tbody>
</table>

*Note: $R^2 = .67$. Adjusted $R^2 = .44$. Intercept = -.102.*

\(^a^\)Unstandardized beta coefficient, represented in the original measurement units, which conveys the predicted change in PEV purchase intention for every one unit of change in the psychological scale.

\(^b^\)Standardized beta coefficient, represented in standard deviation units, which conveys the predicted standard deviation change in PEV purchase intention for a 1 standard deviation change in the psychological scale.

Another multiple regression analysis revealed that the linear combination of the five attitude subscales predicted PEV purchase intention, $F(5,423) = 40.41, p < .001$, accounting for 32% of the adjusted variance in intention (Table 7). Further analysis showed that the following two subscales positively and uniquely predicted purchase intention: functional-personal, $t(423) = 6.73, p < .001$, explaining 7% of variance, and symbolic-personal, $t(423) = 4.17, p < .001$.

\(^\text{12}\) A similar pattern of results was obtained for multiple regression analyses conducted with each of PHEV and BEV purchase intention as the dependent variable.
explaining 3% of variance. Interestingly, the functional-societal subscale was a unique negative predictor, \( t(423) = -2.74, p < .001 \), explaining 1% of variance, which indicates that individuals who scored higher on that subscale reported less interest in purchasing a PEV. Neither the symbolic-societal, \( t(423) = 1.86, ns \), nor the hedonic \( t(423) = 1.35, ns \), subscales were unique predictors of PEV purchase intention.

### Table 7. PEV purchase intention regressed on the attitude subscales

<table>
<thead>
<tr>
<th></th>
<th>( B^a )</th>
<th>SE ( B )</th>
<th>( \beta^b )</th>
<th>( t )</th>
<th>( p )</th>
<th>( sr^2 ) (unique)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional-personal</td>
<td>.52</td>
<td>.08</td>
<td>.34</td>
<td>6.73</td>
<td>&lt;.001</td>
<td>.07</td>
</tr>
<tr>
<td>Functional-societal</td>
<td>-.21</td>
<td>.08</td>
<td>-.13</td>
<td>-2.74</td>
<td>.01</td>
<td>.01</td>
</tr>
<tr>
<td>Symbolic-personal</td>
<td>.28</td>
<td>.07</td>
<td>.23</td>
<td>4.17</td>
<td>&lt;.001</td>
<td>.03</td>
</tr>
<tr>
<td>Symbolic-societal</td>
<td>.11</td>
<td>.06</td>
<td>.11</td>
<td>1.86</td>
<td>.06</td>
<td>.01</td>
</tr>
<tr>
<td>Hedonic</td>
<td>.08</td>
<td>.06</td>
<td>.07</td>
<td>1.35</td>
<td>.18</td>
<td>.003</td>
</tr>
</tbody>
</table>

**Note:** \( R^2 = .32 \). Adjusted \( R^2 = .32 \). Intercept = .12.

\( a \)** Unstandardized beta coefficient, represented in the original measurement units, which conveys the predicted change in PEV purchase intention for every one unit of change in the psychological scale.

\( b \)** Standardized beta coefficient, represented in standard deviation units, which conveys the predicted standard deviation change in PEV purchase intention for a 1 standard deviation change in the psychological scale.

### Multinomial Logit Analysis

A MNL model was estimated with choice (i.e., “most preferred”) as the dependent variable and 49 attributes, defined as numeric, as follows: an alternative-specific constant (ASC) for each vehicle type, six effects coded variables for the GV, and 20 effects coded variables for each of the PHEV and BEV (see Appendix G). In total, 423 respondents were included in the analysis because some respondents were deleted to equalize sample size in each of the three blocks (i.e., with 141 participants remaining per block). An analysis of the original model revealed that two attributes (recharge/refuel time and home charging station rebate) had insignificant coefficient values for the PEVs. Thus, a revised model was estimated excluding
these two attributes. The revised model resulted in an improved model fit, as demonstrated by a reduced Bayesian Information Criterion (BIC) of 17664.41 compared to 17706.32. Because the difference in the BIC values between the two models is greater than 10, there is strong evidence in favour of the revised model. The results of the MNL, estimated with coefficients for every level of each attribute, are shown in Table 8.

An examination of the ASC estimates, which represent the observable portion of utility not represented by the attributes, reveals that GVs were most preferred, followed by PHEVs and BEVs (Table 8). Consistent with this finding, participants selected the GV as the most preferred vehicle in 61% of choice sets, followed by PHEVs (22%) and BEVs (17%). In addition, utility is a theoretical construct that permits the ranking of attributes based on consumers’ associated expected value for each type of vehicle. The magnitude of a utility estimate has no specific interpretation, so one can only examine the sign and significance of these values, as well as the relative difference of utility values. Given that expected utility increases as the levels become more desirable, the likelihood of purchasing a particular type of vehicle increases as utility increases; for instance, utility values in Table 8 reveal that participants preferred vehicles with lower purchase prices and annual fuel costs.

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13 The iteration detail revealed no warnings, indicating that the model converged and that there were no issues with parameter identification.
14 Despite subtle variations in parameter estimates and significance values, an essentially identical pattern of results was produced under both models, with the exception of the non-significant parameters that were removed from the original model.
15 The BIC represents unexplained variation in the dependent variable, and the number of exploratory variables increases the value of the BIC; therefore, a lower BIC value indicates either fewer explanatory variables, better fit, or both. However, given that it is possible to simply increase explained variation by adding extra parameters, the BIC includes a penalty term to account for the number of parameters in the model.
Table 8. Multinomial logit model

<table>
<thead>
<tr>
<th></th>
<th>GV Levels</th>
<th>PHEV Levels</th>
<th>BEV Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASCs</td>
<td>1.598**</td>
<td>0.519**</td>
<td>0.250</td>
</tr>
<tr>
<td>Purchase price</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$16,500</td>
<td>0.19**</td>
<td>0.60**</td>
<td>0.34**</td>
</tr>
<tr>
<td>$20,500</td>
<td>0.00</td>
<td>0.04</td>
<td>0.07</td>
</tr>
<tr>
<td>$24,500</td>
<td>-0.19**</td>
<td>-0.64**</td>
<td>-0.35**</td>
</tr>
<tr>
<td>Estimated annual fuel costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$1,500</td>
<td>0.13**</td>
<td>0.10*</td>
<td>0.07*</td>
</tr>
<tr>
<td>$2,300</td>
<td>-0.01</td>
<td>0.04</td>
<td>0.05</td>
</tr>
<tr>
<td>$3,100</td>
<td>-0.12**</td>
<td>-0.15**</td>
<td>-0.07*</td>
</tr>
<tr>
<td>Estimated annual emissions (CO₂)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,800 kg</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>3,100 kg</td>
<td>-0.03</td>
<td>0.17</td>
<td>0.29</td>
</tr>
<tr>
<td>3,400 kg</td>
<td>-0.02</td>
<td>0.48</td>
<td>0.49</td>
</tr>
<tr>
<td>Range on battery only</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Incentive for purchase or lease</td>
<td></td>
<td></td>
<td></td>
</tr>
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<tr>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Other financial incentives</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>-</td>
<td>-</td>
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<td>-</td>
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<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

* p value < .001
<table>
<thead>
<tr>
<th>Model Parameters</th>
<th>Num. of individuals</th>
<th>$R^2$</th>
<th>Log-likelihood</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>41</td>
<td>0.028</td>
<td>-8,708.23</td>
</tr>
</tbody>
</table>

* Standard error values.

Note: ** $p < .001$, * $p < .05$. Bold estimates are statistically significant. As shown, the centre levels (i.e., reference levels) are all non-significant. This is because in the effect coding for this attribute, where the three effects sum to 0, the middle level tests whether the middle level effect differs from the average of the other levels. However, the fact that the other levels are significant means that the three-level attribute is significant. In addition, the SE values represented above for the reference levels (i.e., Level 1) are manually computed approximations, given that Monte Carlo simulations on the parameters would be required to compute the exact SE for the reference level. Those values, however, would not be dramatically different from those computed above.
**Influence of incentives on vehicle choice.** The utility estimates for the non-financial incentives in Table 8 revealed a significant effect of use of HOV lanes for PEVs during high-traffic times on vehicle preference and, furthermore, that free parking downtown was even more influential than use of HOV lanes on preference for PHEVs. Additionally, an examination of the utility estimates for the financial incentives revealed that participants preferred a $10,000 zero-interest loan over a 7% PST rebate (Table 8). In addition, for PHEVs and BEVs, consumer preference associated with the $0 purchase incentive was lower than that associated with the $5,000 incentive, which was, in turn, lower than that associated with the $10,000 incentive. Figure 4 shows that the relation between purchase incentive amount and preference for PHEVs and BEVs (respectively) is close to linear.

![Utility Estimates for PHEVs and BEVs](image-url)

*Figure 4. Line graph of utility estimates for PHEVs and BEVs (respectively) under different purchase incentive amounts.*

The discrete choice model was also used to simulate vehicle market share under varying levels of the purchase incentive, thus creating valuable market share forecasts for PHEVs, BEVs,
and overall PEVs (Table 9). For example, PHEV new vehicle market share is projected to increase by roughly 3.4% with a $5,000 purchase incentive, relative to a $0 purchase incentive.

Table 9. Market share forecasts for PEVs under various purchase incentive amounts, relative to a $0 incentive

<table>
<thead>
<tr>
<th>Purchase or lease incentive amount</th>
<th>$1,000</th>
<th>$3,000</th>
<th>$5,000</th>
<th>$7,000</th>
<th>$9,000</th>
<th>$10,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHEVs</td>
<td>+0.7%</td>
<td>+2.0%</td>
<td>+3.4%</td>
<td>+4.1%</td>
<td>+4.8%</td>
<td>+5.1%</td>
</tr>
<tr>
<td>BEVs</td>
<td>+0.2%</td>
<td>+0.5%</td>
<td>+0.9%</td>
<td>+2.1%</td>
<td>+3.3%</td>
<td>+3.9%</td>
</tr>
<tr>
<td>Total PEVs</td>
<td>+0.9%</td>
<td>+2.5%</td>
<td>+4.3%</td>
<td>+6.2%</td>
<td>+8.1%</td>
<td>+9.0%</td>
</tr>
</tbody>
</table>

Notes: 1) These values reflect change to the predicted new vehicle share when the incentive is applied to both PHEVs and BEVs. 2) These values were generated by inputting the results from the present study into an Excel-based simulator, assuming a base case (i.e., $0 incentive) of mid-point values (Level 2) from the choice experiment for each vehicle type for purchase price, annual fuel costs, annual emissions, and battery range.

Relative impact of vehicle attributes on choice. Subsequent analyses revealed that, for both PHEV and BEV attributes, purchase price had the largest relative impact on vehicle choice, followed by purchase incentive (Table 10). For BEVs, annual emissions and battery range had a similar impact as purchase incentives. In general, vehicle characteristics (e.g., battery range) impacted BEV preference more than PHEV preference.

---

16 First, the parameter estimate for the reference level was computed by taking the negative sum of the two available estimates for each attribute, given that the sum of the three estimates on each attribute is constrained to be equal to zero. This technique serves to undo the initial coding of the estimates. Next, the range of estimate values for each attribute (i.e., maximum value minus minimum value) was calculated and those values were divided by the sum of the ranges across attributes for each vehicle type to produce the relative impact of each attribute per vehicle type.
Table 10. Rank-ordered relative impact of PHEV and BEV attributes on vehicle choice

<table>
<thead>
<tr>
<th>PHEV Attributes</th>
<th>Relative impact</th>
<th>BEV Attributes</th>
<th>Relative impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price</td>
<td>0.47</td>
<td>Purchase price</td>
<td>0.30</td>
</tr>
<tr>
<td>Purchase incentive</td>
<td>0.15</td>
<td>Purchase incentive</td>
<td>0.17</td>
</tr>
<tr>
<td>Annual fuel costs</td>
<td>0.10</td>
<td>Annual emissions</td>
<td>0.16</td>
</tr>
<tr>
<td>Fast charging station availability</td>
<td>0.09</td>
<td>Battery range</td>
<td>0.14</td>
</tr>
<tr>
<td>Additional incentives</td>
<td>0.08</td>
<td>Other financial incentives</td>
<td>0.06</td>
</tr>
<tr>
<td>Other financial incentives</td>
<td>0.05</td>
<td>Fast charging station availability</td>
<td>0.06</td>
</tr>
<tr>
<td>Battery range</td>
<td>0.03</td>
<td>Annual fuel costs</td>
<td>0.05</td>
</tr>
<tr>
<td>Annual emissions</td>
<td>0.03</td>
<td>Additional incentives</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Discussion

In a research area largely dominated by the rational economic approach – with its base assumption of the rational actor – this study expanded on extant literature by evaluating whether psychological variables from Ajzen’s (1991; 2005) TPB can be valuable additions to traditional consumer decision models, in addition to providing market share forecasts to assist with provincial policy planning related to PEV incentives.

Psychological Influences on Vehicle Preference

Results revealed that the psychological variables from the TPB collectively predicted 44% of the variance in PEV purchase intention. Therefore, consistent with the TPB, the more that individuals’ attitudes, social norms, and perceived behaviour control about PEVs were aligned, the greater their PEV purchase intention. Contrary to the majority of transportation research, which represents consumers as making conscious decisions to maximize expected utility according to financial aspects and functional vehicle features, these findings support recent critiques of the rational actor model from researchers in behavioural economics and psychology (Peattie, 2010). Current results support a growing body of literature suggesting that
psychological variables have much to offer consumer decision models. Although the TPB explained a substantial amount of variance (44%) in PEV purchase intention, this amount is slightly less than the 52% of variance in general proenvironmental behavioural intention explained by the TPB in a recent meta-analysis (Bamberg & Möser, 2007). This difference may be partly because the unique nature of vehicle purchase behaviour, compared to other types of sustainability behaviour, in terms of both frequency and expense. As such, many factors in addition to psychological variables exert influence on vehicle choice (e.g., Brownstone et al., 2000; Dagsvik et al., 2002).

Furthermore, attitudes, social norms, and perceived behavioural control were each uniquely and positively predictive of variance in PEV purchase intention, explaining 4%, 5%, and 8% respectively. Therefore, consumers are more likely to intend to purchase a PEV if they have a favourable evaluative reaction towards PEVs, believe that purchasing a PEV is normal and congruent with the expectations of important reference individuals or groups, and believe that there will be positive consequences associated with the purchase.

Findings related to the attitude scale were especially interesting. PEVs benefit both the individual and society, and as such are a “mixed good” in that they contain elements of both private and public goods (Green, 1992). The majority of research has focused on the individual benefits of PEVs, such as reduced operating costs and, to a lesser-degree, symbolic motives such as conveying one’s values (e.g., Steg, Vlek, & Slotegraaf, 2001) or expressing social status and identity (Dittmar, 1992; Steg, 2005). However, research into the societal benefits of PEVs (such as the environmental benefits of reducing GHG emissions) is somewhat divided: some studies indicate that early adopters are motivated by environmental protection (Curtin et al., 2009; Gallagher & Muehlegger, 2007; Heffner et al., 2007; Kurani et al., 2007), whereas other research
suggests that such considerations do not generally enter into vehicle purchase decisions (e.g., Anable et al., 2008; Lane, 2005; Thatchenkery, 2008). Consistent with these apparently contradictory findings, the present results indicate that although consumers reported higher levels of agreement with societally-relevant versus personally-relevant PEV benefits, perceived individual benefits were more predictive of PEV purchase intentions compared to perceived collective benefits.

The powerful influence of social norms observed in this study is not surprising, given the tendency for individuals to compare their behaviours to those around them, as described by Festinger’s (1954) social comparison theory. A large body of literature has shown that descriptive social norms (i.e., individual’s beliefs about how others typically act) (e.g., Cialdini et al., 1990), and/or injunctive social norms (i.e., individual’s beliefs about how others think that people should behave) (Reno, Cialdini, & Kallgren, 1993) exert a powerful influence on behaviour, including sustainable transportation behaviour (Kormos, Gifford, & Brown, 2015).

Perceived behavioural control was the strongest predictor of PEV purchase intention in the present study, which supports recent research that higher perceived self-efficacy is linked to greater use of sustainable commuting (Abrahamse, Steg, Gifford, & Vlek, 2009). This finding suggests that a consumer may hold positive attitudes concerning PEVs and may think that people who are important in their lives would consider buying a PEV, but might still be unlikely to buy a PEV themselves because of perceptions that they are too expensive or that PEV technology is too confusing.

**Influence of Vehicle Attributes and Incentives on Vehicle Preference**

Purchase price and incentive amount had the greatest relative impact on vehicle preference, attesting to the powerful influence of financial factors in shaping vehicle purchase
decisions. Furthermore, PHEV preferences were more influenced by incentives than were BEV preferences, whereas BEV preferences were more influenced by vehicle characteristics (i.e., emissions and battery range) than were PHEV preferences. These results suggest there may not be as much that can be done – aside from purchase incentives – to encourage BEV adoption until manufacturers have improved these other features that are perceived by consumers to be important.17

Findings also revealed a near-linear association between increased purchase incentive amount and preference for PHEVs and BEVs. Previous research has shown that incentives can influence interest in hybrid electric vehicles (Gallagher & Muehlegger, 2007) and PHEV demand can be as much as 30% greater with the presence of an incentive (Axsen et al., 2013). In addition to the purchase incentive, other financial incentives were also influential in the present analysis. The prospect of a $10,000 zero-interest loan was preferred over a later 7% PST rebate for PHEVs, a finding which seems counterintuitive given that the tax rebate would result in a lower total cost of ownership compared to the loan (i.e., as the rebate would reduce the current cost of the Nissan Leaf in Canada by approximately $2,300); however, the $10,000 loan would reduce the large up-front purchase price premium associated with PEVs more than a later PST rebate. Indeed, previous research shows that immediate consequences tend to modify behaviour more strongly than delayed, uncertain consequences (Frederick, Loewenstein, & O’Donoghue, 2002; Loewenstein & Lerner, 2001). Consequently, the large up-front purchase premium is perhaps weighted more heavily in a psychological sense, resulting in the increased appeal of the substantial zero-interest loan relative to the PST rebate.

17 An important caveat to note is that certain attributes, such as recharge time, which was non-significant for PHEVs and BEVs, may have been so largely because vehicle charging is currently unfamiliar to consumers.
Interestingly, Mock and Yang’s (2014) comparative policy assessment across 11 major international vehicle markets revealed that California has a higher BEV growth rate and market share compared to many other markets, despite having roughly the same level of incentives. The authors speculate that perhaps the use of HOV lanes for PEVs in metropolitan areas in California serve as an additional incentive by reducing commuting time. In support of this speculation, the present findings suggest that the use of HOV lanes significantly influences vehicle preference, and that the prospect of free PEV parking downtown would be even more influential.

A key limitation to this research is that other important attributes, such as those related to aesthetic and safety-related vehicle characteristics, were not included in the choice experiment. Despite the potential importance of these attributes in influencing vehicle purchase decision-making, we were unable to include additional attributes as part of the choice experiment because there were already ten attributes that had to be included. However, aesthetic issues were assessed as part of the hedonic scale in the survey.

