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Analysis

Social influence and consumer preference formation for pro-environmental technology: The case of a U.K. workplace electric-vehicle study

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ABSTRACT

We investigate the roles of social influence in the formation of consumer perceptions and preferences for pro-environmental technologies, using the example of battery electric vehicles (BEVs). The context was a technology-based workplace in the U.K. with around 500 members of staff, 57 of whom took part in a BEV experience project in 2010. Several months later, we recruited a diverse sample of 21 staff to complete semi-structured interviews. Following a multi-method approach, we elicited details about their perceptions and valuation of BEVs, experiences with BEVs, and social interactions relating to BEVs. Participants reported a wide variety of perceptions of BEV attributes, including environmental benefits and functional drawbacks. The majority of participants indicated that their BEV perceptions were "highly influenced" by at least one social interaction. We use the reflexive layers of influence conceptual framework to categorize social influence according to three processes: diffusion, the sharing of BEV-related information; translation, the discussion of uncertain BEV benefits and drawbacks; and reflexivity, the relating of BEV technology to self-concept. Findings suggest that participant perceptions change in part through social negotiation of meaning, lifestyle and identity. Neglect of social influence processes will underestimate the potential for shifts in consumer preferences regarding emerging pro-environmental technologies.

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1. Introduction

The success of emerging pro-environmental technologies and products ultimately depends on consumer perceptions, preferences and valuation. Neoclassical economic models continue to dominate research on consumer choices, representing consumers as "rational individuals" that make deliberative decisions to maximize their individual satisfaction (utility) based on perfect information. However, behavioral economics, psychology, sociology and other fields provide many empirical and theory-based critiques of, and alternatives to, such idealized rational actor models (Jackson, 2005; Peattie, 2010; Shove, 2010; Wilson and Dowlatabadi, 2007). This paper focuses on the notion of consumer preference formation regarding pro-environmental technologies, critiquing the neoclassical assumption that consumer choices are guided by pre-formed, static preferences. In particular, we explore the role of social influence in consumer preference formation.

Social influence can be defined as occurring when an individual's thoughts, feelings or actions are affected by other people. More precisely, we focus on interpersonal influence (as opposed to structural or institutional influence). At least in the case of emerging pro-environmental technologies, such as battery electric vehicles (BEVs), consumers tend not to have pre-existing preferences for novel attributes that they have not previously experienced or thought about, such as nearly silent electric-powered driving with no tailpipe emissions (Caperello and Kurani, 2012; Kurani et al., 1994). Instead, some preferences are constructed in the moment, in the process of facing novel choice sets (Bettman et al., 1998; Norton et al., 1998), and such constructed preferences tend to be based on more abstract construals than established preferences for conventional consumer products (Liberman et al., 2007). Further, these perceptions, preferences, and related "controversies" are often negotiated among individuals and social groups (Axsen and Kurani, 2012a; Kline and Pinch, 1996). This social influence is typically drawn on by consumers seeking to establish meaning for novel products (Wood and Hayes, 2012).

We presently explore social influence and preference formation in the context of a BEV demonstration project implemented at a U.K. workplace in 2010. Drawing from respondents to a screener survey of 191 members of staff at this workplace, we conduct semi-structured interviews with a sub-sample of 21 participants. These interviews collected quantitative and qualitative data to explore two primary research questions:

1. What are participants' perceptions, preferences and controversies (uncertainties) regarding BEVs?

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2. How are these perceptions and preferences shaped through processes of social influence?