Conclusions

Taken together, findings from Study 1 suggest that a combination of non-financial and financial PEV policy measures, especially those that reduce consumers’ total cost of ownership and up-front costs, are invaluable to encourage PEV deployment and market growth within BC. Findings also demonstrate the influential role of psychological variables in shaping vehicle preferences.
CHAPTER 3

Study 2: Latent Class Choice Model

Study Overview and Objectives

Consistent with previous studies that have sought to quantify consumer preferences and demand for low-carbon vehicles, the discrete choice model estimated in Study 1 assumed homogeneous preferences across participants. This approach, although valuable in an aggregate sense, can result in biased predictions in situations where consumer preferences vary widely. Latent class discrete choice modeling – which allows for more nuanced interpretations of behavioural data compared to other logit models (e.g., Shen, 2009) – takes this variation, or heterogeneity, into account by estimating separate sets of coefficients for groups of individuals with distinct patterns of preferences, thus allowing for the identification of segments of consumers with different general preferences (e.g., Swait, 1994; Zito & Salvo, 2012).

Furthermore, “hybrid choice models” can be used to incorporate consumer demographic characteristics and other constructs into latent class choice modeling by segmenting classes according to both preferences and these additional covariates (Ben-Akiva et al., 2002). This modeling approach enables researchers to incorporate behavioural theories, via inclusion of associated variables (e.g., attitudes and beliefs), into discrete choice models. With the exception of several studies (e.g., Axsen, Bailey, & Castro, 2015; Hirdue et al., 2011; Shen, 2009), however, this hybrid latent class approach has rarely been used to evaluate consumer preferences for PEVs, and limited efforts to characterize such consumer segments have been based largely on demographic characteristics.
To address existing gaps in the literature, Study 2 expanded on Study 1 by estimating a latent class model to identify and describe segments of consumers with similar vehicle preferences. Study 2 assessed variations in consumer preference for PEVs while taking into account underlying demographic characteristics and psychological motivations. By integrating data from the stated choice experiment, which yielded class-independent parameter estimates, with survey data, which demonstrated the predictive power of Ajzen’s TPB (1991) in explaining self-reported interest in PEVs, Study 2 explored both the usefulness of psychological characteristics for distinguishing among consumer classes as well as the influence of their inclusion on the fit of vehicle purchase decision-making models. This research builds on a recent latent class analysis – which created preference-based consumer segments to examine how differing lifestyle patterns and levels of environmental concern are related to PEV interest (Axsen, Bailey, & Castro, 2015) – by exploring how PEV preference is associated with the TPB, a classic theory in psychology.

Method

A latent class model was estimated using the stated choice and survey data gathered in Study 1 (see Appendices A & B), where the participants were 423 BC residents, at least 18 years of age, who plan to purchase/lease a new vehicle in the next 12 months.

Data Analysis

A latent class choice model was estimated using Latent GOLD Choice 5.0 (see Vermunt & Magidson, 2013). This model accounts for preference heterogeneity among participants by separating the sample into a discrete number of segments, consisting of respondents with similar patterns of vehicle preferences (Wedel & Kamakura, 1998), and then estimating different sets of
random utility parameters and membership probability for each segment using maximum likelihood to optimally account for response patterns (see Greene & Hensher, 2003). A key advantage of latent class analysis is that it allows for the identification of characteristics that typify and distinguish the classes through the inclusion of individual-level covariates, such as demographic and psychological characteristics, in the class membership component of the model (e.g., Strazzera, Mura, & Contu, 2012).

Results

Latent Class Choice Analysis

Determining the optimal number of classes. Latent class analyses with 1 to 10 classes were conducted on the data of Study 1 (Table 11). The 5-class solution was deemed optimal given that it had the lowest values on two measures of model parsimony and quality – namely, the Consistent Akaike Information Criterion (CAIC) and Bayesian Information Criterion (BIC) (see Appendix C and Louviere et al., 2000). The increase in the pseudo $R^2$ statistic from .03 for the 1-class model to .43 for the 5-class model also suggests the improved predictive performance of this latter model. As would be expected, the $R^2$ statistic continues to increase with additional classes, but this increase is negligible.
Table 11. Model diagnostics for 1-10 latent classes (n = 413)

<table>
<thead>
<tr>
<th>Classes</th>
<th>Log-likelihood (LL)</th>
<th>BIC (LL)(^a)</th>
<th>AIC(^3) (LL)(^b)</th>
<th>CAIC (LL)(^c)</th>
<th>Number of parameters (k)</th>
<th>df(^d)</th>
<th>Pseudo (R^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-8516.99</td>
<td>17280.94</td>
<td>17156.98</td>
<td>17321.94</td>
<td>41</td>
<td>372</td>
<td>0.03</td>
</tr>
<tr>
<td>2</td>
<td>-6937.99</td>
<td>14375.92</td>
<td>14124.98</td>
<td>14458.92</td>
<td>83</td>
<td>330</td>
<td>0.26</td>
</tr>
<tr>
<td>3</td>
<td>-6209.95</td>
<td>13172.83</td>
<td>12794.90</td>
<td>13297.83</td>
<td>125</td>
<td>288</td>
<td>0.35</td>
</tr>
<tr>
<td>4</td>
<td>-5937.34</td>
<td>12880.60</td>
<td>12375.69</td>
<td>13047.60</td>
<td>167</td>
<td>246</td>
<td>0.40</td>
</tr>
<tr>
<td>5</td>
<td>-5708.16</td>
<td>12675.22</td>
<td>12043.32</td>
<td>12884.22</td>
<td>209</td>
<td>204</td>
<td>0.43</td>
</tr>
<tr>
<td>6</td>
<td>-5582.12</td>
<td>12676.13</td>
<td>11917.24</td>
<td>12927.13</td>
<td>251</td>
<td>162</td>
<td>0.44</td>
</tr>
<tr>
<td>7</td>
<td>-5467.12</td>
<td>12699.12</td>
<td>11813.25</td>
<td>12992.12</td>
<td>293</td>
<td>120</td>
<td>0.45</td>
</tr>
<tr>
<td>8</td>
<td>-5380.28</td>
<td>12778.42</td>
<td>11765.57</td>
<td>13113.42</td>
<td>335</td>
<td>78</td>
<td>0.47</td>
</tr>
<tr>
<td>9</td>
<td>-5273.94</td>
<td>12818.72</td>
<td>11678.88</td>
<td>13195.72</td>
<td>377</td>
<td>36</td>
<td>0.48</td>
</tr>
<tr>
<td>10</td>
<td>-5200.04</td>
<td>12923.90</td>
<td>11657.08</td>
<td>13342.90</td>
<td>419</td>
<td>-6</td>
<td>0.49</td>
</tr>
</tbody>
</table>

Notes: Model estimated using the effect coded ASCs and attributes. Number of individuals \(n = 413\), number of observations \(N = 29736\).

\(^a\)Bayesian Information Criterion = \(-\text{LL} + \left(\frac{k}{2}\right)\ln(N)\)
\(^b\)Akaike Information Criterion = \(-2(\text{LL} - k)\)
\(^c\)Consistent Akaike Information Criterion = \(-2\ln(L) + p(1 + \ln(N))\)

**Interpretation of the classes.** The estimated choice probabilities for the 5-class solution, as shown in Table 12, suggest the following interpretation: consumers in Class 1 are \textit{GV-oriented} (i.e., 58% of respondents who most preferred the GV fell into this class); respondents in Class 2 have \textit{flexible (or undetermined) preferences} for GVs, PHEVs, or BEVs; Class 3 participants are \textit{PHEV-leaning}; Class 4 individuals are generally \textit{dissatisfied with the options} presented (i.e., they most frequently chose the ‘no purchase’ option); and participants in Class 5 are \textit{BEV-leaning}.
Table 12. *Estimated choice probabilities for the 5-class model*

<table>
<thead>
<tr>
<th>Choice 4 (No purchase)</th>
<th>Class 1</th>
<th>Class 2</th>
<th>Class 3</th>
<th>Class 4</th>
<th>Class 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choice 1 (GV)</td>
<td>0.58</td>
<td>0.32</td>
<td>0.03</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td>Choice 2 (PHEV)</td>
<td>0.05</td>
<td>0.37</td>
<td>0.43</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>Choice 3 (BEV)</td>
<td>0.01</td>
<td>0.23</td>
<td>0.18</td>
<td>0.09</td>
<td>0.49</td>
</tr>
<tr>
<td>Choice 4 (No purchase)</td>
<td>0.07</td>
<td>0.06</td>
<td>0.07</td>
<td>0.78</td>
<td>0.01</td>
</tr>
</tbody>
</table>

*Note: Model estimated using the effect coded ASCs and experimental design attributes, without any demographic or psychological covariates added and using standard (Hessian) errors.*

**Posterior Probability Analyses**

To examine psychological and demographic differences among the classes, each participant was assigned to the class to which he/she had the highest likelihood of belonging, as indicated by the highest posterior probability value. Resulting descriptive statistics for each class are shown in Table 13.
Table 13. Descriptive statistics for each class (with membership determined based on highest posterior probability)

<table>
<thead>
<tr>
<th></th>
<th>GV-oriented (n = 141)</th>
<th>Flexible preferences (n = 112)</th>
<th>PHEV-leaning (n = 68)</th>
<th>Dissatisfied with options (n = 55)</th>
<th>BEV-leaning (n = 47)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Gender (% male)</td>
<td>56.1%</td>
<td>-</td>
<td>45.5%</td>
<td>-</td>
<td>47.1%</td>
</tr>
<tr>
<td>Age</td>
<td>3.30</td>
<td>1.59</td>
<td>2.77</td>
<td>1.53</td>
<td>2.60</td>
</tr>
<tr>
<td>Education</td>
<td>3.57</td>
<td>1.29</td>
<td>3.80</td>
<td>1.20</td>
<td>3.92</td>
</tr>
<tr>
<td>Household income</td>
<td>2.97</td>
<td>1.53</td>
<td>3.05</td>
<td>1.60</td>
<td>2.99</td>
</tr>
<tr>
<td>Budget for next vehicle</td>
<td>$26,640</td>
<td>$13,742</td>
<td>$25,509</td>
<td>$23,374</td>
<td>$29,862</td>
</tr>
<tr>
<td>Social norms scale</td>
<td>3.07</td>
<td>1.14</td>
<td>3.51</td>
<td>1.08</td>
<td>4.16</td>
</tr>
<tr>
<td>Perceived behavioural control scale</td>
<td>3.00</td>
<td>1.43</td>
<td>2.90</td>
<td>1.22</td>
<td>3.94</td>
</tr>
<tr>
<td>Attitudes scale</td>
<td>3.78</td>
<td>0.99</td>
<td>4.39</td>
<td>0.82</td>
<td>4.93</td>
</tr>
<tr>
<td>Symbolic-personal subscale</td>
<td>3.16</td>
<td>1.32</td>
<td>3.61</td>
<td>1.24</td>
<td>4.36</td>
</tr>
<tr>
<td>Symbolic-societal subscale</td>
<td>3.72</td>
<td>1.51</td>
<td>4.50</td>
<td>1.23</td>
<td>4.94</td>
</tr>
<tr>
<td>Hedonic subscale</td>
<td>4.32</td>
<td>1.42</td>
<td>4.89</td>
<td>1.27</td>
<td>5.31</td>
</tr>
<tr>
<td>Functional-societal subscale</td>
<td>4.55</td>
<td>1.44</td>
<td>5.16</td>
<td>1.16</td>
<td>5.45</td>
</tr>
<tr>
<td>Functional-personal subscale</td>
<td>3.56</td>
<td>1.13</td>
<td>4.34</td>
<td>1.04</td>
<td>4.93</td>
</tr>
<tr>
<td>PEV purchase intentions</td>
<td>2.41</td>
<td>1.34</td>
<td>2.81</td>
<td>1.48</td>
<td>3.94</td>
</tr>
</tbody>
</table>

Notes: Gender (male = 1, female = 2)
Age (less than 29 years = 1, 30 - 39 years = 2, 40 - 49 years = 3, 50 - 59 years = 4, 60 - 69 years = 5, 70 years and more = 6)
Education (elementary/middle school graduate = 1, high school graduate = 2, some post-secondary education = 3, college, diploma, or trade certification = 4, Bachelor's degree = 5, graduate, post-doctoral, or professional degree = 6)
Income (less than $25,000 = 1, $25,000-$50,000 = 2, $50,000-$75,000 = 3, $100,000-$125,000 = 4, $125,000 or more = 5)
Scale ranged from 1 (Strongly disagree) to 7 (Strongly agree) for all psychological scales.
Examine the psychological differences among the classes. A multivariate analysis of variance (MANOVA) was conducted with the three psychological scales as the dependent variables and class membership as the independent variable. A significant overall effect of class membership was found, Pillai’s Trace = .27, $F(12, 1173) = 9.69, p < .001$, partial $\eta^2 = .09$, and univariate results revealed differences among classes on the attitudes ($F = 26.86, p < .001$, partial $\eta^2 = .22$), social norms ($F = 13.04, p < .001$, partial $\eta^2 = .12$), and perceived behavioural control scales ($F = 8.95, p < .001$, partial $\eta^2 = .08$). Post-hoc multiple comparisons, performed using Dunnett $t$-tests, showed that individuals in the GV-oriented class reported less favourable attitudes towards PEVs compared to all other classes (all $p < .001$). Those in the GV-oriented class also reported less agreement with the social norms items compared to the PHEV- and BEV-leaning classes (both $p < .001$), but not compared to the flexible preferences and dissatisfied with options classes ($p = .03$ and $p = .12$, respectively). Similarly, respondents in the GV-oriented class reported lower levels of behavioural control over the PEV purchase compared to the PHEV- and BEV-leaning classes ($p < .001$ and $p = .003$, respectively), but not compared to the flexible preferences or dissatisfied with options classes ($p = .71$ and $p = .88$, respectively). These differences can be seen in Figure 5.

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21 A Bonferroni adjustment was performed, such that statistical significance was set at $p < .017$ (i.e., .05 divided by three).
Figure 5. Class means for the psychological variables from the TPB (Ajzen, 1991).

**Examining demographic differences among the classes.** Several one-way analyses of variance were conducted to assess demographic differences among the five classes. Age differed significantly across the classes, $F(4, 418) = 3.66, p < .01$, and Dunnett’s $t$-tests revealed that the GV-oriented class contained a greater proportion of older individuals compared to the PHEV-leaning class ($p = .01$).\(^{22}\) Likewise, gender differences across the classes approached significance, $F(4, 410) = 2.19, p < .07$, with the GV-oriented class containing a greater proportion of males than the dissatisfied with options class ($p = .05$). However, education level, $F(4, 418) = 1.43, ns$, household income, $F(4, 416) = .44, ns$, and budget for the next vehicle, $F(4,$

\(^{22}\) The age difference between the GV-oriented class and both the flexible class ($p = .03$) and the BEV-oriented class ($p = .03$) approached significance, such that older consumers showed greater preference for GVs, but did not meet the Bonferroni adjusted value of $p < .013$. 

---

[Graph showing mean scale values for Attitudes about PEVs, Social norms, Perceived behavioural control]
418) = 1.82, *ns*, did not differ among the classes.

Interesting to note is that, in Table 13, the differences between household income and budget for next vehicle between the GV-oriented and BEV-leaning are small, which suggests that other factors aside from simple rational economics are also important.

**Discrete Choice and Class Membership Model**

Following the analyses that assigned class membership based on posterior probability values, a latent class choice model was estimated with four demographic covariates (age, gender, education level, and household income) and three psychological covariates (attitudes, social norms, and perceived behavioural control) (Table 14). Problematically, the standard errors associated with the covariates used to predict the intercept term in the class membership model are underestimated because the model assumes one value per participant, whereas there is actually considerable replication per participant (i.e., 72 rows of replication because there were 18 choice sets with four vehicle alternatives). Despite these issues, the inclusion of covariates is common practice in the latent class literature but, regardless, cautious interpretation of the following findings is warranted.

**Overall attribute and covariate results.** Parameter estimates for the vehicle attributes were in the anticipated direction (Table 14); for example, the model yielded significant negative estimates for purchase price and fuel costs (indicating less preference for higher values) across all five classes, as well as significant positive estimates for purchase/lease incentives (indicating

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23 This lack of significance is maybe because of the large standard deviations (especially for budget for next vehicle), but it is worthy to note that the means are in the anticipated direction.

24 Parameter estimates for the vehicle attributes were largely identical to that when the model was estimated without any covariates. When the latent class analysis was re-run with 1-10 classes on the full aggregate model from Study 1, as well as the four demographic and three psychological covariates, model diagnostics still suggest that the 5-class solution is the most parsimonious, and the same pattern of choice probabilities emerges, which suggests an identical interpretation of the classes.
greater preference for higher values) in the three PEV-interested classes. As indicated by the Wald (=) statistics, all five classes demonstrated the same degree of sensitivity to all vehicle attributes except purchase price, which had the strongest influence on the GV-oriented class.

Class-specific descriptive statistics (Table 13) and findings from the class membership component of the latent class model (Table 14) were examined to characterize participants in each class. Wald statistics revealed that attitudes towards PEVs and, to a lesser degree, perceived behavioural control affected class membership probabilities. A subsequent latent class analysis, which differed from that summarized in Table 14 in that it included the specific attitude subscales, showed that the effect of the attitudes scale was driven almost entirely by the influence of the functional-personal subscale (see Appendix D).

**Class-specific results.** An examination of the alternative specific constant (ASC) values in Table 14 supported the initial labeling of the classes from Table 12 and Table 13. The GV-oriented class, which comprised 33% of the sample (as shown by the membership probability), strongly preferred conventional vehicles but also showed moderate interest in PHEVs. These respondents – who tended to be significantly older, more typically male, and to hold negative attitudes towards PEVs – were only influenced by purchase price and fuel costs.

The flexible (or undetermined) preferences class (29% of the sample) is characterized by consumers who placed high value on GVs but who were also interested, although less so, in PHEVs and BEVs. In addition to purchase price and fuel costs, which influenced all classes, the vehicle preferences of these consumers were positively influenced by battery range, purchase/lease incentives, and fast-charging station availability, as well as non-financial incentives. Interestingly, this class was not motivated by concerns about vehicle emissions.
Individuals who perceived a lack of control over the PEV purchase had a higher probability of belonging to this class.

Consumers in the PHEV--leaning class (14% of the sample) were most interested in PHEVs, followed by GVs and BEVs. This class was strongly influenced by the purchase/lease incentive, but was also sensitive to GHG emissions and other financial incentives, as well as to the availability of charging infrastructure. Those with a high degree of perceived behavioural control and favourable PEV attitudes were likely to be in this class.

The dissatisfied with options class (13% of the sample) had negative ASCs for all three vehicle types, indicating a lack of interest in any of the vehicles. However, the GV constant was non-significant, which suggests that these consumers are the least disinterested in a GV. These individuals placed significant value on GHG emissions and charging infrastructure availability.

The BEV-leaning class (11% of the sample) had positive and significant ASCs for all three vehicle types, although they were most interested in BEVs. These respondents were influenced by all attributes, but most notably by the purchase/lease incentive followed by other financial incentives. Additionally, individuals with highly favourable attitudes towards PEVs and a high degree of perceived behavioural control had a greater probability of belonging to this class.

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Note: Analysis of the quality control questions revealed that participants who failed both of these questions were not over-represented in this class.
Table 14. Coefficient estimates for 5-segment latent class model including covariates (n = 413)

<table>
<thead>
<tr>
<th>Membership probability</th>
<th>Wald</th>
<th>Wald(=)</th>
<th>GV-oriented</th>
<th>Flexible preferences</th>
<th>PHEV-leaning</th>
<th>Dissatisfied with options</th>
<th>BEV-leaning</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Discrete choice model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GV constant</td>
<td>305.87***</td>
<td>132.26***</td>
<td>5.95***</td>
<td>4.79***</td>
<td>2.41***</td>
<td>-0.09</td>
<td>5.01***</td>
</tr>
<tr>
<td>PHEV constant</td>
<td>157.21***</td>
<td>97.63***</td>
<td>2.14**</td>
<td>3.06***</td>
<td>3.25***</td>
<td>-1.66***</td>
<td>4.09***</td>
</tr>
<tr>
<td>BEV constant</td>
<td>86.31***</td>
<td>62.26***</td>
<td>0.23</td>
<td>2.28***</td>
<td>1.89***</td>
<td>-1.46**</td>
<td>5.50***</td>
</tr>
<tr>
<td>Purchase price</td>
<td>242.84***</td>
<td>11.14*</td>
<td>-0.72***</td>
<td>-0.65***</td>
<td>-0.50***</td>
<td>-0.34***</td>
<td>-0.47***</td>
</tr>
<tr>
<td>Annual fuel costs</td>
<td>41.17***</td>
<td>4.52</td>
<td>-0.23**</td>
<td>-0.07*</td>
<td>-0.20***</td>
<td>-0.17**</td>
<td>-0.23***</td>
</tr>
<tr>
<td>Annual emissions</td>
<td>18.09***</td>
<td>6.89</td>
<td>-0.12</td>
<td>-0.01</td>
<td>-0.19***</td>
<td>-0.16*</td>
<td>-0.19***</td>
</tr>
<tr>
<td>Battery range</td>
<td>18.59***</td>
<td>1.62</td>
<td>-0.02</td>
<td>0.16**</td>
<td>0.09</td>
<td>0.15</td>
<td>0.17*</td>
</tr>
<tr>
<td>Purchase/lease incentive</td>
<td>51.43***</td>
<td>4.47</td>
<td>0.13</td>
<td>0.20***</td>
<td>0.40***</td>
<td>0.15</td>
<td>0.32***</td>
</tr>
<tr>
<td>Other financial incentives$^d$</td>
<td>8.30</td>
<td>8.25</td>
<td>-0.07</td>
<td>0.01</td>
<td>-0.13*</td>
<td>-0.05</td>
<td>0.13*</td>
</tr>
<tr>
<td>Additional incentives$^d$</td>
<td>21.00***</td>
<td>3.89</td>
<td>-0.11</td>
<td>-0.12*</td>
<td>-0.10</td>
<td>0.01</td>
<td>-0.19**</td>
</tr>
<tr>
<td>Fast charging station availability</td>
<td>15.03**</td>
<td>1.14</td>
<td>0.04</td>
<td>0.12*</td>
<td>0.19**</td>
<td>0.18*</td>
<td>0.13*</td>
</tr>
<tr>
<td><strong>Class membership model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>7.87</td>
<td>0.15**</td>
<td>-0.05</td>
<td>-0.08</td>
<td>-0.09</td>
<td>-0.10</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>5.60</td>
<td>-0.36*</td>
<td>-0.24</td>
<td>-0.16</td>
<td>0.35</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>2.99</td>
<td>-0.13</td>
<td>0.01</td>
<td>0.07</td>
<td>-0.08</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>Household income</td>
<td>0.30</td>
<td>0.00</td>
<td>0.03</td>
<td>-0.02</td>
<td>-0.03</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>Social norms scale</td>
<td>1.33</td>
<td>-0.09</td>
<td>0.03</td>
<td>0.18</td>
<td>-0.08</td>
<td>-0.04</td>
<td></td>
</tr>
<tr>
<td>Perceived behavioural control</td>
<td>12.56*</td>
<td>-0.10</td>
<td>-0.22**</td>
<td>0.18*</td>
<td>-0.04</td>
<td>0.19*</td>
<td></td>
</tr>
<tr>
<td>Attitudes scale</td>
<td>33.26***</td>
<td>-0.83***</td>
<td>-0.20</td>
<td>0.46**</td>
<td>-0.14</td>
<td>0.71***</td>
<td></td>
</tr>
</tbody>
</table>

$^*$ These attributes were both reverse-coded.

Number of individuals n = 413, number of observations N = 29,736.

* p < .05, **p < .01, *** p < .001. Note that the model was performed with the attributes entered using the experimental design and coded as numeric for the 5-class solution (i.e., given that it was found to be ideal when using the effect coded attributes in the initial latent class analysis). Using standard (Hessian) errors.
Model Comparisons

Four versions of the latent class choice model were estimated, as follows: 1) the original model from Study 1 without covariates (i.e., only including the following eight attributes: purchase price, annual fuel costs, annual emissions, battery range, purchase/lease incentive, other financial incentives, additional incentives, and fast charging station availability); 2) the original model with three psychological covariates (attitudes towards PEVs, social norms, and perceived behavioural control); 3) the original model with four demographic covariates (age, gender, education level, and household income); and 4) the original model with the above psychological and demographic covariates. Given that a lower BIC value indicates either better fit (i.e., less unexplained variation in the dependent variable), fewer explanatory variables, or both, inclusion of the psychological covariates improved model fit,\(^{26}\) whereas inclusion of the demographic covariates had neutral (if not slightly adverse) affect on model fit given that the number of parameters is factored in (Table 15).\(^{27}\) Furthermore, the evidence in favour of the model including the psychological variables, compared to the original model, is very strong given that the difference in BIC values between the models is greater than 10 (Kass & Wasserman, 1995).

\(^{26}\) The BIC decreased from 12,671.45 to 12,530.28.

\(^{27}\) The BIC increased from 12,671.45 to 12,739.54.
Table 15. Model diagnostics for the various 5-class latent class analyses (n = 413)

<table>
<thead>
<tr>
<th>Models</th>
<th>Log-likelihood (LL)</th>
<th>BIC (LL)&lt;sup&gt;a&lt;/sup&gt;</th>
<th>AIC&lt;sup&gt;3&lt;/sup&gt; (LL)&lt;sup&gt;b&lt;/sup&gt;</th>
<th>CAIC (LL)&lt;sup&gt;c&lt;/sup&gt;</th>
<th>Number of parameters (k)</th>
<th>df</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without covariates</td>
<td>-5,706.28</td>
<td>12,671.45</td>
<td>12,039.55</td>
<td>12,880.45</td>
<td>209</td>
<td>204</td>
</tr>
<tr>
<td>Including psychological covariates</td>
<td>-5,600.08</td>
<td>12,530.28</td>
<td>11,863.17</td>
<td>12,751.28</td>
<td>221</td>
<td>190</td>
</tr>
<tr>
<td>Including demographic covariates</td>
<td>-5,692.13</td>
<td>12,739.54</td>
<td>12,059.27</td>
<td>12,964.54</td>
<td>225</td>
<td>188</td>
</tr>
<tr>
<td>Including psychological and demographic covariates</td>
<td>-5,593.32</td>
<td>12,613.05</td>
<td>11,897.64</td>
<td>12,850.05</td>
<td>237</td>
<td>174</td>
</tr>
</tbody>
</table>

Notes: Number of individuals n = 413, number of observations N = 29,736. Analyses conducted with effect coded ASCs and attributes.  
<sup>a</sup> Bayesian Information Criterion = -LL + [(k/2)Ln(N)]  
<sup>b</sup> Aikaike Information Criterion = -2(LL – k)  
<sup>c</sup> Consistent Aikaike Information Criterion = -2ln(L) + p*(1 + ln(N))

Discussion

To help achieve GHG reduction goals, many governments have set ambitious targets for PEV adoption. In Canada, for example, the Canadian Electric Vehicle Technology Roadmap lays out a goal of 500,000 PEVs on the road by 2018 (Natural Resources Canada, 2010). To inform policy development and assist with efforts to accelerate PEV market growth, it is necessary to understand not only the factors that influence vehicle preferences but also how these influences vary across different segments of consumers. For instance, some classes of consumers with identifiable characteristics may be swayed towards a PEV purchase by government incentives, whereas others may be unaffected by such incentives. Towards this goal, Study 2 extended findings from Study 1 by incorporating stated choice and survey data to examine an array of contextual, psychological, and demographic influences that underlie vehicle choices in classes of consumers with varying preferences. Through the application of a hybrid model, which has rarely been used to examine PEV preferences (with the exception of several recent studies, e.g.,
Axsen, Bailey, & Castro, 2015; Hirdue et al., 2011), Study 2 revealed important differences among the five identified classes and demonstrated the beneficial effect of including psychological covariates on model fit.

**Characterizing Consumer Preference Segments**

Consistent with Hirdue et al. (2011), class membership was mostly determined by underlying preferences, which predisposed participants towards certain vehicle choices irrespective of variations in choice experiment attributes. And yet analyses did reveal additional similarities and differences among these preference segments. Specifically, in-line with previous research (e.g., Axsen, Bailey, & Castro, 2015; Axsen et al., 2015; Hirdue et al., 2011; Tanaka et al., 2014), all classes had significant negative estimates for purchase price and fuel costs. However, the influence of several other attributes differed across the consumer segments; for example, purchase/lease incentives and other financial incentives were only related to vehicle decisions for consumers in the PEV-interested classes. Findings also offer insight into the psychological and demographic characteristics of each class and, taken together, this information can be used to describe the segments.

Each of the two largest classes (together comprising two-thirds of the sample) primarily preferred GVs. Of these, the largest class, who strongly preferred conventional vehicles but also demonstrated mild interest in PHEVs, consisted of generally older consumers (consistent with Hirdue et al., 2011) and more typically male consumers with unfavourable attitudes towards PEVs. Despite a sensitivity to purchase price and annual fuel costs, these individuals were not affected by purchase/lease incentives. The second-largest class had flexible preferences in that they showed moderate interest in PEVs in addition to GVs. This class was sensitive to the purchase/lease incentive, as well as to battery range and charging infrastructure, but was not
affected by vehicle emissions. Also, these respondents tended to perceive a lack of control and ease regarding PEV purchasing.

Each of two additional classes (together comprising a quarter of the sample) expressed primary interest in PEVs. Of these, one class was most interested in PHEVs, but also showed some interest in GVs and BEVs. Respondents in this class were influenced by the financial incentives, including the purchase/lease incentive, as well as vehicle emissions and charging infrastructure. Consumers in this class were likely to have a high degree of perceived control and ease over the PEV purchase in addition to favourable attitudes towards PEVs. The other, smaller class, preferred BEVs and, although these individuals were sensitive to all attributes, they were most affected by the financial incentives. They tended to hold positive attitudes towards PEVs and to associate a high degree of control and ease with the PEV purchase. These findings are consistent with Hirdue et al. (2011), who found that those in the BEV-oriented class were more likely to have recently adopted a proenvironmental lifestyle, and to have a positive general valuation of BEVs.

The remaining class of participants were generally dissatisfied with the vehicle options presented in the choice experiment but were the most interested in conventional vehicles. Interestingly, this class was insensitive to financial incentives, although they were affected by annual emissions and charging infrastructure. Given that this class had the lowest budget for their next vehicle of all the classes (Table 13), perhaps the GV was the only vehicle that individuals in this class could reasonably afford. In addition, because these participants were somewhat environmentally conscious – being attitudinally similar to those with flexible vehicle preferences (Figure 5) – and because they preferred a vehicle that is less expensive than a PEV,
this class may have consisted of those who would have chosen a hybrid had that vehicle option
been available.

**Contribution of Demographic and Psychological Variables**

Demographic and psychological characteristics differed across the five latent classes,
suggesting that these constructs are valuable additions to economic decision-making models.
Specifically, class membership was associated with age and gender, but not education level and
household income.

Vehicle preferences were also systematically related to participants’ attitudes and
perceived behavioural control and, lesser so, to social norms. Of these, attitudes exerted the
strongest influence on class membership, with the GV-oriented and PEV-leaning classes likely to
have negative and positive attitudes, respectively, towards PEVs. These findings are consistent
with findings that interest in low-carbon vehicles tends to be greater among individuals with
more environmental concern (e.g., Axsen et al., 2015). Furthermore, consistent with the results
from Study 1, this effect of attitudes on vehicle preference was primarily associated with ratings
on the functional-personal subscale. These findings underscore the need for a more controlled
examination of the causal influence of these attitude subscales on vehicle preference. In addition,
perceived behavioural control was the second-most influential psychological construct in
determining class membership probabilities. PEV-leaning classes were most likely to have
perceptions of ease and control over the PEV purchase, whereas those with flexible vehicle
preferences tended to perceive a lack of ease and control over the purchase.

Social norms varied across the classes according to the posterior probability analyses but
not according to the class membership model, possibly due to discrepancies in the method of
class assignment. Important to note is that in the posterior probability analyses, participants were
assigned to the class of highest probability of membership, whereas in the latent class model participants were assigned to classes probabilistically such that respondents had a certain probability of belonging to each segment. Thus, the forced class assignment of the posterior probability analyses may have driven a moderately insignificant social norms effect over the threshold of significance.

Comparisons of models with and without the covariates revealed that inclusion of the psychological covariates significantly improved model fit, relative to both the original model as well as the model including only demographic covariates. Some research has found that latent class models including demographic characteristics produce improved model fits compared to models excluding individual characteristics (e.g., Wen & Lai, 2010), and other latent class research has found that the inclusion of attitudinal data (i.e., environmental attitudes) significantly improves model fit relative to including only demographic variables (Aldrich et al., 2007). As explained by Vij and Walker (2015), these integrated choice and (observable) latent variable models have something to add compared to equivalent (by fit) standard choice models without latent variables because they allow for the identification of structural relationships between observable variables that could not be identified by a choice model without latent variables.

**Conclusions**

In summary, these findings both support and expand on the findings from Study 1 in demonstrating not only that PEV preference is shaped by several important demographic and psychological characteristics but also that the inclusion of psychological covariates can improve latent class models of vehicle choice. This study is part of a small but growing body of research offering evidence to substantiate the merit of integrating behavioural theories into traditional
economic choice modeling approaches, although it also highlights some challenges (e.g., in terms of the complexity of data collection and analysis) that accompany the inclusion of these additional variables.
CHAPTER 4

Study 3: Message Framing of PEV Benefits

Study Overview and Objectives

Results from Studies 1 and 2 indicate that the psychological variables from Ajzen’s (1991) TPB, especially attitudes about PEVs, exert considerable influence on individuals’ vehicle preferences and purchase intentions. According to a typology proposed by Axsen and Kurani (2012), benefits associated with PEVs can vary according to whether they relate to personal-functional aspects (e.g., to save money on operating costs), personal-symbolic aspects (e.g., to allow for an expression of one’s identity), societal-functional aspects (e.g., to reduce transportation-related GHG emissions), and societal-symbolic aspects (e.g., to motivate other consumers). In Study 1, participants indicated higher levels of agreement with items in the societally-relevant attitude subscale compared to the personally-relevant subscale. Interestingly, however, only the personally-relevant subscales uniquely predicted PEV purchase intention, which highlights an interesting possible discrepancy between the attitudes about which participants report the greatest agreement (i.e., perceived benefits accrued to the public) and those that seem to exert the greatest influence on purchase intention (i.e., perceived benefits accrued to the individual).

Study 3 attempts to resolve this discrepancy and extend these previous findings through use of a controlled message framing experiment that evaluates the impact of psychological distance (i.e., feeling of immediacy to the individual) on PEV purchase intentions among Canadian and American participants. Specifically, Study 3 aims to experimentally manipulate messages about PEVs to emphasize either personal benefits (e.g., to save money on operating
costs or allow for an expression of one’s identity) or societal benefits (e.g., to reduce transportation-related GHG emissions or motivate other consumers) to examine the potential causal impact of such message frames on purchase intentions. Consistent with construal level theory, which postulates that mental representations become increasingly abstract as psychological distance between the event in question and an individual’s personal experience increases (Liberman, Trope, & Stephan, 2007; Trope & Liberman, 2003), messages emphasizing personal relevance are hypothesized to be most effective at increasing PEV purchase intention (e.g., Leiserowitz, 2007; Maio & Haddock, 2007). The applied goal of this study is to provide insight into how to communicate PEV benefits, via advertisements and other promotional material, in a manner that is optimally engaging for prospective buyers, and thus influential in terms of proenvironmental choices.

Method

Participants

A sample of 468 participants was recruited using Crowdflower, with 233 from Canada and 235 from the United States. This sample size is based on Cohen’s (1992) recommendation that at least 85 participants are needed to detect a medium effect size, when \( \alpha = .05 \), \( \beta = .2 \), and power = .8. Individuals were eligible to participate if they were over the age of 18 and owned at least one vehicle. Participants were randomly assigned to the pure control condition \( (n = 117) \), benefits control condition \( (n = 120) \), personal benefits message frame condition \( (n = 111) \), or societal benefits message frame condition \( (n = 120) \).

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28 We attempted to recruit all of the participants from a Canadian sample on Crowdflower; however, after exhausting all eligible Canadian participants who met the inclusion criteria, recruitment was expanded to obtain the remaining participants from the United States on Crowdflower.
The mean age of participants across the two countries was 36.79 years ($SD = 12.48$); specifically, the mean age of Canadian participants was 37.06 ($SD = 12.32$) and that of American participants was 36.52 ($SD = 12.66$). The sample consisted of 266 (56.8%) females and 201 (42.9%) males. As shown in Table 16, the gender balance between the two countries was largely equal. The largest group of participants (approximately a third of the total sample) reported a bachelor’s degree as their highest level of education obtained (Table 16). Furthermore, two-thirds of respondents indicated that they live in a suburban neighbourhood, and more than half reported living in a detached home, with an additional quarter of the sample living in an apartment or condominium. The average household income (before taxes) for Canadian participants who provided that information ($n = 232$) was C$75,150 ($SD = 41,230$) and for Americans ($n = 235$) it was US$67,685 ($SD = 51,187$), which translates into roughly similar income percentiles per country.29

29 Note: Income data were collected in the currency of each country, respectively, and so values presented herein are irrespective of recent changes in exchange rates. The average household income for Canadian participants translates into the roughly 70th percentile (MoneySense 2013 estimates based on Statistics Canada 2011 data), and the average household income for Americans translates into the 62nd percentile (2013 U.S. Census Bureau).
Table 16. **Demographic statistics for the overall sample and for the samples from Canada (n = 233) and the United States (n = 235)**

<table>
<thead>
<tr>
<th>Demographic Category</th>
<th>Overall</th>
<th>Canada</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>201</td>
<td>42.9%</td>
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<td>266</td>
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<td>Postgraduate</td>
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<tr>
<td>Downtown core</td>
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<tr>
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<td>148</td>
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<tr>
<td>Suburban (&gt; 2 km to city core)</td>
<td>165</td>
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<td>Rural</td>
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<tr>
<td>Apartment or condominium</td>
<td>121</td>
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<td>56</td>
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<tr>
<td>Other</td>
<td>7</td>
<td>1.5%</td>
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</table>

**Materials and Procedure**

**Pilot testing.** Twenty-five Canadian participants were recruited through Crowdflower for pilot testing. Following resolution of an initial issue with the survey link, which necessitated the exclusion of the first seven participants, data collection for the remaining 16 pilot test
participants began on November 2, 2015. Given that no further modifications were made to the survey, these 16 individuals were later included in the data analysis.

**Recruitment.** Including pilot testing, recruitment occurred between November 2 and November 27, 2015. In total, 529 participants were recruited using Crowdflower (272 from Canada and 257 from the United States). Of these participants, 61 individuals (11.5% of the initial sample) were lost to attrition, resulting in a final sample of 468 individuals (233 Canadians and 235 Americans). Participants were informed that the purpose of the study was to investigate their attitudes towards different types of vehicles. Respondents were each paid $0.75 CAD for completing the 20-minute survey and, to prevent multiple submissions from the same person, the task was restricted to accept only one response per Crowdflower ID.