We offer three main contributions to the fields of sustainable consumption and ecological economics. First, we elicit and categorize consumer perceptions and controversies relating to BEVs in this case study. Second, we apply a novel conceptual framework (which we call reflexive layers of influence) that accounts for three distinct processes of social influence relating to consumer perceptions, drawing from Axsen and Kurani (2012a,b). Third, to apply this conceptual framework, we follow a multi-method approach that integrates complementary qualitative and quantitative research tools. Content and narrative analyses identify consumer perceptions relating to BEVs, in addition to processes of social influence that shaped these perceptions. A discrete choice model provides a more aggregated perspective of consumer perceptions (or preferences), which vary by consumer "lifestyle." Finally, a statistical regression teases out aggregated patterns in the observed processes of social influence. Although we follow a purposive selection technique to ensure that our interview sample includes a wide range of participants, we are careful not to inappropriately generalize our results to other contexts. That said, results from this case generally support the notion that consumer preferences for emerging pro-environmental technologies are indeed constructed, and in many cases are formed through social interactions.

2. Behavioral Theory

2.1. Electric Vehicles as a Pro-environmental Product

We presently focus on electric vehicles as an example of emerging pro-environmental technology. Electric vehicles represent a spectrum of emerging vehicle technologies powered by electricity drawn from the electrical grid. There are two broad categories of EVs. Plug-in hybrid vehicles can be powered by grid electricity for an initial distance, say 10 to 40 miles, but are otherwise powered by an internal combustion engine running on petrol (gasoline) or diesel until the battery is recharged. In contrast, battery electric vehicles (BEVs) are powered solely by electricity for a range of 75 to 150 miles (longer range BEVs do exist but are presently less typical and more expensive) and require regular recharging to operate because they have no internal combustion engine. The present study focuses on a workplace BEV experience project.

Of course, there are many other contexts for pro-environmental decision making including, for example, other alternative fuel vehicles (e.g., hydrogen fuel-cell and biofuel powered vehicles), transit use, cycling, household heating and lighting, low-energy appliances, residential solar panels, and the purchase and use of other "green" consumer products. These purchases or practices may follow very different conditions such as frequency (i.e., daily, weekly, or once every few years), size of financial investment, technical novelty and uncertainty, as well as social visibility and likelihood of connection to personal identity (Shove and Warde, 2002). Considering the diversity of behavioral contexts, we are careful not to generalize our present exploratory results of BEV valuation to all other consumer contexts. At the same time, however, we feel that our chosen BEV case study does provide a useful context to explore the general idea of social influence and consumer preference formation — which may help to guide future research on this topic.

2.2. Consumer Perceptions and Preferences

To aid in the analysis of consumers' perspectives, we present a two-by-two attribute typology that distinguishes types of consumer perceptions: functional vs. symbolic, and private vs. societal (Axsen and Kurani, 2012a). Most technical and economic studies focus on the private-functional aspects of pro-environmental technologies. For example, studies of BEVs typically focus on the technology's tendency to reduce fuel and operation costs or to limit driving range and increase refueling/recharging time relative to conventional vehicles (e.g., Hidrue et al., 2011; Potoglou and Kanaroglou, 2007) — in other words, functional benefits or limitations that affect the individual. Pro-environmental technologies can also offer private-symbolic benefits by conveying a different social meaning than previous products (Hirschman, 1981; Steg, 2005), such as intelligence, responsibility (Heffner et al., 2007), or personality (Skippon and Garwood, 2011). In addition to these "private" attributes, pro-environmental technologies can be novel in that they may offer societal-functional benefits. BEVs offer reduced air pollution, greenhouse gas emissions and energy security, or encourage others to think of and act on such issues (societal-symbolic benefits). We employ the term "societal" as a broad category of collective benefits, including environmental benefits and other regional or national benefits such as increased energy security. Consumer perceptions of private, societal, functional and symbolic attributes can substantially change over time through experience with the technology, social interactions, and development of the technology itself (Axsen and Kurani, 2012a).

Depending on discipline and perspective, market research varies by focus on these attribute categories, as well as orientation towards individual versus social aspects of these perceptions. For example, the rational actor model utilized in neoclassical economics depicts consumers as optimizing, deliberative, autonomous and typically isolated, selecting behaviors from a choice set in order to maximize individual utility according to exogenous, static preferences. Such individual-focused models have been prevalent in alternative-fuel vehicle market research over the last three decades (Bunch et al., 1993; Hidrue et al., 2011; Potoglou and Kanaroglou, 2007; Train, 1980). Some recent advancements attempt to incorporate social factors into such models through parameters representing aggregated preference changes (Axsen et al., 2009; Mau et al., 2008), information search channels (van Rijnsoever et al., 2009), and social network position (Paez et al., 2008). However, such aggregations do not yield insight into specific processes of interpersonal influence.