Recruitment via Crowdflower is increasing among behavioural researchers. Crowdflower is similar to Mechanical Turk (MTurk), another popular recruitment method, and both of these services allow people from any country to complete small tasks online to receive a modest amount of financial compensation, or to post tasks (including surveys) for others to complete. Data collection via this method has the advantage of being inexpensive and fast. Additionally, research suggests that this type of recruitment can result in surprisingly high quality data and samples that are more representative demographically than student samples and other types of online samples (e.g., Buhrmester, Kwang, & Gosling, 2011). Furthermore, findings suggest that compensation rates do not influence data quality (e.g., Buhrmester et al., 2011), perhaps because individuals perceive their participation as a source of entertainment and a way to earn extra money rather than as a primary source of income (Paolacci et al., 2010).

**Study period.** Participants were referred to the online Qualtrics survey (see Appendices E & F). After reading the letter of information for implied consent, all participants were
presented with an introduction to the survey as well as a brief overview of four vehicle types currently on the market (i.e., GV, HEV, PHEV, and BEV). They were then asked to complete the brief environmental attitudes inventory (EAI-24) scale, which is a shortened version of a large 12-factor scale created to assess an individual’s tendency to evaluate the environment with favour or disfavour (Milfont & Duckitt, 2010). Participants indicated their agreement with each statement, along a scale from 1 (Strongly disagree) to 7 (Strongly agree). Next, each participant was randomly assigned to one of the following four conditions: pure control, benefits control, personal benefits message frame, or societal benefits message frame. Those in the pure control condition were not presented with a message frame nor were they asked to indicate their pre-existing perceived benefits of PEVs (to allow for a measure of baseline survey responses in the absence of any specific frame). Participants assigned to the benefits control condition were asked to free-associate their perceived benefits of PEV ownership without being presented with any message frame.

Participants assigned to each message-frame condition were asked to watch a video containing a condition-specific message about some potential benefits of PEVs. Those assigned to the personal benefits message frame condition watched a video in which an actor said that she is considering purchasing a PEV for the following individual benefits: reduced operating costs due to decreased fuel use; expression of identity, values, and beliefs; and, connecting with other like-minded people. These participants were then asked to indicate their agreement with each benefit listed in the video, along a scale from 1 (Strongly disagree) to 7 (Strongly agree). Next, they were asked, “Of the benefit that you agree with the most, why do you feel this way?” In contrast, participants assigned to the societal benefits message frame condition watched a video in which an actor said that she is considering purchasing a PEV for the following public benefits:
to help fight climate change by reducing GHGs; to serve as an inspiration to others; and to help reduce our dependence on petroleum. These participants were then asked to indicate their agreement with each benefit listed in the video, along a scale from 1 (Strongly disagree) to 7 (Strongly agree). Next, they were asked, “Of the benefit that you agree with the most, why do you feel this way?”

Next, participants in all four conditions indicated their purchase intention by stating how likely they would be to purchase each of four vehicle types previously presented (i.e., GV, HEV, PHEV, and BEV) as well as to participate in car-sharing within the next ten years, each on a scale ranging from 1 (Very unlikely) to 7 (Very likely). They then responded to the 15-item attitudes about PEVs scale, as described above, in which they indicated the extent to which they agreed with the items that pertained to the functional-personal, functional-societal, symbolic-personal, and symbolic-societal benefits of PEVs (see Appendix E). In addition, two quality control questions were inserted amongst these scale items (i.e., “Please select ‘neutral’ before continuing” and “Please select somewhat agree’ before continuing”). Last, participants were asked about their gender, age, education level, income, residence type and general location, and number of current registered vehicles. Participation took approximately 20 minutes.

**Pre-analysis Variable Computations**

Prior to conducting the analyses, variable indices were created for the EAI and PEV attitudes scales (see Appendix E). Of the 24 items in the EAI scale, 12 items were reverse-coded before the scale mean was computed. In addition, one of the 15 items from the PEV attitudes scale was reverse-coded before the following four subscale means were calculated: functional-

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30 Data related to car sharing was collected for use in future analyses.
personal, symbolic-personal, functional-societal, and symbolic-societal. The first two personally-relevant subscales were then averaged to yield a mean, as were the latter two societally-relevant subscales.

Furthermore, for ease of analysis, purchase intention for the two vehicle types that involve charging (i.e., PHEV and BEV) was averaged to represent mean PEV purchase intention, and the two control conditions were merged, such that the resulting three conditions were as follows: 1 (pure control and benefits control conditions), 2 (personal benefits message frame condition), and 3 (societal benefits message frame condition). However, analyses were conducted with and without the merged control conditions.

**Results**

**Descriptive Statistics**

Means and standard deviations were calculated for all key variables (Table 17). As shown in Table 17, participants across all conditions generally reported higher levels of agreement with the societally-relevant versus personally-relevant subscales. In addition, respondents generally expressed greater intentions to purchase a GV compared to a PEV. Independent samples t-tests, conducted on the EAI scale as well as the four attitude subscales and the aggregated personal and societal subscales revealed no significance differences between the scores reported by Canadian and American participants. Additional t-tests demonstrated that neither participant age, nor GV and PEV purchase intention differed between the two countries.

Of the two quality control questions, 49 participants (10.5% of the sample) failed one question and an additional 25 participants (5.3%) failed both of these questions, which indicates
that 394 (84.2% of the sample) answered both quality control questions correctly. Furthermore, results of an independent samples t-test indicated that the total number of failed quality control questions did not differ between the Canadian ($M = .18, SD = .48$) and American ($M = .24, SD = .56$) subsets of the sample, $t(466) = -1.11, ns$. The responses to the open-ended questions were scant and of poor quality, and so no further analyses were conducted on the qualitative data.

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31 These participants were retained in the subsequent analyses because condition was not associated with the number of quality control questions answered incorrectly, $F(3, 464) = .15, ns$, or with whether either quality control question was incorrectly, $F(3, 464) = .20, ns$, demonstrating that participants who failed the quality control questions were equally distributed across the four conditions.
Table 17. Descriptive statistics for control conditions (n = 237), personal benefits message frame condition (n = 111), and societal benefits message frame condition (n = 120)

<table>
<thead>
<tr>
<th></th>
<th>M</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
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<tr>
<td><strong>EAI scale</strong></td>
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<td>Control conditions a</td>
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<td>.39</td>
<td>3.17</td>
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<td>Personal benefits condition</td>
<td>4.41</td>
<td>.38</td>
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<td>.42</td>
<td>3.58</td>
<td>6.33</td>
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<td><strong>Personally-relevant subscales b</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control conditions</td>
<td>4.15</td>
<td>1.04</td>
<td>1.13</td>
<td>7.00</td>
</tr>
<tr>
<td>Personal benefits condition</td>
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<td>1.01</td>
<td>1.13</td>
<td>6.67</td>
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<td>1.05</td>
<td>1.38</td>
<td>7.00</td>
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<td><strong>Societally-relevant subscales b</strong></td>
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<td></td>
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<tr>
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<td></td>
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<td>1.00</td>
<td>7.00</td>
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<tr>
<td><strong>Likelihood of PEV purchase c</strong></td>
<td></td>
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<tr>
<td>Control conditions</td>
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<td>4.05</td>
<td>1.42</td>
<td>1.00</td>
<td>7.00</td>
</tr>
</tbody>
</table>

a Pure control condition merged with the benefits control condition.
b Average of functional and symbolic PEV attitude subscales.
c Average likelihood of purchasing a PHEV and BEV.
Reliability Analysis

The internal consistency of the 24-item EAI scale was assessed and found to be very poor (Cronbach’s $\alpha = .39$), with all items yielding poor item-total correlation values. Thus, no further analyses were conducted with this scale. The low internal consistency of this scale will be discussed below.\(^{32}\) The psychometric properties of the seven-item personally-relevant and six-item societally-relevant PEV attitude subscales were also assessed and were both found to be good (Cronbach’s $\alpha = .84$ and .80, respectively), with all items yielding good item-total correlations (Kline, 2000).

Manipulation Check

As a manipulation check, independent-sample $t$-tests were conducted to compare attitude subscale means to determine whether the message frames had the intended effect of increasing agreement with either the personal or societal benefits of PEVs. Personal subscale scores for individuals in the personal benefits condition ($M = 4.44, SD = 1.01$) did not differ from those in the societal benefits condition ($M = 4.50, SD = 1.05$), $t(229) = -.45, ns$. Likewise, societal subscale scores for individuals in the personal benefits condition ($M = 4.77, SD = .96$) did not differ from those in the societal benefits condition ($M = 4.83, SD = 1.05$), $t(229) = -.41, ns$. Therefore, despite slight differences in subscale means between these two conditions, the message frame manipulation did not significantly affect self-reported attitudes towards PEVs (which were assessed following the message framing).\(^{33}\)

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\(^{32}\) Fortunately, the EAI was only intended to serve as a covariate in the present research to control for pre-existing differences in environmental attitudes across the four conditions. Given the random assignment to conditions, however, such underlying differences in environmental attitudes were expected to be roughly equally distributed across the conditions.

\(^{33}\) Note: There was no corresponding scale to assess attitudes towards GVs.
Data Analysis

Analyses of variance (ANOVAs) were conducted to analyze differences among the conditions in the likelihood of purchasing a PEV. In addition, two planned contrasts were conducted: one to assess whether purchase intention differed between the control group and the two message frame conditions, and the other to assess whether the personal benefits and societal benefits message frame conditions had a differential impact on vehicle purchase intention.

Impact of condition on PEV purchase intention. An overall effect of message frame condition (collapsed across the two control conditions) was found on PEV purchase intention, $F(2, 465) = 3.86, p < .05$ (Figure 6). The planned contrasts revealed that the combined effect of receiving either message frame significantly increased PEV purchase intention compared to the control groups, $t(465) = 2.77, p < .01$ (one-tailed), but that intention did not differ between those who received the personal versus societal benefits message frames, $t(465) = .10, ns$ (one-tailed). Subsequent post hoc Tukey analyses further revealed that PEV purchase intention did not differ between the control conditions and the personal benefits message frame, but that those in the aggregated control condition reported significantly lower PEV purchase intention than those in the societal message frame condition, $p = .05$.

Separate analyses were then conducted for each of the two control conditions, and the overall effect of condition on PEV purchase intention was marginally significant when using the

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34 The test of homogeneity of variances revealed that the variances of the groups are not significantly different, Levene’s statistic = 2.90, ns. Also, an additional ANCOVA revealed that message frame condition still had a significant effect on PEV purchase intention after controlling for country membership, $F(2, 465) = 3.38, p < .05$.

35 Results for GV purchase intention are parallel (although in the opposite direction). Specifically, an overall effect of message frame condition (collapsed across the two control conditions) was also found on GV purchase intention, $F(2, 506) = 3.21, p < .05$. The planned contrasts revealed that the combined effect of receiving any message frame significantly decreased GV purchase intention compared to the control groups, $t(506) = -2.15, p < .05$ (one-tailed), but that intention did not differ between those who received the personal versus social benefits message frames, $t(506) = -1.36, ns$ (one-tailed).
pure control condition, $F(2, 345) = 3.07, p = .05$ (Figure 7). Again, the planned contrast comparing the pure control group to the combined message frame conditions was significant, $t(345) = 2.47, p < .05$, but the hypothesis that those in the personal benefits condition would express less interest in PEVs compared to the societal benefits condition was not supported, $t(345) = .10, ns$. However, no overall effect of condition was found on PEV purchase intention when using the benefits control condition, $F(2, 348) = 2.25, ns$, which indicates that the effect of condition on vehicle purchase intention was only true when compared to the pure control condition. 

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36 Results of an independent-samples $t$-test revealed that PEV purchase intention did not differ significantly between the pure control condition and benefits control condition, $t(235) = -.33, ns$.

37 Again, results for GV purchase intention are parallel (although in the opposite direction). Specifically, when separate analyses were conducted on each of the two control conditions, there was an overall effect of condition on GV purchase intention when using the pure control condition, $F(2, 378) = 3.64, p < .05$. Planned contrasts revealed a significant difference between the pure control and both of the message frame conditions, $t(378) = -2.34, p < .05$, but the hypothesis that those in the societal message frame condition would express lower GV purchase intention than those in the personal benefits condition was not supported, $t(378) = 1.36, ns$. However, no overall effect of condition on GV purchase intention was found when using the benefits control condition, $F(2, 379) = 1.60, ns$, which indicates again that the effect of condition on vehicle purchase intention was only true for the pure control condition. Subsequent results of an independent-samples $t$-test revealed that GV purchase intention did not differ significantly between the pure control condition and benefits control condition, $t(235) = .84, ns$. 

Figure 6. Mean PEV purchase/lease likelihood for the two control conditions (collapsed) and the two message frame conditions.

Figure 7. Mean PEV purchase/lease likelihood for each of the two control conditions and the two message frame conditions.
Discussion

This experiment evaluated the causal impact of psychological distance in messages about PEV benefits on vehicle purchase intention among Canadian and American consumers. Consistent with construal level theory (Trope & Liberman, 2003), messages were hypothesized to be most persuasive when they emphasized personal relevance (e.g., Leiserowitz, 2007; Maio & Haddock, 2007), although the current findings failed to support this hypothesis. Instead, results demonstrated that the combined effect of receiving messages emphasizing personally- and societally-relevant PEV benefits increased related purchase intentions compared to the control group, but that these message frame conditions did not have a differential effect on PEV purchase intention.

Priming Positive Associations with PEVs

Similar to a recent field experiment, which found that environmental and monetary framing conditions both increased electricity conservation intentions (Steinhorst, Klockner, & Matthies, 2015), the combined effect of the two message frame conditions in the present study increased PEV purchase intention. The lack of a differential effect of the two videos may have occurred because the message frames did not successfully increase agreement with the intended attitude subscales, as revealed by the failed manipulation check. Given that it is difficult to disentangle personal PEV benefits from societal ones, as there is considerable overlap between the two (i.e., mitigating climate change has both societal and, ultimately, personal benefits), the message frames may not have been strong enough to elicit the intended divergent effect. Future research should employ independent raters to evaluate the message frame videos beforehand to more accurately establish their construct validity, thereby increasing the likelihood of observing an effect (if one exists).
Interestingly, participants assigned to the two message frame conditions (taken together) expressed greater PEV purchase intention compared to those in the pure control condition. This finding suggests that although the prime failed to alter the intended attitude subscales, the videos perhaps increased the salience of positive aspects of PEVs, thus priming generally positive associations with these vehicles. Through priming, thinking about something (e.g., the merits of PEVs) can increase construct accessibility and change subsequent related attitudes and behaviours (e.g., PEV purchase intentions). Additional evidence for a priming effect comes from the fact that participants in the benefits control condition (i.e., who were simply asked to free-associate their perceived benefits of PEVs) also increased their PEV purchase intentions relative to those in the pure control condition. However, the fact that messages were most persuasive among participants who watched either of the two videos suggests an added influence of a social norm effect from watching the actor in the video.\(^{38}\)

To date, a large body of research has explored priming effects (see Wheeler & deMarree, 2009 for review), and has found that a wide range of behaviours can be influenced by subtle environmental stimuli. For example, Bargh, Chen, and Burrows’ (1996) seminal study showed that participants primed to think about old age (with words related to elderly stereotypes) walked more slowly down the hall after the experiment. The replicability of priming effects has come under scrutiny lately though, with several studies failing to reproduce significant effects for classic priming studies (e.g., Doyen, Klein, Pichon, & Cleeremans, 2012). Seemingly, such effects are fickle and can yield variable results, and so it is difficult to say how reliable or long-lasting the present effect may be in real life situations. More recent research has aimed to explore

\(^{38}\) A fifth condition in which participants watched both of the personal and societal benefits message framing videos was not included, and so it is unknown as to whether or not there might be a synergistic effect of being presented with these two frames together. Future research may benefit from exploring this possible additive effect.
the mechanisms that underlie such priming effects. One possibility in the current study is that the three conditions may have activated consumers’ environmental values and then influenced reported intentions to be aligned with those values. However, to assess whether this apparent priming of general positive associations about PEVs is occurring through a value-based effect, future research would need to include a measure of environmental values.

**The Central Route to Persuasion**

Alternatively, aside from a priming effect, the observed findings may be the result of a persuasion effect. Specifically, the elaboration likelihood model (Petty & Cacioppo, 1981), which has been applied to advertising and marketing, proposes two information processing routes to persuasion (i.e., attitude change) that range along a continuum from low to high elaboration: 1) the *peripheral route* involves low elaboration and occurs when the audience attends to superficial cues, and 2) the *central route* involves high elaboration and occurs when the audience processes the merit of an argument. Thus, this model can help to explain how encouraging consumers to consider the merits of PEVs can change their related attitudes and intentions. In particular, the two-step method employed in this present study required those assigned to the video message frame conditions to first watch a video and then to indicate their agreement with each of the benefits mentioned in the video. This second step was included in an effort to strengthen the potential effect of the prime, although this issue-relevant thinking may have provided more opportunity for cognitive elaboration on the benefits presented, thereby eliciting the observed effect.

**Limitations**

Given that environmental attitudes are a latent construct, existing solely in the mind, they must be assessed by indirect measures, such as self-report techniques. In the present research, the
reliability of the brief EAI-24 scale was unacceptably low. Milfont and Duckitt (2010) initially developed the EAI scale to take into account the multidimensional nature of environmental attitudes by incorporating measures of 12 factors identified to be important in previous research (e.g., Maloney & Ward, 1973; Stern & Dietz, 1994). Milfont and Duckitt (2010) established the validity and reliability of the complete EAI (with 120 items: 10 for each of 12 scales) and the short version of the “EAI-S” (with 72 items: 6 for each of 12 scales). However, the psychometric properties of the brief “EAI-24,” which consists of the two items with the highest mean-item total correlations for each of the 12 scales, have not been investigated, except for an unpublished manuscript by Milfont and Duckitt (2007). The fact that the 12 EAI scales have been shown to be unidimensional and to have high internal consistency (Milfont & Duckitt, 2010) suggests that perhaps it is not feasible to obtain adequate reliability values by assessing these disparate factors using merely two items per facet, and thus the low alpha value is not surprising given that it was a multidimensional and non-homogeneous scale. Even Milfont and Duckitt (2010) acknowledge that the large number of items in the complete EAI and EAI-S are required to sufficiently cover the 12 (comprehensive) factors.

Future research aiming to assess environmental attitudes that is unable to employ the lengthy complete EAI (or EAI-S) due to time constraints, may consider excluding scales that are not as relevant to the research at hand (e.g., such as the enjoyment of nature scale in the present research), rather than using the EAI-24. Alternatively, if the research requires the assessment of the full 12 factors, Sutton and Gyuris (2013) have developed a 37-item EAI scale with established reliability for evaluating the multidimensional nature of environmental attitudes with less response burden compared to the longer versions of the EAI.
Finally, this study employed a between-subjects design, which had the advantage of experimental ease but the disadvantage of precluding an examination of any dynamics between the impact of individual and societal benefit message frames. Therefore, an alternate possible explanation for the observed findings is that potential use of a within-subjects design – with its increased statistical power – may have revealed differences between the message framing groups.

**Conclusions**

Although more research is needed to establish the theoretical meaning of the obtained findings, this research demonstrates the importance of describing the benefits of PEVs. Indeed, regardless of whether the observed findings occurred because of a general priming effect or a persuasion effect via the elaboration likelihood model’s central route to attitude change (Petty & Cacioppo, 1981), the present findings suggest that encouraging consumers to consider the benefits of PEVs can increase subsequent purchase intentions.
CHAPTER 5

General Discussion and Conclusions

Overview

Through a series of three studies, this program of research integrated theories and methodologies from psychology, economics, policy, and marketing to offer insight into the multifactorial influences on consumer preferences for PEVs. In Study 1, a survey and stated choice experiment evaluated the influence of various PEV incentives, as well as the psychological variables from Ajzen’s (1991) TPB, on vehicle preferences among BC residents. Study 2 combined these data sources using a latent class choice model to segment consumers based on vehicle preferences, profile the demographic and psychological characteristics of each class, and explore the effect of including such variables on model fit. Study 3 extended these findings through a randomized controlled experiment conducted among Canadian and American participants, which examined the impact of psychological distance in messages about PEV benefits on vehicle purchase intention.

Taken together, obtained findings attest to the important role of personal influences (e.g., favourable attitudes towards PEVs and a high degree of perceived behavioural control over the vehicle purchase), interpersonal influences (e.g., descriptive and injunctive social norms that support PEV ownership), and contextual influences (e.g., appealing financial incentives) in facilitating a transition to PEVs. As we now discuss, these results have valuable implications for PEV policies and decision-making models, as well as for targeted marketing and communications approaches.
Implications for PEV Policies

Aggregated findings from the choice experiment highlight the powerful influence of financial factors in shaping vehicle purchase decisions, with purchase price – followed by purchase incentive amount – having the greatest impact. Consistent with the rational actor model, demand-focused PEV policies involving purchase incentives increased the attractiveness (or expected utility) of PEV purchases (e.g., Osbaldiston & Schott, 2012). Lewin’s (1951) classic three-stage model of behaviour change proposes that these interventions interrupt pre-existing consumption patterns (e.g., purchasing GVs) by increasing the appeal of a competing alternative (e.g., a PEV).

From a policy perspective, such incentives are an appealing behaviour change strategy because they can be easily implemented on a broad scale (e.g., McDonald, Keesler, Kauffman, & Schneider, 2006). Given that one applied objective of this research was to conduct a government-funded proactive policy analysis to assist with provincial policy planning, PEV new vehicle market share in BC was estimated under varying hypothetical incentive levels. A near-linear positive association was observed between monetary purchase incentive amount and PEV preference, for example, with PEV new vehicle market share forecasted to increase by 0.9%, 4.3% and 9.0% under a $1,000, $5,000 and $10,000 incentive, respectively. These findings suggest that policy measures that reduce up-front costs are invaluable in encouraging PEV market growth in BC. Obtained results were shared with contacts at the Government of BC through a report and Excel-based interactive policy simulator. Subsequent feedback indicated that these findings and proactive policy analysis tools were critical in helping to inform the design of the recently-announced new Clean Energy Vehicle Program, as well as longer-term strategies for supporting PEV uptake in BC.
The present results are consistent with Mock and Yang’s (2014) comparative PEV policy assessment across 11 major international vehicle markets (not including Canada), which revealed that subsidies such as purchase incentives and tax rebates are a powerful lever to increase PEV uptake. This observed association between the level of incentives offered per country and PEV market share is consistent across vehicle markets, with Norway, the Netherlands, and California being the world leaders in market growth. For example, in Norway – which has the highest PEV market share worldwide – a combination of approaches are employed to reduce the total relative cost of PEV ownership, including a 25% value-added tax levied on GVs but not PEVs, as well as free public parking for PEVs.

Important to note, however, is that although financial incentives can increase extrinsic (external) motivation to perform a behaviour, they run the risk of decreasing intrinsic (internal) motivation to continue performing the behaviour in the absence of the incentive (e.g., Deci & Ryan, 1980; Deci et al., 1999). Yet some research indicates that these incentives can actually promote positive attitudes towards the behaviour, thus increasing subsequent intrinsic motivation (Eisenberger & Cameron, 1996). Therefore, it is important to consider the influence of underlying mental constructs in addition to that of financial incentives.

**Implications for PEV Decision-making Models**

As already mentioned, research in this area typically assesses consumer preferences for quantitative vehicle attributes, such as battery range, by WTP (i.e., how much additional purchase price the sample is willing to pay for an additional unit of an attribute) and, based on rational choice theory, consumers are assumed to make conscious trade-offs among these attributes to maximize expected benefit. However, consumers often lack the fundamental building blocks (e.g., current fuel costs) required to objectively weigh the costs and benefits
associated with PEV ownership (e.g., Turrentine & Kurani, 2007), suggesting that they more often engage in limited economic rationality and that decisions are heavily influenced by additional variables. Despite the implicit assumption that underlying psychological constructs influence decisions, such variables are rarely included in these economic models of vehicle choice because they are assumed to be captured by the alternative-specific constant (which represents the observable portion of utility of each vehicle alternative not represented by the attributes). If psychological data is collected via a survey, it is more commonly used to provide context to economic results. And yet, explicit inclusion of environmental attitudes has been shown to significantly improve model fit (e.g., Aldrich et al., 2007), and recent choice modeling evidence suggests that greater PEV interest has been shown to be associated with environmental orientation and concern (Axsen, Bailey, & Castro, 2015; Ewing & Sarigollu, 2000; Hirdue et al., 2011).

For these reasons, the basic premise of the rational actor model has come under criticism lately (e.g., Peattie, 2010), and some research has begun to integrate additional non-economic variables into these models. With the exception of several recent studies (e.g., Axsen, Bailey, & Castro, 2015; Ewing & Sarigollu, 2000; Hirdue et al., 2011), however, there are few applications of psychological theory to consumer preferences for alternative-fuel vehicles using discrete choice models or latent class models. Attitudinal data is rarely included in class-based models, which tend to assume instead that consumer valuation of a product is equal to the sum of valuations of vehicle attributes. The TPB has been previously combined with economic models to yield improved prediction of WTP for more general environmental products (Liebe, Preisendorfer, & Meyerhoff, 2011) and, as a contribution to these efforts to expand beyond a
strictly economically rational approach, this research reported here employed a novel application of a classic theory in psychology – the TPB (Ajzen, 1991) – to vehicle choice models.

**Integrating psychological theories into traditional economic models.** Psychological variables from Ajzen’s (1991; 2005) TPB collectively predicted a considerable amount of variance (44%) in PEV purchase intentions, with attitudes, social norms, and perceived behavioural control each being uniquely and positively predictive of intentions. Thus, aside from financial considerations, consumers are more likely to purchase a PEV if they: have a favourable attitude about PEVs as well as a belief that the consequences of the purchase will be positive; believe that purchasing a PEV is normal and congruent with the expectations of important reference individuals or groups; and perceive that they can successfully carry out the actions required to purchase a PEV. In addition, consistent with previous literature, the inclusion of psychological variables improved the fit of latent class models of vehicle choice, relative to models without any additional variables as well as relative to those including only demographic variables.

The inclusion of psychological variables may enhance estimation of these models by providing a measureable representation of otherwise unobserved variables (i.e., which are typically subsumed under the catch-all of the alternative-specific constant) that influence choice (Walker & Ben-Akiva, 2002). As explained by Vij and Walker (2015), these integrated choice and (observable) latent variable models have something to add compared to standard choice models without latent variables because they allow for the identification of structural relationships between observable variables that could not be identified by a choice model without latent variables. Thus, this research provides evidence to substantiate the merit of
integrating psychological theories into traditional economic choice modeling approaches to more thoroughly account for vehicle preferences.

The psychologically-rational actor? These findings suggest that decision-makers can also be assumed to maximize utility by taking into account non-economically-rational processes. Indeed, as the name implies, the theory of planned behaviour (as well as its predecessor, the theory of reasoned action) is also a utility-maximizing approach in that it assumes behavioural actions are the result of a reasoned decision to optimize positive evaluative responses, congruence with social norms, and behavioural ease and efficacy (see Morton et al., 2011). Apparently, consumers are rational in that they seek to maximize their perceived utility by optimizing: 1) expected economic outcomes of decisions, and 2) anticipated psychological yield. In a research area largely dominated by the rational economic approach, these findings support a growing body of literature suggesting that traditional consumer decision-making models of vehicle preference should be expanded to include a more fulsome conception of underlying mental constructs. Thus, these results further suggest that relevant disciplines outside of economics, including (but not limited to) psychology, should be encouraged to contribute to apply their behavioural theories to enhance such choice models.

Implications for Targeted Marketing Approaches

According to Rogers (2003), consumers can be classified into four categories according to when they adopt a new technology: innovator, early adopter, early majority, or late majority. And yet, recent research has shown that differing motives, such as lifestyle engagement and environmental concern, underlie varying consumer interest in PEVs (e.g., Axsen, Bailey, & Castro, 2015). The research presented here classified consumers according primarily to their vehicle preferences, and the latent class choice analysis revealed the following 5-class solution:
the *GV-oriented class* (33% of the sample), *Flexible (or undetermined) preferences class* (29%), *PHEV-oriented class* (14%), *Dissatisfied with options class* (13%), and *BEV-oriented class* (11%). Identification of these preference segments, as well as the characteristics of individuals within each class, revealed important demographic and psychological differences among the classes.

Insight into the heterogeneity of consumers’ responses to incentives and the mental constructs that underpin distinct consumer classes may be useful in the development of targeted messaging strategies. Specifically, increased understanding of which consumers are, and are not, receptive to alternative vehicle technologies can inform segment-specific advertisements or information campaigns designed to ‘nudge’ consumers (see Thaler & Sunstein, 2008) towards low-carbon vehicles, rather than adopting a mono-marketing approach across potential buyers.

Although one-third of consumers were not receptive to the idea of purchasing a PEV, others appeared to be amenable to alternative vehicle technologies. Class membership was associated with age and gender, as well as with attitudes (especially those related to functional-personal PEV benefits), perceived behavioural control, and (albeit lesser so) social norms. Attitudes exerted the strongest influence on class membership, with the GV-oriented and PEV-leaning classes likely to have negative and positive attitudes, respectively, towards PEVs. Perceived behavioural control was the second-most influential psychological construct in determining class membership probabilities, where the PEV-leaning classes were most likely to have perceptions of ease and control over the vehicle purchase, whereas those with flexible (or undetermined) vehicle preferences tended to perceive a lack of ease and control over the purchase.
Findings that respondents in the GV-oriented and dissatisfied with options classes were unaffected by financial incentives can help to reduce the possibility of inefficient messaging by suggesting that PEVs advertisements should perhaps especially target younger women (as they were overrepresented in these classes). Aside from the influence of incentives, however, attitude change campaigns may nudge consumers towards a PEV purchase by emphasizing the functional-personal benefits of PEVs (e.g., saving money because of reduced operating costs). Last, individuals in the flexible class may be swayed to purchase a PEV if cost comes down because these consumers were sensitive to financial incentives but they perceived a low degree of behavioural control. The finding that perceived behavioural control was highly significant suggests that a consumer may hold positive attitudes concerning PEVs and may think that people who are important in their lives would consider buying a PEV, but might still be unlikely to buy a PEV themselves because of perceptions that they are too expensive or that PEV technology is too confusing. Therefore, messages should aim to decrease confusion regarding PEV purchases. Additionally, only the PEV-interested classes demonstrated decisions that were systematically influenced by incentives and charging station availability.

It is, however, important to take a holistic approach to interpreting the influence of the psychological data on PEV preferences because, although hybrid latent class choice models offer a valuable means to integrate psychological theories into choice models and can increase the predictive power of such models, a combination of insights gleaned through the multi-method approach is preferable given the strengths and weaknesses of each method.

**Implications for Communications Approaches**

PEVs are a “mixed good” in that they confer potential private goods (i.e., individual benefits), such as decreased operating expenses, and public goods (i.e., societal benefits), such as
decreased GHG emissions (Axsen & Kurani, 2012; Green, 1992; Heffner et al., 2007). In the present research, consumers initially reported higher levels of agreement with collective versus personal PEV benefits, although the latter were more predictive of actual PEV purchase intentions. In an attempt to disentangle the respective influences of perceptions of personal and societal PEV benefits on vehicle preferences, a subsequent controlled experiment evaluated the impact of psychological distance in messages about PEV benefits on purchase intention. Consistent with construal level theory (Trope & Liberman, 2003), messages highlighting personally-relevant PEV benefits were hypothesized to be more persuasive than those highlighting societally-relevant benefits; however, the message frames (combined) increased PEV purchase intentions relative to the control condition, but did not have a differential effect on intention. This finding may have occurred due to a priming effect of a general positive association with PEVs or a persuasion effect via the elaboration likelihood model's central route to attitude change (Petty & Cacioppo, 1981). These findings are similar to a recent field experiment in which each of an environmental and a monetary framing condition were found to increase electricity conservation intentions (Steinhorst, Klockner, & Matthies, 2015).

Given that the message frames did not have the intended effect on increasing agreement with personal or societal PEV benefits in the present research, it is still unknown whether such messages may have a differentially persuasive effect. However, this research demonstrates the beneficial effect of emphasizing any benefits of PEVs through communications (e.g., through advertisements and promotional materials).

Limitations

Despite the strengths afforded by the mixed-method approach employed in this program of research, several limitations are important to note.
**Unrealistically high estimates?** First, these studies rely exclusively on self-report data through both the choice experiment and survey. Problematically, self-reported proenvironmental behaviour can vary widely from objective behaviour (Kormos & Gifford, 2014); therefore, reported purchase intentions (i.e., “stated preference”) may not accurately reflect ultimate purchase decisions (i.e., “revealed preference”). Self-report data can be susceptible to various biases, including the social desirability bias, which refers to the tendency for participants to respond in a manner that will be viewed positively by others and thus could result in over-reporting of PEV interest or purchase intentions and under-reporting of GV purchase intentions (see Tarrant & Cordell, 1997). However, some recent research has also shown that stated preferences, assessed via discrete choice experiments, demonstrate high external validity of revealed preferences (Lancsar & Swait, 2014).

Furthermore, forecasts of future PEV adoption rates tend to be unrealistically high given that they do not take practical and functional constraints into account. To create more realistic PEV market share forecasts, recent BC PEV penetration scenarios have been conducted using a discrete choice and constraint model, involving supply-related limitations (e.g., current PEV model types and availability in dealerships) and demand-related limitations (e.g., consumer awareness and home charging access) (Axsen, Goldberg, Bailey, Kamiya, Langman, Cairns, Wolinetz, & Miele, 2015). This research found that estimated latent PEV demand would be 32% new market share by 2020 in the absence of any constraints, whereas the inclusion of the constraints dramatically reduced this forecast to only 1%.

**Static versus dynamic preferences and beliefs.** Another potential shortcoming of this research is that it presumes consumer preferences and beliefs are static, whereas in reality they are dynamic; consumers’ attitudes, perceptions, and behaviours are influenced by others in their
social networks. Previous research has shown that higher social norms are associated with more behaviour change for sustainable transportation (e.g., Kormos, Gifford, & Brown, 2015) and, in turn, that social norms change as the adoption rates increase (e.g., Axsen et al., 2009). Indeed, consumer perceptions can change over time, with the availability of new information (e.g., Calef & Goble, 2007) as well as with personal experience owning a PEV (Turrentine et al., 2011).

**Necessary software changes.** While conducting the latent class analysis, it became apparent that some software changes are necessary given that current statistical software packages are not adequately equipped to include covariates, such as demographic and psychological variables, into latent class modeling. As mentioned earlier, the Latent Gold Choice 5.0 software under-estimates standard errors in hybrid latent class choice models. These issues were circumvented in the present research through analyses of the posterior probabilities, but there remains a need for software that allows researchers to combine choice and non-choice (i.e., survey) data without these concerns related to repetition among individual-level covariates.

**Future Research**

Future research would benefit from examining additional variables beyond Ajzen’s (1991) TPB in the context of PEVs. Indeed, the TPB itself was born out of the addition of the perceived behavioural control variable to the theory of reasoned action (Ajzen & Fishbein, 1975), and so other valuable additions likely still exist. For instance, self-identity (i.e., whether a consumer views himself/herself as the sort of individual who would own a PEV) may be valuable in the context of PEVs given that it has been added to the TPB to yield improved prediction of proenvironmental behaviours, including environmental activism (Fielding, McDonald, & Louis, 2008) and recycling (White & Hyde, 2012).
In addition, given that deep GHG reductions will necessitate a shift towards vehicles that use various alternative fuels, including biofuels and hydrogen (IEA, 2015; Williams et al., 2012), future research should explore the full suite of alternative-fuel vehicles – including PEVs as well as hydrogen fuel cell and natural gas vehicles – to provide insights as to which policies may best facilitate uptake of these low-carbon vehicles. Last, future research would benefit from exploring influences on consumer preferences for car sharing and autonomous driving.

Conclusions

From an economic perspective, the main limitation of the TPB is that it excludes the cost component thought to be essential to decision-making and, from a psychological perspective, mental constructs are conspicuously missing from traditional economic choice modeling approaches. Thus, this dissertation integrated classic theories and methodological approaches from economics and psychology to provide comprehensive insight into the influences on consumer vehicle preferences, revealing that demand-focused policies as well as favourable attitudes and beliefs will interact to facilitate a transition to PEVs in Canada.

Although a global shift towards vehicles powered by alternative-fuels is widely viewed to be required for climate stabilization, and despite several waves of interest in PEVs over the past 35 years, as well as considerable advancements in battery technology and power converter costs (especially over the past ten years), PEVs have yet to make serious gains over fossil fuels (Melton, Axsen, & Sperling, in press). Indeed, PEV new market share is currently still less than 1% in most major auto markets, including Canada. However, ambitious PEV sales targets and related policies are starting to pay off: annual global PEVs sales have doubled in recent years (Cobb, 2014; IEA, 2013). Perhaps after numerous sputters and false starts, PEV technologies are
finally starting to gain traction in the market, providing hope that their rich potential to help mitigate climate change may yet be realized.
References


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Welcome to the Vehicle Choices and Attitudes Survey

This survey includes the following seven sections:
1) Overview of Vehicle Types Presented in Survey
2) Background: Electric Vehicles in BC
3) Your Vehicle Preferences: Choice Sets
4) Your Thoughts on Electric Vehicles
5) Your Future Purchase Intentions
6) Questions about Yourself

Part 1: Overview of Vehicle Types Presented in Survey

Thank you for your interest in taking the survey. In the survey, we will ask you to make purchase decisions by evaluating different kinds of vehicles and so, as background information, please read the following brief summaries of the three main types of vehicles that will be presented.

Conventional Vehicle: The internal combustion engine vehicle is the conventional vehicle most commonly seen on the road. It uses no electricity as engines in these vehicles receive their power from the combustion of a fuel (typically gasoline) with air.

Two Types of PEVs:

Plug-in Hybrid Electric Vehicle: The plug-in hybrid electric vehicle can run on electricity for a certain distance (thus it can be plugged-in and charged using electricity) but once the battery is depleted, it can also run on gasoline like a conventional vehicle. Some examples of these vehicles are the Chevrolet Volt, Toyota Prius Plug-in Hybrid, Ford C-Max Energi, and the Honda Accord Plug-in Hybrid.

(Note: Plug-in hybrid electric vehicles are different from the more-common hybrid vehicle (e.g., the Toyota Prius), which runs on gasoline using an internal combustion engine, and also uses an electric motor to improve fuel economy, but cannot be plugged into an electrical outlet.)

Battery Electric Vehicle: The battery electric vehicle, which runs solely on electricity, is powered by a battery running an electric motor, its batteries are charged by plugging into an electrical outlet. Some examples of these vehicles are the Nissan Leaf, Tesla Model S, Smart ED, Ford Focus Electric, and the Mitsubishi iMiEV.
Conventional Vehicle

Hybrid Vehicle

Plug-in Hybrid Electric Vehicle

Battery Electric Vehicle

<table>
<thead>
<tr>
<th></th>
<th>Conventional Vehicle</th>
<th>Hybrid Vehicle</th>
<th>Plug-in Hybrid Electric Vehicle</th>
<th>Battery Electric Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>Uses only gasoline</td>
<td></td>
<td>Can use gasoline and/or electricity</td>
<td>Uses only electricity</td>
</tr>
<tr>
<td>Electricity</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Part 2: Background: Electric Vehicles in BC

Thank you for reading the overview of the vehicle types that will be presented in this survey. We will now present some background information that summarizes recent initiatives related to electric vehicles in the Province of BC (BC).