In contrast, social models of consumption explicitly represent the "social embeddedness" of consumer behavior and decision-making (Jackson, 2005), looking at individuals acting as part of a household, community and social network (Peattie, 2010). Applications of social models to pro-environmental market research are rare, but can yield very important and novel insights regarding the formation of preferences relating to symbolic and societal aspects of the technology. Examples include explorations of symbolism in the hybrid vehicle market (Heffner et al., 2007), social influence in driver evaluations of plug-in hybrid vehicles (Axsen and Kurani, 2012a), and the social construction of wind power (Jolivet and Heiskanen, 2010), residential energy behavior (Galis and Gyberg, 2011; Lovell, 2009) and air conditioning use (Hitchings, 2011). Empirical research suggests that perceptions of the societal attributes of pro-environmental technologies are particularly prone to social negotiation, at least in the context of alternative-fuel vehicles (Axsen and Kurani, 2011). A more complete review of social influence perspectives is provided by Axsen and Kurani (2012b).

Presently, we seek to account for individual and social aspects of consumer preferences for BEVs, including the roles of interactions with other individuals, as well as media and other sources of information. In this effort, we look at the formation of BEV perceptions and preferences, as well as the uncertainty and potential dynamics of those preferences.

2.3. A Conceptual Framework: Reflexive Layers of Influence (RLI)

This study utilizes the reflexive layers of influence (RLI) framework. RLI was developed based on social theory and empirical insight regarding processes of social influence relating to consumer valuation of pro-environmental behaviors (Axsen and Kurani, 2010). The RLI framework identifies and integrates three processes of influence pertaining to new

products: diffusion, translation, and reflexivity. Respectively, these processes describe increasingly complex forms of social interaction, ranging from communicating awareness of the product to integrating the product's perceived benefits into lifestyle and self-concept (Axsen and Kurani, 2012a,b). Here, we summarize those three processes in turn.

Diffusion describes interpersonal influence as being transmitted through the flow of functional information among individuals. This process is relatively simple, where awareness or functional information flows in a particular direction or pattern based on consumer-based categories (Rogers, 2003) or social network structure (Borgatti et al., 2009; Valente, 2005). For example, Rogers' (2003) diffusion of innovations (DOI) model focuses on "innovators" (members of the first group to adopt an idea) and "early adopters" (members of the second) who diffuse information to later consumers ("early majority", "late majority" and "laggards"). Diffusion can also be intentionally coordinated by a critical mass of organized, motivated, and resourceful individuals seeking to sustain widespread societal action (Marwell et al., 1988; Oliver et al., 1985). Diffusion-based models have been previously applied to many products, including residential heating systems (Noonan et al., 2013), cycling (Goetzke and Rave, 2011) and green buildings (Kahn and Vaughn, 2009).

The second process in the RLI framework, translation, represents the negotiation of a new product's perceived benefits and meanings in a social context (Bruun and Hukkinen, 2003). As individuals first become aware of a new product (through diffusion), the product may be subject to a high degree of interpretive flexibility; different individuals may have differing and potentially uncertain interpretations of the products' meaning and content, and these interpretations may influence further technological development (Pinch and Bijker, 1984). Therefore, while diffusion brings awareness to the individual, it is through translation that he or she tries to assess and personalize the product's attributes. Translation thus involves more active shaping of consumer perceptions and preferences.