To date, approximately 1,000 electric vehicles have been purchased in BC.

In BC, 93% of electricity generated is clean energy from renewable sources (mostly from hydroelectric dams). Given the environmental benefits of electifying transportation, the Province of BC, in conjunction with other agencies, has undertaken various initiatives to encourage individuals to switch to electric vehicles.

**Standard charging stations:**
Recently, there has been much focus on establishing a province-wide network of electric vehicle charging stations. To date, over 500 *standard charging stations* (which have 220V outlets, with a plug like the one used by a stove, that can fully charge an electric vehicle in six to eight hours) have been installed across BC. This infrastructure is thought to be an important step in providing electric vehicle drivers with sufficient access to charging while away from home.

**Fast charging stations:**
In addition, *fast charging stations* are being built across the province to help facilitate longer-duration driving along major routes using only electricity. These stations can fully charge an electric vehicle in 10-30 minutes.

**Purchase Incentives:**
The Clean Energy Vehicles (CEV) for BCTM Point of Sale Incentive Program was implemented by the Province to encourage adoption of alternative vehicles, including electric vehicles, within BC. This program allowed car buyers, or those obtaining a 36-month lease, to receive a rebate on the pre-tax sticker price of eligible vehicles at the time of sale. The program has currently reached its threshold for the time being.
Part 3: Your Vehicle Preferences: Choice Sets

1. You will be asked to select the vehicle that you most prefer by clicking on the relevant box to indicate your preference. Please note that you cannot change your selection once it has been made. After selecting your preferred vehicle, the next choice set will appear.

2. Then you will be asked to select the vehicle you most prefer of the remaining two vehicles, and afterwards that option will also turn grey.

3. For each choice set, you will be given the option to indicate whether you would actually NOT purchase any of the vehicles presented.

After reviewing these three questions for each choice set, click ‘Next’. On each new page, you will be presented with a similar table with the same type of attributes, but the features of the vehicles will change, and you will be asked to indicate your preference for each new set of descriptions. There will be 10 of these. The features will change for each choice set, and so please read all features carefully before making a selection.
### Sample choice set A.

<table>
<thead>
<tr>
<th></th>
<th>Conventional Vehicle</th>
<th>Plug-in Hybrid Electric Vehicle</th>
<th>Battery Electric Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price</td>
<td>$24,500</td>
<td>$34,000</td>
<td>$33,000</td>
</tr>
<tr>
<td>Estimated annual fuel costs</td>
<td>$2,300</td>
<td>$1,400</td>
<td>$520</td>
</tr>
<tr>
<td>Estimated annual emissions</td>
<td>2,800 kg CO2</td>
<td>2,000 kg CO2</td>
<td>2,816 kg CO2</td>
</tr>
<tr>
<td>Standard recharge time/refuel time</td>
<td>10 min</td>
<td>3.5 hr.</td>
<td>4 hr.</td>
</tr>
<tr>
<td>Range on battery only</td>
<td>Not applicable</td>
<td>75 km</td>
<td>160 km</td>
</tr>
<tr>
<td>Incentive for purchase or lease</td>
<td>$0</td>
<td>$5,000</td>
<td>$0</td>
</tr>
<tr>
<td>Other financial incentives</td>
<td>None</td>
<td>7% PST tax rebate</td>
<td>7% PST tax rebate</td>
</tr>
<tr>
<td>Home charging station rebate</td>
<td>Not applicable</td>
<td>$0</td>
<td>$500</td>
</tr>
<tr>
<td>Additional incentives</td>
<td>None</td>
<td>None</td>
<td>Free parking downtown</td>
</tr>
<tr>
<td>Fast charging station availability</td>
<td>Not applicable</td>
<td>All highways</td>
<td>All highways</td>
</tr>
</tbody>
</table>

Which would you MOST likely choose?

- [ ]
- [ ]
- [ ]

### Sample choice set B.

<table>
<thead>
<tr>
<th></th>
<th>Conventional Vehicle</th>
<th>Plug-in Hybrid Electric Vehicle</th>
<th>Battery Electric Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price</td>
<td>$24,500</td>
<td>$34,000</td>
<td>$33,000</td>
</tr>
<tr>
<td>Estimated annual fuel costs</td>
<td>$2,300</td>
<td>$1,400</td>
<td>$520</td>
</tr>
<tr>
<td>Estimated annual emissions</td>
<td>2,800 kg CO2</td>
<td>2,000 kg CO2</td>
<td>2,816 kg CO2</td>
</tr>
<tr>
<td>Standard recharge time/refuel time</td>
<td>10 min</td>
<td>3.5 hr.</td>
<td>4 hr.</td>
</tr>
<tr>
<td>Range on battery only</td>
<td>Not applicable</td>
<td>75 km</td>
<td>160 km</td>
</tr>
<tr>
<td>Incentive for purchase or lease</td>
<td>$0</td>
<td>$5,000</td>
<td>$0</td>
</tr>
<tr>
<td>Other financial incentives</td>
<td>None</td>
<td>7% PST tax rebate</td>
<td>7% PST tax rebate</td>
</tr>
<tr>
<td>Home charging station rebate</td>
<td>Not applicable</td>
<td>$0</td>
<td>$500</td>
</tr>
<tr>
<td>Additional incentives</td>
<td>None</td>
<td>None</td>
<td>Free parking downtown</td>
</tr>
<tr>
<td>Fast charging station availability</td>
<td>Not applicable</td>
<td>All highways</td>
<td>All highways</td>
</tr>
</tbody>
</table>

Which would you MOST likely choose?

- [ ]
- [ ]
- [ ]

Which of the remaining options would you MOST likely choose?

- [ ]

If you would not purchase any of these three vehicles, please check this box. □
Part 4: Your Thoughts on Electric Vehicles

Thank you for completing the choice sets to indicate your vehicle preferences. We will now ask you some questions related to your thoughts about electric vehicles.

PEV Attitude Scale

Please respond to the following questions, thinking specifically about purchasing an electric vehicle (either a plug-in hybrid electric vehicle or a battery electric vehicle). For each question below, please indicate the extent to which you agree or disagree, along a scale from 1 (Strongly disagree) to 7 (Strongly agree).

<table>
<thead>
<tr>
<th>Statements</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owning an electric vehicle would suit my daily life and routine.</td>
<td></td>
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<tr>
<td>Purchasing an electric vehicle would NOT be an effective way to improve air quality.</td>
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<td>Owning an electric vehicle is a status symbol.</td>
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<td>Driving an electric vehicle would allow me to express my identity, values, and beliefs.</td>
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<tr>
<td>Owning an electric vehicle would help reduce our dependence on petroleum.</td>
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<tr>
<td>People who drive electric vehicles are sending a message to the government, as well as to automotive and oil companies.</td>
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<tr>
<td>Driving an electric vehicle would help me to connect with other like-minded people.</td>
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<tr>
<td>Electric vehicles can be as pleasurable to drive as a conventional vehicle.</td>
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<tr>
<td>I am concerned about the environmental impact of the batteries in electric vehicles, including manufacturing and disposal.</td>
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<tr>
<td>Purchasing an electric vehicle would be an effective way to help fight climate change by reducing greenhouse gas emissions.</td>
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</tr>
<tr>
<td>Electric vehicles can be as visually appealing as a conventional vehicle.</td>
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<td></td>
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</tr>
<tr>
<td>The purchase price of electric vehicles is too high.</td>
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<td></td>
</tr>
<tr>
<td>I find the idea of reduced operating costs (due to decreased fuel use with an electric vehicle) very appealing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The types of electric vehicles currently available do NOT suit my transportation needs.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individuals who choose to drive electric vehicles are an inspiration to others.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Social Norms Scale**

Please respond to the following questions, thinking specifically about purchasing an electric vehicle (i.e., either a plug-in hybrid electric vehicle or a battery electric vehicle). For each question below, please indicate the extent to which you agree or disagree, along a scale from 1 *(Strongly disagree)* to 7 *(Strongly agree)*.

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

**Statements:**
- Many of my family and friends *expect me to buy* an electric vehicle.
- In general, those closest to me *would approve of me purchasing* an electric vehicle.
- Many of the people who are important to me *would consider purchasing* an electric vehicle.
- In general, those closest to me *think that more people should buy* an electric vehicle.
- Many of my family and friends own a fuel-efficient vehicle (i.e., either an efficient internal combustion engine, hybrid, or electric vehicle).

**Perceived Behavioural Control Scale**

Please respond to the following questions, thinking specifically about purchasing an electric vehicle (i.e., either a plug-in hybrid electric vehicle or a battery electric vehicle). For each question below, please indicate the extent to which you agree or disagree, along a scale from 1 *(Strongly disagree)* to 7 *(Strongly agree)*.

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

**Statements:**
- It would be *financially feasible* for me to purchase an electric vehicle.
- If I wanted to, I could *easily purchase* an electric vehicle.
- The type of vehicle I purchase is mostly *within my control*.
- It would be *more difficult* for me to buy an electric vehicle than a conventional vehicle.
- It would be too confusing to figure out which type of electric vehicle to purchase.
### Part 5: Your Future Purchase Intentions

For the following questions, please think about your purchase intentions for your next vehicle, and indicate how likely you will be to purchase each type of vehicle.

<table>
<thead>
<tr>
<th></th>
<th>Very unlikely</th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

How likely will you be to purchase an **internal combustion engine vehicle** as your next vehicle?

*The internal combustion engine vehicle is the conventional vehicle most commonly seen on the road.*

How likely will you be to purchase a **hybrid vehicle** as your next vehicle?

*The hybrid vehicle* (e.g., the Toyota Prius) runs on gasoline using an internal combustion engine, but it also uses an electric motor and small battery to improve fuel economy. Hybrid vehicles cannot be plugged into an electrical outlet.

How likely will you be to purchase a **plug-in hybrid electric vehicle** as your next vehicle?

*The plug-in hybrid electric vehicle* (e.g., the Chevrolet Volt) combines characteristics of the internal combustion engine, hybrid-electric vehicle, and battery electric vehicle. It can run on electricity for a certain distance and, once the battery is depleted, it can run on gasoline or another bio-source fuel, like a conventional vehicle.

How likely will you be to purchase a **battery-electric vehicle** as your next vehicle?

*The battery electric vehicle* (e.g., the Nissan Leaf) is powered by a battery
running an electric motor. Its batteries are charged by plugging into an electrical outlet.

Please indicate how many years from now your household will purchase each of the following types of vehicles. Please tick one time period for each vehicle, or indicate that you are not planning to purchase that type of vehicle.

<table>
<thead>
<tr>
<th>Purchase Time Horizon</th>
<th>Internal Combustion Engine Vehicle</th>
<th>Hybrid Vehicle</th>
<th>Electric Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not planning to purchase this type of vehicle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 months from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 year from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 years from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 years from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 years from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 years from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5 years from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 years from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.5 years from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years from now</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 5 years</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

How much do you expect to spend on your next vehicle? __________

******

Part 6: Questions about Yourself

Thank you for sharing your thoughts about electric vehicles. To finish the survey, we will ask you some general demographic questions about yourself and your household. The information you provide in this section will be used only for descriptive purposes. Your responses are anonymous and confidential, and cannot be used to identify you personally.

1. What is your gender? [Please select one]
   - Male
   - Female
   - Other
2. What age category do you fall into?
   - Less than 29 years
   - 30 - 39 years
   - 40 - 49 years
   - 50 – 59 years
   - 60 – 69 years
   - 70 years and more

3. Please indicate the highest level of education you have completed. [Please select one]
   - Elementary/Middle School Graduate (grades 1 – 8)
   - High School Graduate (grades 9 – 12)
   - Some post-secondary education
   - College, Diploma, or Trade Certification
   - Bachelor’s Degree
   - Graduate, Post-doctoral, or Professional Degree

4. Please indicate the category that best describes the area in which you live. [Please select one]
   - Downtown core
   - Suburban near downtown (less than 2 kms to city core)
   - Suburban farther from downtown (more than 2 kms to city core)
   - Rural

5. Please indicate your approximate household income in the last full year before taxes. [Please select one]
   - Less than $25,000
   - $25,000-$50,000
   - $50,000-$75,000
   - $100,000-$125,000
   - $125,000 or more

6. Please indicate which of the following best describes your household: [Please select one]
   - Single-person household
   - Couple with no children or dependents
   - One-parent family with children or dependents
   - Couple with children or dependents
   - Group household (i.e., shared but not family)

7. Please indicate your total household size (i.e., how many adults and children live in your household, including yourself): [Please select one]
   - 1
   - 2
   - 3
   - 4
   - 5 or more
8. Please indicate the number of registered vehicles in your household, including your own:
   1
   2
   3
   4 or more

9. Please indicate which of the following best describes your principal residence.
   Single-family detached home
   Semi-detached home (e.g., townhouse or duplex)
   Apartment or condominium
   Other (e.g., houseboat, mobile home, etc.)

10. What is your average number of kilometres driven per weekday (i.e., including commuting plus any evening driving)? ________

11. What is your average number of kilometres driven per day on the weekend? ________

12. Please estimate the total number of extra kilometres driven per year as part of occasional or unusual trips (e.g., vacations): __________

This is the end of the survey. Thank you for participating in the survey - we really appreciate your time and input! If you have any comments concerning the survey, such as those that may help us to improve future surveys, please type them in the box below.
Welcome to the Vehicle Choices and Attitudes Survey

This survey includes the following seven sections:

1) Letter of Information for Implied Consent
2) Overview of Vehicle Types Presented in Survey
3) Background: Electric Vehicles in British Columbia
4) Your Vehicle Preferences: Choose Sets
5) Your Thoughts on Electric Vehicles
6) Your Future Purchase Intentions
7) Questions about Yourself.

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1) Letter of Information for Implied Consent

You are invited to participate in a study that examines vehicle choices and attitudes. This study is being conducted by Christine Kornes, as part of her PhD in the Department of Psychology at the University of Victoria, and the research is supervised by Dr. Robert Gifford. If you have any questions about this research, you may contact Christine Kornes (kornesciv@uvic.ca, 250-885-2844 or Dr. Gifford (gifford@uvic.ca, 250-825-2323).

Purpose and Objectives: This project aims to investigate the decision making processes of prospective car buyers in British Columbia. Participating takes approximately 15-20 minutes, and you will be compensated in accordance with the amounts stated in your Panel. For this research, we hope to better understand the influence of various financial incentives, personal characteristics, and attitudes on one's choices.

Participant Selection: You have been selected to participate in the research according to your Panel's standard recruiting procedures and because you meet the eligibility criteria for this study (i.e., you are a British Columbia resident in the market to purchase a new vehicle). Your Panel has selected you to participate in the study on behalf of winning a research consulting company affiliated with Dr. Twiskhof, who is also conducting this project. As a member of the Panel, the data you submit will be kept confidential. However, if you choose to withdraw from the survey, you will be linked to the study's website server and your fully anonymized data will be stored on that server, not on your Panel's server.

What if I withdraw? If you agree to voluntarily participate in this research, you will be presented with a series of choices involving these vehicles, and you will be asked to indicate which vehicle you prefer and second most, as well as whether you will actually purchase any of the vehicles presented. There are no specific rules associated with participating in this study, but it is recommended that you complete the survey within one week of receiving the invitation from your Panel.

Benefits and Potential Risks: Participation in this study may provide benefits to yourself, including financial compensation and recognition in the survey with the option to withdraw from the study. However, participation in this study will not affect your vehicle purchase.

Compensation: As a way to compensate you for any inconvenience related to your participation, you will be compensated in accordance with the amounts stated in your invitation from your Panel. If you agree to participate in this study, you will be asked to provide compensation to you, which may not exceed $20. It is unlawful to provide undue compensation to researchers in this field. You may withdraw at any time by simply closing the page in your web browser.

Voluntary Participation: Your participation is voluntary and you may withdraw at any time without any consequences or any explanation. In the event that you do withdraw, your data will be deleted from the database. You can withdraw at any time by simply closing the page in your web browser.

Anonymity and Confidentiality: Your anonymity will be protected because no identifying information will be associated with your data. Any personal information you provide will be kept confidential and can only be accessed by the researchers. Please note that the information you provide will be stored on a server in the U.S. Therefore, even though the information will be protected with security safeguards, the data may be subject to access under the U.S. Patriot Act. Your Panel's data is encrypted and data from the survey will be stored in four different secure databases. The data collected is not associated with the data submitted to the study or the researcher. This information will be used only for research purposes and will not be shared with any third-party service providers.

Dissemination of Results: Upon completion of the survey, the aggregate results of the study will be shared with others through a PhD dissertation summaries.
2) Overview of Vehicle Types Presented in Survey

Thank you for your interest in taking the survey. In the survey, we will ask you to make purchase decisions by evaluating different kinds of vehicles and so, as background information, please read the following brief overview of the three main types of vehicles that will be presented.

**Conventional Vehicle:** The internal combustion engine vehicle is the conventional vehicle most commonly seen on the road. It uses no electric motors or engines in these vehicles receive their power from the combustion of a fuel (typically gasoline) with air.

**Plug-In Hybrid Electric Vehicle:** Throttling in electric hybrid vehicles can run on electricity for a certain distance (this can be plugged in and charged using electricity, but once the battery is depleted, it can also run on gasoline like a conventional vehicle. Some examples of plug-in hybrids are the Chevrolet Volt, Ford Fusion/Prius Hybrid, Ford C-Max/Energi, and the Honda Accord Plug-in hybrid.

**Battery Electric Vehicle:** The battery electric vehicle, which runs solely on electricity, is powered by a battery containing an electric motor. Its batteries are charged by plugging into an electrical outlet. Some examples of these vehicles are the Nissan Leaf, Tesla Model S, Smart ED, Ford Focus Electric, and the Mitsubishi iMiEV.

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**Conventional Vehicle:** Cannot use only gasoline. 
**Plug-In Hybrid Electric Vehicle:** Can use gasoline only as an auxiliary. 
**Battery Electric Vehicle:** Cannot use gasoline at all.
3) Background: Electric Vehicles in British Columbia

To date, approximately 1,000 electric vehicles have been purchased in BC.

In BC, 97% of electricity generated is clean energy from renewable sources, primarily from hydroelectric dams. Given the environmental benefits of electricity-powered transportation, the Province of BC, in conjunction with other agencies, has undertaken various initiatives to encourage individuals to switch to electric vehicles.

**Instant charging stations:**
Recently, there has been much focus on establishing a province-wide network of electric vehicle charging stations. To date, over 100 instant charging stations (which have 300V outlets, a plug like the one used by a stove, that can fully charge an electric vehicle in one hour) have been installed across BC. This infrastructure is thought to be an important step in providing electric vehicle drivers with sufficient access to charging while away from home.

**Fast charging stations:**
In BC, fast charging stations are being built across the province to help facilitate long-distance driving along major routes along with only electricity. These stations can fully charge an electric vehicle in 10-30 minutes.

**Purchase incentives:**
The Clean Energy Vehicle (CEV) for BC™ Point of Sale Incentive Program was implemented by the Province to encourage adoption of alternative vehicles, including electric vehicles, within BC. The program allowed for a maximum of 35% of purchase or lease incentives (at the time of sale) for eligible vehicles. The program has now reached its maximum for the time being.

---

4) Your Vehicle Preferences: Choice Sets

Thank you for answering the background information. On the following pages, you will be presented with 10 different choice sets that each describe various attributes of vehicles that might influence your purchase decisions.