Through the third process in the RLI framework, reflexivity, the individual links their (diffused) awareness and (translated) assessment of the product to their lifestyle and self-concept. The individual's self-concept is how they perceive of and present themselves, and has been linked to pro-societal consumer behavior (Peattie, 2010; Stets and Biga, 2003). Consumers actively seek out and define their self-concept through enactment of lifestyles, which are packages of related practices, knowledge and skills (Axsen et al., 2012; Giddens, 1991; Spaargaren, 2003). Reflexivity is the dynamic, continuous process through which one defines and expresses oneself. For example, consideration and adoption of a BEV may be a means to enact and represent a shift towards an environmentally- or societally-conscious lifestyle and, in turn, self-concept. The consumer wants the new product either to fit coherently into their current self-concept, or to align with a new identity (Spaargaren and Van Vliet, 2000).

Further, a consumer's readiness and willingness to explore a new product or new lifestyle depends on the stability of their present lifestyle and self-concept. Here, we use the concept of liminality (Turner, 1969), where an individual is in a more liminal state if he or she is more open to new lifestyle, potentially if the individual is undergoing a life transition (e.g., new job, moving residence, or marriage/divorce), has access to a diverse social network, and/or has access to resources such as time and money (Axsen and Kurani, 2012a). The consumer's liminality will affect the reflexive process: assessment of the new product may be constrained by their current self-concept (less liminal), or may stimulate reconsideration or revision of self-concept (more liminal). Lifestyle liminality has been quantitatively shown to relate to consumer openness to pro-environmental technologies (Axsen et al., 2012).

Previous qualitative research suggests the importance of distinguishing between each social influence process as these processes can be linked to private, symbolic and societal attributes of pro-environmental technology (Axsen and Kurani, 2012a). This previous study applied different perspectives of social influence to a sample of California households that were driving and evaluating plug-in hybrid vehicles. The present study utilizes this RLI framework to observe social influence and preference formation in a novel context (a U.K. workplace) by integrating qualitative and quantitative analysis. This paper is the first application of RLI to a multi-method empirical study.

3. Methods

3.1. Study Context and Sample

The study took place at the Shell Technology Centre in Thornton, England. During 2010, 57 of around 500 members of staff took part in a BEV experience project, which we will refer to as the "BEV Study." The BEV Study utilized two 2010-generation electric cars (four-seater, small hatchbacks) — by "2010-generation", we mean a BEV model that was available for purchase in 2010, but was less technologically advanced than later generation models available at the time of writing (2013). These 2010-generation BEVs were powered by 30 kW electric motors with lithium-ion batteries in place of the conventional internal combustion engine and fuel tank. These vehicles had an on-board charger enabling them to be charged with a standard U.K. 13 A, 240 V domestic power source, and could be fully charged in about 6 hours. In practice, the driving range of these BEVs was around 60 miles.

This workplace context provided several unique opportunities to observe social influence and preference formation. First, the exposure of a limited number of staff to an actual BEV served to stimulate conversations among other staff and some that did not take part in the BEV Study, some of whom did not have any direct exposure to the technology at all. Secondly, this medium-sized workplace is an ideal context to explore social influence at the "total network" level — that is, observing how employees influence one another as information is spread further from the source (the actual BEV Study participants) to coworkers without direct experience. Thirdly, the technology-oriented nature of the workplace provided the opportunity to compare social influence within "high-tech" social groups, e.g., coworkers, to social influence within relatively lower-tech social groups, such as friends and family.

To identify which aspects of a given participant's social network were stimulated by the BEV Study, we collected information about their personal (or egocentric) social network which includes the individual participant (ego), their social connections (alters), and the relationships among them (Carrasco et al., 2008). In a sense, a personal network is a sample from a total network; by mapping out several personal networks we observed processes of influence across the workplace.

Clearly, this project context and sample were not intended to be representative of U.K. car buyers. Instead, we sought to include participants drawn from a particular worksite with a breadth of ages, income levels, household sizes, technical backgrounds, lifestyle practices, degrees of exposure to BEVs, and social network structures. This breadth of participants assured that we observed preference formation and social influence process in a variety of contexts. Another limitation of our sampling frame is that none of our participants actually bought BEVs — they only drove a BEV or heard about the BEV Study. However, observation of this sample can still arguably provide insights into preference formation in the early market for an emerging pro-environmental technology.