Each choice set contains two vehicle types (previously described) - conventional combustion engine vehicle, plug-in hybrid electric vehicle, and battery electric vehicle. Please think about the attributes which:

- **ONLY differ in how they are powered (i.e., and not in terms of style, cargo space, type of vehicle),
- are new cars.

The features of the vehicles will change with each different choice set, but the details presented are based on plausible assumptions about yearly driving based on 20,000 km driven per year costs, and emissions.

Please imagine that you are getting serious about purchasing a new vehicle as you read over the following vehicle descriptions in the choice set. You will be asked to pick your preference for all the following 10 features for each vehicle (although not all the information provided may be relevant, or of interest, to you).

- **Reported as kilograms of carbon dioxide (kg CO2):**
- **Estimated annual fuel costs (dollars per year):**
- **Estimated annual emissions (kg CO2):**
- **Standard recharge time (minutes):**
- **Range on battery only (km):**
- **Incentive for purchase or lease (dollars):**
- **Other financial incentives:**
- **Home-charging station-eligible:**
- **Additional incentives:**
- **Fast charging station availability:**

Please note that some vehicles (i.e., greenhouses gas emitters) are also relevant to battery electric vehicles because of emissions from producing electricity at the power plant. As a point of reference, 1,000 kg of CO2 would be produced by an average conventional car driven for 30 hours non-stop, or on part of the energy used by an average house for 90 days.
Please note that emissions (i.e., greenhouse gas emissions) are also relevant to battery electric vehicles because of emissions from producing electricity at the power plant. As a point of reference, 1,000 kg of CO2 would be produced by an average conventional car driven for 30 hours round trip, or as part of the energy used by an average house for 28 days.

Also note that a typical residential charging station costs between $1,000 - $2,200 to purchase and install.

For the 10 choice sets on the following pages:

1) First, you will be asked to select the vehicle that you most prefer by clicking arrows in the relevant box to indicate your preference. (Please note that you cannot change your selection once it has been made.) After selecting your preferred vehicle, that selection will turn grey.

2) Then you will be asked to select the vehicle you most prefer of the remaining two vehicles, and afterwards that option will turn grey.

3) Last, for each choice set, you will be given the option to indicate whether you would actually NOT purchase any of the vehicles presented.

After answering these three questions for each choice set, click ‘Next’. On each new page, you will be presented with a similar table with the same types of vehicles, but the features of the vehicles will change, and you will be asked to indicate your preferences for each new set of alternatives. There will be 10 of these. The features will change for each choice set, and so please read all features carefully before making a selection.

Which would you MOST likely choose?
<table>
<thead>
<tr>
<th></th>
<th>Conventional Vehicle</th>
<th>Plug-in Hybrid Electric Vehicle</th>
<th>Battery Electric Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price</td>
<td>$24,500</td>
<td>$42,000</td>
<td>$31,000</td>
</tr>
<tr>
<td>Estimated annual fuel costs</td>
<td>$1,010</td>
<td>$2,030</td>
<td>$3,300</td>
</tr>
<tr>
<td>Estimated annual emissions</td>
<td>3,100 lb CO2</td>
<td>2,800 lb CO2</td>
<td>2,800 lb CO2</td>
</tr>
<tr>
<td>Standard recharge intermittent time</td>
<td>10 hr</td>
<td>5 hr</td>
<td>10 hr</td>
</tr>
<tr>
<td>Range on battery only</td>
<td>75 km</td>
<td>55 km</td>
<td>55 km</td>
</tr>
<tr>
<td>Incentive for purchase of lease</td>
<td>0</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Other financial incentives</td>
<td>None</td>
<td>7% PST tax rebate</td>
<td>$10,000 zero-interest loan</td>
</tr>
<tr>
<td>Home charging station rebate</td>
<td>None</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Additional Incentives</td>
<td>None</td>
<td>Use of HOV lanes during high traffic times</td>
<td>Use of HOV lanes during high traffic times</td>
</tr>
<tr>
<td>Fast charging station availability</td>
<td>None</td>
<td>None</td>
<td>Some major highways</td>
</tr>
</tbody>
</table>

Which would you MOST likely choose? ☒
Which of the remaining options would you MOST likely choose?  □

If you would not purchase any of these three vehicles, please check this box. □
1) Choice Set 1 of 10

<table>
<thead>
<tr>
<th>Feature</th>
<th>Conventional Vehicle</th>
<th>Plug-in Hybrid Electric Vehicle</th>
<th>Battery Electric Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchase price</td>
<td>$24,000</td>
<td>$22,000</td>
<td>$31,000</td>
</tr>
<tr>
<td>Estimated annual fuel costs</td>
<td>$1,000</td>
<td>$715</td>
<td>$390</td>
</tr>
<tr>
<td>Estimated annual emissions</td>
<td>0.15 kg CO2</td>
<td>0.84 kg CO2</td>
<td>2.932 kg CO2</td>
</tr>
<tr>
<td>Standard recharge time</td>
<td>12 hr</td>
<td>3.5 hr</td>
<td>10 hr</td>
</tr>
<tr>
<td>Range on battery only</td>
<td>Not applicable</td>
<td>75 km</td>
<td>50 km</td>
</tr>
<tr>
<td>Incentive for purchase or lease</td>
<td>$50</td>
<td>$100</td>
<td>$0</td>
</tr>
<tr>
<td>Other financial incentives</td>
<td>None</td>
<td>2% PTT tax rebate</td>
<td>$10,000 zero interest loan</td>
</tr>
<tr>
<td>Home charging station rebate</td>
<td>Not applicable</td>
<td>None</td>
<td>$0</td>
</tr>
<tr>
<td>Additional incentives</td>
<td>None</td>
<td>None</td>
<td>Use of HOV lanes during high traffic hours</td>
</tr>
<tr>
<td>Fast charging station availability</td>
<td>Not applicable</td>
<td>None</td>
<td>Some major highways</td>
</tr>
</tbody>
</table>

Which would you MOST likely choose?  
Which of the remaining options would you MOST likely choose?  
If you would not purchase any of these three vehicles, please check this box.

5) Your Thoughts on Electric Vehicles

Thank you for completing the choice sets to indicate your vehicle preferences. We will now ask you some questions related to your thoughts about electric vehicles.

Please respond to the following questions, thinking specifically about purchasing an electric vehicle (either a plug-in hybrid electric vehicle or a battery electric vehicle).

For each question below, indicate the extent to which you agree or disagree, using a scale from 1 (Strongly disagree) to 7 (Strongly agree).

- Owning an electric vehicle would suit my daily life and routines
- I am concerned about the environmental impact of the batteries in electric vehicles, including manufacturing and disposal
- Most of my family and friends expect me to buy an electric vehicle
- Electric vehicles can be as pleasurable to drive as a conventional vehicle
- It would be financially feasible for me to purchase an electric vehicle
- In general, those close to me would approve of me purchasing an electric vehicle
- Purchasing an electric vehicle would be an effective way to help fight climate change by reducing greenhouse gas emissions

[Further questions and answers]
Please respond to the following questions, thinking specifically about purchasing an electric vehicle (either a plug-in hybrid electric vehicle or a battery electric vehicle).

For each question below, please indicate the extent to which you agree or disagree, using a scale from 1 (completely disagree) to 7 (strongly agree).

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Question</th>
<th>Agree/Disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>In general, these changes in my life that more people should buy an electric vehicle</td>
<td>Disagree</td>
</tr>
<tr>
<td>Owning an electric vehicle would help me to connect with other like-minded people</td>
<td>Disagree</td>
</tr>
<tr>
<td>If I wanted to, I could easily purchase an electric vehicle</td>
<td>Disagree</td>
</tr>
<tr>
<td>People who drive electric vehicles are sending a message to the government, as well as to automobiles and oil companies</td>
<td>Disagree</td>
</tr>
<tr>
<td>The type of vehicle I purchase is mostly within my budget</td>
<td>Disagree</td>
</tr>
<tr>
<td>This type of electric vehicle currently available do NOT suit my transportation needs</td>
<td>Disagree</td>
</tr>
<tr>
<td>Individuals who choose to drive electric vehicles are an imposition to others</td>
<td>Disagree</td>
</tr>
<tr>
<td>Many of my family and friends expect me to buy an electric vehicle</td>
<td>Disagree</td>
</tr>
<tr>
<td>Electric vehicles can be as pleasurable to drive as a conventional vehicle</td>
<td>Disagree</td>
</tr>
<tr>
<td>It would be financially feasible for me to purchase an electric vehicle.</td>
<td>Disagree</td>
</tr>
<tr>
<td>In general, those closest to me would approve of my purchasing an electric vehicle</td>
<td>Disagree</td>
</tr>
</tbody>
</table>
People who drive electric vehicles are sending a message to the government, as well as to automakers and oil companies.  

This type of vehicle I purchase is mostly within my control.  

The types of electric vehicles currently available do NOT suit my transportation needs.  

Individuals who choose to drive electric vehicles are an inspiration to others.  

Strongly Agree | Neither Agree nor Disagree | Strongly Disagree
1 | 2 | 3 | 4 | 5 | 6 | 7

Many of my family and friends own a fuel-efficient vehicle (i.e., either an efficient internal combustion engine, hybrid, or electric vehicle).  

Owning an electric vehicle would help reduce our dependence on petroleum.  

Driving an electric vehicle would allow me to express my identity, values, and beliefs.  

It would be more difficult for me to buy an electric vehicle than a conventional vehicle.  

Please check the number that on the scale below you are likely to purchase the next vehicle.  

Purchasing an electric vehicle would NOT be an effective way to improve air quality.  

Owning an electric vehicle is a status symbol.  

Department of Psychology  
University of Victoria  
WebStimuli www.webstimuli.com

6) Your Future Purchase Intentions

For the following questions, please think about your purchase intentions for your next vehicle, and indicate how likely you will be to purchase each type of vehicle.

<table>
<thead>
<tr>
<th>Very Likely</th>
<th>Very Unlikely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

How likely will you be to purchase a conventional vehicle as your next vehicle?

The overall cost of ownership for a conventional vehicle is on the rise.

How likely will you be to purchase a hybrid vehicle as your next vehicle?

How likely will you be to purchase a plug-in hybrid electric vehicle as your next vehicle?

How likely will you be to purchase a battery electric vehicle as your next vehicle?

Please select the type of vehicle that your household is planning to purchase.

- Conventional Vehicle
- Hybrid Vehicle
- Plug-in Hybrid Electric Vehicle
- Battery Electric Vehicle
- Other Type of Vehicle
1) What is your gender?
- Male
- Female
- Other

2) Which age category applies to you?
- Less than 20 years
- 20-39 years
- 40-49 years
- 50-59 years
- 60-69 years
- 70 years or more

3) Please indicate the highest level of education you have completed:
- Elementary/Kindergarten to Grade 8
- High School Graduates (grades 9-12)
- Some Post-Secondary Education
- College/University or Trade Certification
- Bachelor's Degree
- Master's, Post-doctoral, or Professional Degree

4) Which category best describes the area in which you live?
- Downtown core
- Suburban near downtown (less than 2 kms to city core)
- Residential further from downtown (more than 2 kms to city core)
- Rural

5) Please indicate your approximate household income in the last full year before taxes
- Less than $25,000
1. Which category best describes your age?
   - 20-29 years
   - 30-39 years
   - 40-49 years
   - 50-59 years
   - 60-69 years
   - 70 years and more

2. Please indicate the highest level of education you have completed.
   - Elementary / Middle School Education (grades 1-8)
   - High School Education (grades 9-12)
   - Some Post-Secondary Education
   - College Diploma, or Trade Certification
   - Bachelor’s Degree
   - Graduate, Professional, or Professional Degree

3. Which category best describes the area in which you live?
   - Downtown core
   - Suburban near downtown (less than 3 km to city core)
   - Suburban farther from downtown (more than 3 km to city core)
   - Rural

4. Please indicate your approximate household income in the last full year before taxes.
   - Less than $25,000
   - $25,000 - $45,000
   - $45,000 - $75,000
   - $75,000 - $100,000
   - $100,000 - $125,000
   - $125,000 or more

5. Which of the following best describes your household?
   - Single person household
   - Couple with no children or dependents
   - One parent family with children or dependents
   - Couple with children or dependents
   - Group household (e.g., shared housing, roommates)

6. Please indicate which of the following best describes your principal residence.
   - Single-detached home
   - Semi-detached home (e.g., two-family or duplex)
   - Apartments or condominium
   - Other (specify:  houseboat, mobile home, etc.)

7. Do you rent or own your principal residence?
   - Rent
   - Own

8. How many registered vehicles are there in your household, including your own?
   - 0
   - 1
   - 2
   - 3 or more

9. What is your average number of kilometers driven per weekday (i.e., including commuting plus any evening driving)?

10. What is your average number of kilometers driven per day on the weekend?

11. Please estimate the total number of extra kilometers driven per year as part of occasional or unusual trips (e.g., vacations).

12. Do you have any comments related to the survey that you would like to share, such as your thoughts about electric vehicles or feedback about the survey questions themselves? (Optional)
6. Please indicate which of the following best describes your principal residence:
   - Single-detached home
   - Semi-detached home (e.g., townhouse or duplex)
   - Apartment or condominium
   - Other (e.g., houseboat, mobile home, etc.)

5. Do you rent or own your principal residence?
   - Rent
   - Own

10. How many registered vehicles are there in your household, including your own?
    - 0
    - 1
    - 2
    - 3
    - 4 or more

11. What is your average number of kilometres driven per week (i.e., including commuting plus any evening driving)?

12. What is your average number of kilometres driven per day on the weekend?

13. Please estimate the total number of extra kilometres driven per week as part of occasional or unusual trips (e.g., vacations).

14. Do you have any comments related to the survey that you would like to share, such as your thoughts about electric vehicles or feedback about the survey questions themselves? (optional)

Thank you for your participation!

Please CLICK HERE to register your participation with your Panel.

Your responses will be an important part of a PhD dissertation on vehicle preferences and attitudes of prospective car buyers in BC. With this research, we hope to better understand the influence of various financial incentives, personal characteristics, and attitudes on vehicle choice. In addition, results from this study will be shared with the Province of BC to help inform decision making regarding potential future changes to the electric vehicle incentive program.

If you have any questions about this research, you may contact Christine Kerris (ckerris@uvic.ca, 250-651-2064) or Dr. Robert Ghisellini (rggisellini@uvic.ca, 250-721-1632).

We gratefully acknowledge the financial support of the Province of British Columbia.
Appendix B – Ethics Approval and Renewal for Studies 1 & 2

Subject: Approval of Ethics Application - Kormos 13-501
From: "Jeta Rugova-Plakolli, Human Research Ethics Office" <ethics@uvic.ca>
Date: Thu, January 16, 2014 11:21 am
To: "ckormos@uvic.ca" <ckormos@uvic.ca>
Cc: "Robert Gifford" <rgifford@uvic.ca> (more)
Priority: Normal
Options: View Full Header | View Printable Version | Download this as a file

Dear Christine Kormos,

Your application for ethics approval entitled 'The Influence of Financial Incentives and Psychological Constructs from the Theory of Planned Behaviour on Electric Vehicle Preference Using Discrete Choice Modeling' has been approved and assigned Protocol Number 13-501.

As per federal regulations, ethics protocols are approved for a one-year period only. If you need to maintain ethics approval beyond 15-Jan-15, please submit a 'Request for Annual Renewal' form prior to the expiry date. As a reminder, we will email you about six weeks before your protocol expires with a request for your renewal submission or your project completion details.

You may begin your research and will receive your certificate of approval via regular mail.

Good luck with your study.

Jeta Rugova-Plakolli
Human Research Ethics | University of Victoria | Administrative Services Building B202 | Victoria, BC | Canada
Tel: 250-472-4545 | Fax: 250-721-8960 | http://www.research.uvic.ca | E-mail: ethics@uvic.ca

This email message may contain confidential information and is intended only for the individual named. If you have received this email by mistake, please notify the sender immediately and delete the email from your system. Further unauthorized distribution is prohibited and is contrary to University computing policy.
Certificate of Renewed Approval

PRINCIPAL INVESTIGATOR: Christine Kormos

UVic STATUS: Ph.D. Student

UVic DEPARTMENT: PSYC

SUPERVISOR: Dr. Robert Gifford

ETHICS PROTOCOL NUMBER: 13-501

Minimal Risk - Delegated

ORGINAL APPROVAL DATE: 16-Jan-14

RENEWED ON: 21-Jan-15

APPROVAL EXPIRY DATE: 15-Jan-16


RESEARCH TEAM MEMBERS: Committee Members: Dr. Anthony Marley (UVic), Dr. Curran Crawford (UVic), Dr. Towhidul Islam (External, University of Guelph/INNOVAOR8)
Survey Hosting/Programming (Innovation): Paul Ma, Poh Tan

DECLARED PROJECT FUNDING: Clean Energy Vehicles Program (BC Ministry of Environment); NSERC Grant (Dr. Anthony Marley)

CONDITIONS OF APPROVAL

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.

[Signature]

Dr. Rachael Scarth
Associate Vice-President Research Operations

Certificate Issued On: 21-Jan-15
Appendix C - Coefficient Estimates for 5-class Model

<table>
<thead>
<tr>
<th>Membership probability</th>
<th>GV-oriented</th>
<th>Flexible</th>
<th>PHEV-leaning</th>
<th>Dissatisfied</th>
<th>BEV-leaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>GV constant</td>
<td>5.98***</td>
<td>4.71***</td>
<td>2.42***</td>
<td>-0.06</td>
<td>5.05***</td>
</tr>
<tr>
<td>PHEV constant</td>
<td>2.05**</td>
<td>3.00***</td>
<td>3.40***</td>
<td>-1.60***</td>
<td>4.15***</td>
</tr>
<tr>
<td>BEV constant</td>
<td>0.23</td>
<td>2.20***</td>
<td>2.05***</td>
<td>-1.36**</td>
<td>5.57***</td>
</tr>
<tr>
<td>Purchase price</td>
<td>-0.73***</td>
<td>-0.65***</td>
<td>-0.49***</td>
<td>-0.32***</td>
<td>-0.48***</td>
</tr>
<tr>
<td>Annual fuel costs</td>
<td>-0.22**</td>
<td>-0.07*</td>
<td>-0.21***</td>
<td>-0.18**</td>
<td>-0.22***</td>
</tr>
<tr>
<td>Annual emissions</td>
<td>-0.12</td>
<td>0.00</td>
<td>-0.21**</td>
<td>-0.16*</td>
<td>-0.19**</td>
</tr>
<tr>
<td>Battery range</td>
<td>-0.02</td>
<td>0.15**</td>
<td>0.08</td>
<td>0.15</td>
<td>0.18*</td>
</tr>
<tr>
<td>Incentive for purchase or lease</td>
<td>0.16</td>
<td>0.21***</td>
<td>0.40***</td>
<td>0.13</td>
<td>0.30***</td>
</tr>
<tr>
<td>Other financial incentives</td>
<td>-0.07</td>
<td>0.01</td>
<td>-0.13*</td>
<td>-0.07</td>
<td>0.09</td>
</tr>
<tr>
<td>Additional incentives</td>
<td>-0.10</td>
<td>-0.11*</td>
<td>-0.12</td>
<td>0.02</td>
<td>-0.18**</td>
</tr>
<tr>
<td>Fast charging station availability</td>
<td>0.06</td>
<td>0.12*</td>
<td>0.19**</td>
<td>0.16</td>
<td>0.15*</td>
</tr>
</tbody>
</table>

Note: * p < .05, ** p < .01, *** p < .001. n = 413. Also, parameter values per class obtained from choice analysis using the effect coded ASCs and with the attributes entered using the experimental design and coded as numeric for the 5-class solution (i.e., given that it was found to be ideal when using the effect coded attributes in the initial latent class analysis). Using Standard (Hessian) standard errors.
Appendix D - Coefficient Estimates for 5-class Model, Including the Covariates and Attitude Subscales

<table>
<thead>
<tr>
<th>Membership probability</th>
<th>Wald</th>
<th>Wald(=)</th>
<th>.33</th>
<th>.29</th>
<th>.14</th>
<th>.13</th>
<th>.11</th>
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</thead>
<tbody>
<tr>
<td><strong>Discrete Choice Model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GV constant</td>
<td>766.68***</td>
<td>253.51***</td>
<td>5.92***</td>
<td>4.76***</td>
<td>2.44***</td>
<td>-0.10</td>
<td>5.00***</td>
</tr>
<tr>
<td>PHEV constant</td>
<td>232.49***</td>
<td>76.44***</td>
<td>2.11**</td>
<td>3.04***</td>
<td>3.26***</td>
<td>-1.66***</td>
<td>4.15***</td>
</tr>
<tr>
<td>BEV constant</td>
<td>151.62***</td>
<td>75.53***</td>
<td>0.18</td>
<td>2.25***</td>
<td>1.87***</td>
<td>-1.46**</td>
<td>5.52***</td>
</tr>
<tr>
<td>Purchase price</td>
<td>448.55***</td>
<td>17.86**</td>
<td>-0.71***</td>
<td>-0.65***</td>
<td>-0.51***</td>
<td>-0.34***</td>
<td>-0.46***</td>
</tr>
<tr>
<td>Annual fuel costs</td>
<td>38.75***</td>
<td>5.78</td>
<td>-0.21*</td>
<td>-0.07*</td>
<td>-0.21***</td>
<td>-0.17*</td>
<td>-0.22***</td>
</tr>
<tr>
<td>Annual emissions</td>
<td>25.63***</td>
<td>10.70*</td>
<td>-0.13</td>
<td>0.00</td>
<td>-0.19**</td>
<td>-0.16*</td>
<td>-0.19**</td>
</tr>
<tr>
<td>Battery range</td>
<td>17.85**</td>
<td>1.52</td>
<td>-0.03</td>
<td>0.01*</td>
<td>0.16**</td>
<td>0.10</td>
<td>0.15*</td>
</tr>
<tr>
<td>Incentive for purchase or lease</td>
<td>75.50***</td>
<td>7.41</td>
<td>0.14</td>
<td>0.20***</td>
<td>0.40***</td>
<td>0.15</td>
<td>0.33***</td>
</tr>
<tr>
<td>Other financial incentives</td>
<td>6.51</td>
<td>6.35</td>
<td>-0.05</td>
<td>0.01</td>
<td>-0.13*</td>
<td>-0.05</td>
<td>0.12*</td>
</tr>
<tr>
<td>Additional incentives</td>
<td>15.10**</td>
<td>2.40</td>
<td>-0.12</td>
<td>-0.12*</td>
<td>-0.11</td>
<td>0.01</td>
<td>-0.18**</td>
</tr>
<tr>
<td>Fast charging station availability</td>
<td>20.46***</td>
<td>1.61</td>
<td>0.03</td>
<td>0.12*</td>
<td>0.20**</td>
<td>0.18*</td>
<td>0.13*</td>
</tr>
<tr>
<td><strong>Class Membership Model</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>5.65</td>
<td>0.13*</td>
<td>-0.06</td>
<td>-0.06</td>
<td>0.09</td>
<td>0.09</td>
<td>-0.10</td>
</tr>
<tr>
<td>Gender</td>
<td>5.94</td>
<td>-0.32</td>
<td>-0.24</td>
<td>-0.19</td>
<td>0.32</td>
<td>0.44</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>4.58</td>
<td>-0.15*</td>
<td>-0.01</td>
<td>0.06</td>
<td>-0.09</td>
<td>0.19</td>
<td></td>
</tr>
<tr>
<td>Household income</td>
<td>0.40</td>
<td>0.00</td>
<td>0.03</td>
<td>-0.03</td>
<td>-0.03</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Social norms scale</td>
<td>2.68</td>
<td>-0.10</td>
<td>0.04</td>
<td>0.20</td>
<td>-0.17</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Perceived behavioural control</td>
<td>9.43</td>
<td>-0.09</td>
<td>-0.22**</td>
<td>0.17*</td>
<td>-0.06</td>
<td>0.19*</td>
<td></td>
</tr>
<tr>
<td>Symbolic personal</td>
<td>3.89</td>
<td>-0.05</td>
<td>-0.16</td>
<td>0.22</td>
<td>0.10</td>
<td>-0.11</td>
<td></td>
</tr>
<tr>
<td>Symbolic societal</td>
<td>4.87</td>
<td>-0.19*</td>
<td>0.05</td>
<td>-0.05</td>
<td>0.16</td>
<td>0.03</td>
<td></td>
</tr>
<tr>
<td>Hedonic</td>
<td>1.53</td>
<td>0.02</td>
<td>0.07</td>
<td>-0.10</td>
<td>-0.08</td>
<td>0.08</td>
<td></td>
</tr>
<tr>
<td>Functional societal</td>
<td>2.28</td>
<td>-0.05</td>
<td>-0.05</td>
<td>0.13</td>
<td>-0.16</td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>25.80***</td>
<td>-0.60***</td>
<td>-0.14</td>
<td>0.29*</td>
<td>-0.12</td>
<td>0.56**</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>----------</td>
<td>----------</td>
<td>-------</td>
<td>--------</td>
<td>-------</td>
<td>--------</td>
<td></td>
</tr>
</tbody>
</table>

Note: Number of individuals $n = 413$.

Note: *$p < .05$, **$p < .01$, ***$p < .001$. Also, parameter values-per class obtained from choice analysis with the attributes entered using the experimental design and coded as numeric for the 5-class solution (i.e., given that it was found to be ideal when using the effect coded attributes in the initial latent class analysis). Note that the class membership component of the model was performed using the experimental design attributes. Using Standard (Hessian) standard errors.
Appendix E – Survey for Study 3

Overview of Vehicle Types Presented in Survey

Thank you for your interest in taking the survey. In the survey, we will ask you to make purchase decisions by evaluating different kinds of vehicles and so, as background information, please read the following brief summaries of the three main types of vehicles that will be presented.

**Conventional Vehicle:** The internal combustion engine vehicle is the conventional vehicle most commonly seen on the road. It uses no electricity as engines in these vehicles receive their power from the combustion of a fuel (typically gasoline) with air.

**Two Types of PEVs:**

**Plug-in Hybrid Electric Vehicle:** The plug-in hybrid electric vehicle can run on electricity for a certain distance (thus it can be plugged-in and charged using electricity) but once the battery is depleted, it can also run on gasoline like a conventional vehicle. Some examples of these vehicles are the Chevrolet Volt, Toyota Prius Plug-in Hybrid, Ford C-Max Energi, and the Honda Accord Plug-in Hybrid.

(Note: Plug-in hybrid electric vehicles are different from the more-common hybrid vehicle (e.g., the Toyota Prius), which runs on gasoline using an internal combustion engine, and also uses an electric motor to improve fuel economy, but cannot be plugged into an electrical outlet.)

**Battery Electric Vehicle:** The battery electric vehicle, which runs solely on electricity, is powered by a battery running an electric motor, its batteries are charged by plugging into an electrical outlet. Some examples of these vehicles are the Nissan Leaf, Tesla Model S, Smart ED, Ford Focus Electric, and the Mitsubishi iMiEV.

<table>
<thead>
<tr>
<th></th>
<th>Conventional Vehicle</th>
<th>Hybrid Vehicle</th>
<th>Plug-in Hybrid Electric Vehicle</th>
<th>Battery Electric Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gasoline</strong></td>
<td>Uses only gasoline</td>
<td></td>
<td>Can use gasoline and/or electricity</td>
<td>Uses only electricity</td>
</tr>
<tr>
<td><strong>Electricity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Brief Version of the Environmental Attitudes Inventory (Milfont & Duckitt, 2010)**
Please read each statement below and indicate the strength of your agreement with it along a scale from 1 (Strongly disagree) to 7 (Strongly agree). As with all of the questions in the survey, there is no right or wrong answer; we are curious to know your opinions whatever they may be.

*(Note: In the actual survey, the presentation order of these items was randomized.)*

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>I really like going on trips into the countryside, for example to forests or fields.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2.</td>
<td>I think spending time in nature is boring. (R)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3.</td>
<td>Governments should control the rate at which raw materials are used to ensure that they last as long as possible.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>4.</td>
<td>I am opposed to governments controlling and regulating the way raw materials are used in order to try and make them last longer. (R)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>5.</td>
<td>I would like to join and actively participate in an environmentalist group.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>6.</td>
<td>I would NOT get involved in an environmentalist organization. (R)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>7.</td>
<td>One of the most important reasons to keep lakes and rivers clean is so that people have a place to enjoy water sports.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>8.</td>
<td>We need to keep rivers and lakes clean in order to protect the environment, and NOT as places for people to enjoy water sports. (R)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>9.</td>
<td>Modern science will NOT be able to solve our environmental problems. (R)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>10.</td>
<td>Modern science will solve our environmental problems.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>11.</td>
<td>Humans are severely abusing the environment.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>12.</td>
<td>I do not believe that the environment</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
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<td>---</td>
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<td>---</td>
</tr>
<tr>
<td>13.</td>
<td>I'd prefer a garden that is wild and natural to a well groomed and ordered one. (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>I'd much prefer a garden that is well groomed and ordered to a wild and natural one.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>I am NOT the kind of person who makes efforts to conserve natural resources. (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16.</td>
<td>Whenever possible, I try to save natural resources.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17.</td>
<td>Human beings were created or evolved to dominate the rest of nature.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>I DO NOT believe humans were created or evolved to dominate the rest of nature. (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>Protecting peoples' jobs is more important than protecting the environment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>Protecting the environment is more important than protecting peoples' jobs. (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>It makes me sad to see forests cleared for agriculture.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>It does NOT make me sad to see natural environments destroyed. (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>Families should be encouraged to limit themselves to two children or less.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>Please select “Somewhat agree” before continuing.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>A married couple should have as many children as they wish, as long as they can adequately provide for them. (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Condition-dependent Message Frames

Pure control condition:

*Participants assigned to the pure control condition will not be presented with a message frame nor will they be asked to indicate any of their perceived benefits of PEVs.*

Benefits control condition:

*Participants assigned to the benefits control condition will not be presented with a message frame, but they will be asked the following question:* 

People who chose to purchase PEVs (i.e., plug-in hybrid electric vehicles and battery electric vehicles) do so for a variety of reasons. What do you think are some of the main benefits of owning a PEV (please list as many as come to mind)?

______________________________________________________________________________
______________________________________________________________________________
___________________________________________________

Personal benefits condition:

Please watch the following short video before continuing with the survey.

Approximate script for the video: “I’ve been thinking a lot lately about buying an electric vehicle – I’m still looking into different options, but I’m leaning towards maybe a Chevy Volt or a Nissan Leaf. I like the idea of saving money on fuel costs. It also would be a good fit with who I am and would be a way for me to express my environmental values, and to connect with similar-minded people.”

People who chose to purchase a PEV may do so for a variety of reasons. For example, some consumers, like the one in this video, may be drawn to PEVs because of benefits to themselves. To what extent do you agree with each of the following three potential individual benefits mentioned in the video?

*(Note: In the actual survey, the presentation order of these items was randomized.)*

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PEVs can reduce operating costs due to decreased fuel use.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>2. PEVs can serve as an expression of identity, values, beliefs, and status.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>3. PEVs can facilitate connections with other like-minded people.</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Of the benefit that you agree with the most, why do you feel this way?

______________________________________________________________________________
______________________________________________________________________________
____________________________________

Societal benefits condition:
Please watch the following short video before continuing with the survey.

Approximate script for the video: “I’ve been thinking a lot lately about buying an electric vehicle – I’m still looking into different options, but I’m leaning towards maybe a Chevy Volt or a Nissan Leaf. I like the idea of reducing our reliance on petroleum and also of doing my part to help fight climate change. It also would be a good way to inspire other drivers to consider making the switch to an EV.”

People who chose to purchase a PEV may do so for a variety of reasons. For example, consumers, like the one in this video, may be drawn to PEVs because of benefits to society. To what extent do you agree with each of the following three potential public benefits mentioned in the video?

(Note: In the actual survey, the presentation order of these items was randomized.)

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. PEVs can help to fight climate change by reducing greenhouse gas emissions</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2. PEVs can serve as an inspiration to others</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3. PEVs can help to reduce our dependence on petroleum</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

Of the benefit that you agree with the most, why do you feel this way?

______________________________________________________________________________
______________________________________________________________________________
## Future Vehicle Purchase Questions

For the following questions, please indicate how likely you will be to purchase or partake in each of the following **within the next ten years**.

*Note: In the actual survey, the presentation order of these items was randomized.*

<table>
<thead>
<tr>
<th></th>
<th>Very unlikely</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th>Very likely</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How likely will you be to purchase an internal combustion engine (i.e., conventional gas) vehicle?</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

*The internal combustion engine vehicle is the conventional vehicle most commonly seen on the road.*

| 2. How likely will you be to purchase a hybrid vehicle? | ○ | ○ | ○ | ○ | ○ | ○ |

*The *hybrid vehicle* (e.g., the Toyota Prius) runs on gasoline using an internal combustion engine, but it also uses an electric motor and small battery to improve fuel economy. Hybrid vehicles cannot be plugged into an electrical outlet.*

| 3. How likely will you be to purchase a plug-in hybrid electric vehicle? | ○ | ○ | ○ | ○ | ○ | ○ |

*The *plug-in hybrid electric vehicle* (e.g., the Chevrolet Volt) combines characteristics of the internal combustion engine, hybrid-electric vehicle, and battery electric vehicle. It can run on electricity for a certain distance and, once the battery is depleted, it can run on gasoline or another bio-source fuel, like a conventional vehicle.*

| 4. How likely will you be to purchase a battery-electric vehicle? | ○ | ○ | ○ | ○ | ○ | ○ |

*The *battery electric vehicle* (e.g., the Nissan Leaf) is powered by a battery running an electric motor. Its batteries are charged by plugging into an electrical outlet.*

| 5. How likely will you be to participate in carsharing? | ○ | ○ | ○ | ○ | ○ | ○ |

*Carsharing (e.g., Zipcar) is a type of short-term (often by the hour) car rental that allows people to have occasional access to a vehicle or a different type of vehicle than they use daily.*
Attitudes Scale

Please respond to the following questions, thinking specifically about purchasing an electric vehicle (either a plug-in hybrid electric vehicle or a battery electric vehicle) and indicate the extent to which you agree or disagree with each question.

(Note: In the actual survey, the presentation order of these items was randomized and the subscale titles were removed.)

<table>
<thead>
<tr>
<th></th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Somewhat disagree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat agree</th>
<th>Agree</th>
<th>Strongly agree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functional-societal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Purchasing an electric vehicle would be an effective way to help fight climate change by reducing greenhouse gas emissions.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>2. Purchasing an electric vehicle would be an effective way to improve air quality.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>3. Owning an electric vehicle would help reduce our dependence on petroleum.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>4. I am concerned about the environmental impact of the batteries in electric vehicles, including manufacturing and disposal.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td><strong>Symbolic-societal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Individuals who choose to drive electric vehicles are an inspiration to others.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>6. People who drive electric vehicles are sending a message to the government, as well as to automotive and oil companies.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td><strong>Functional-personal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>7. The purchase price of electric vehicles is reasonable.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>8. I find the idea of reduced operating costs (due to decreased fuel use with an electric vehicle) very appealing.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>9. The types of electric vehicles currently available suit my transportation needs.</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
Owning an electric vehicle would suit my daily life and routine.

Driving an electric vehicle would allow me to express my identity, values, and beliefs.

Owning an electric vehicle is a status symbol.

Please select “Somewhat disagree” before continuing.

Driving an electric vehicle would help me to connect with other like-minded people.

---

**Symbolic-personal**

**Demographic Questions**

Please provide the following information about yourself. Your answers to these questions are anonymous and confidential, and cannot be used to identify you personally.

1. **Sex:**
   - Male
   - Female
   - Prefer not to disclose

2. **Birth year:** 19 _ _

3. **Highest educational level completed:**
   - Grade school or some high school
   - High school graduate
   - Some university/college
   - University/college graduate
   - Some graduate school
   - Masters, doctoral, or professional degree

4. In the last full year, what was your household income before taxes? (optional) $______

5. **Type of area in which your residence is located, in your opinion:**
6. Number of registered vehicles in your household: ______

7. Which of the following best describes your dwelling?

- Detached house
- Semi-detached house (e.g., townhouse, etc.)
- Apartment or condominium
- Other (e.g., houseboat, etc.)

This is the end of the survey. Thank you for your interest in participating - we really appreciate your time and input!

If you have any questions or comments concerning the survey, please type them in the box below.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________
Appendix F – Ethics Approval for Study 3

Certificate of Approval

<table>
<thead>
<tr>
<th>Principal Investigator:</th>
<th>Christine Kormos</th>
<th>Ethics Protocol Number: 15-242</th>
</tr>
</thead>
<tbody>
<tr>
<td>UVic Status:</td>
<td>Ph.D. Student</td>
<td></td>
</tr>
<tr>
<td>UVic Department:</td>
<td>PSYC</td>
<td></td>
</tr>
<tr>
<td>Supervisor:</td>
<td>Dr. Robert Gifford</td>
<td></td>
</tr>
<tr>
<td>Original Approval Date:</td>
<td>20-Aug-15</td>
<td></td>
</tr>
<tr>
<td>Approved On:</td>
<td>20-Aug-15</td>
<td></td>
</tr>
<tr>
<td>Approval Expiry Date:</td>
<td>19-Aug-16</td>
<td></td>
</tr>
</tbody>
</table>

Project Title: Individual versus societal benefits of plug-in electric vehicles: A comparison of message frames

Research Team Members: Dr. Anthony A.J. Marley (UVic), Dr. Curran Crawford (UVic)
Student/Research Assistant: Kyle Weatherby

Declared Project Funding: NSERC (under Dr. Anthony Marley)

Conditions of Approval

This Certificate of Approval is valid for the above term provided there is no change in the protocol.

Modifications
To make any changes to the approved research procedures in your study, please submit a "Request for Modification" form. You must receive ethics approval before proceeding with your modified protocol.

Renewals
Your ethics approval must be current for the period during which you are recruiting participants or collecting data. To renew your protocol, please submit a "Request for Renewal" form before the expiry date on your certificate. You will be sent an emailed reminder prompting you to renew your protocol about six weeks before your expiry date.

Project Closures
When you have completed all data collection activities and will have no further contact with participants, please notify the Human Research Ethics Board by submitting a "Notice of Project Completion" form.

Certification

This certifies that the UVic Human Research Ethics Board has examined this research protocol and concluded that, in all respects, the proposed research meets the appropriate standards of ethics as outlined by the University of Victoria Research Regulations Involving Human Participants.

Rachael Scarth
Dr. Rachael Scarth
Associate Vice-President Research Operations

Certificate Issued On: 20-Aug-15
Appendix G – Formula for Multinomial Logit Model (Study 1)

Choice set has $J$ options. For $i = 1, \ldots, J$, 

$$\text{Prob}(\text{choice} = i) = \frac{\exp(a_i + \beta'x_i)}{\sum_{j=1}^{J} \exp(a_j + \beta'x_j)}$$

where

$\text{Prob}(\text{choice} = i)$ is probability that respondent chooses alternative $i$ (i.e., GV, PHEV, BEV),

$\beta'$ is a vector of parameters (to be estimated),

and $x_i$ = is a vector of attribute values for alternative $i$ (e.g., purchase price and battery range).