In this paper, all participant names are pseudonyms, and all participants spoke on behalf of their personal perceptions and preferences, not those of their employer.

3.2. Research Design

Fig. 1 depicts the conceptual framework of this study, which utilized the BEV Study context to explore the research topic, and in particular the three social influence processes reviewed in Section 2.3. The BEV Study is presumed to have generated two types of experiences among

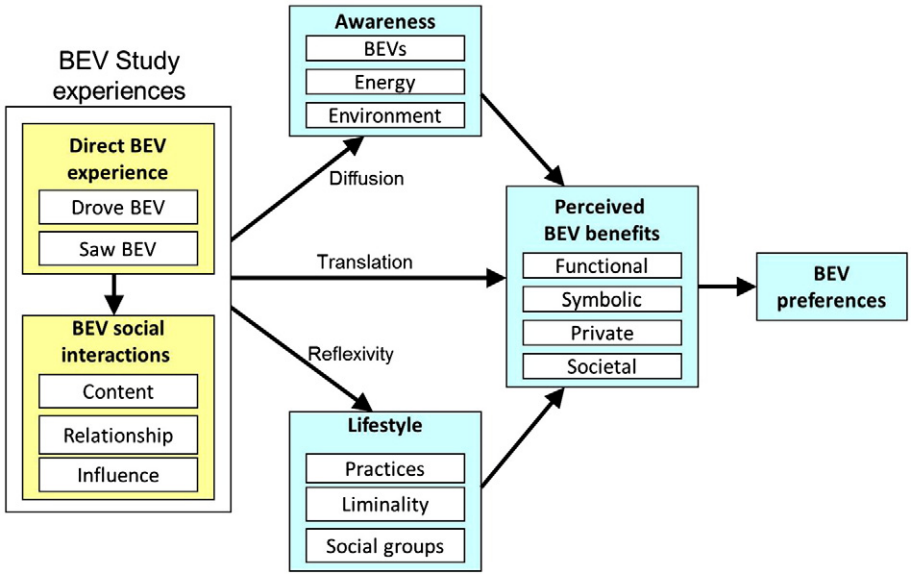

Fig. 1. Conceptual framework of social influence and BEV preferences.

employees: 1) direct experience with the vehicle, such as driving or seeing the BEV, and 2) BEV-related social interactions. These types of experiences may influence an individual employee following one of the three RLI processes: 1) affecting awareness through diffusion, 2) affecting their personal evaluation (or preferences) of the technology through translation, and/or 3) affecting their self-concept through reflexivity. The employees' BEV preferences are determined by their overall perceptions of BEV benefits (and drawbacks) and how these benefits relate to their self-concept. For the present study, we do not take the additional step of inferring or forecasting purchase behavior from elicited preferences, due to the lack of an existing (substantial) BEV market.

Due to the complexity of this research topic, we utilized a multi-method research design (McCracken, 1988). All data reported in this paper was collected using semi-structured interviews. The interview design collected quantitative and qualitative data, which permitted quantitative and qualitative analysis techniques to address our two central research questions (Table 1). We assessed consumer perceptions, preferences, and controversies using content analysis of open-ended interview questions, in addition to estimating discrete choice models based on a stated preference choice experiment. The content analysis permitted insight into a variety of consumer perceptions, while the choice model produces an aggregated, quantitative picture of participant valuation of BEVs and their attributes (at present). We assess social influence processes through narrative analysis of participant accounts of BEV-related social interactions, while the regression analysis of participant ratings identifies the relative influence of specific social interaction patterns. We feel that our overall research design combines complementary perspectives on how BEV preferences can change through social influence.

Table 1
Combining qualitative and quantitative approaches to answer research questions in a multi-method research design.

Research question	Qualitative approach	Quantitative approach
1) Identify consumer perceptions, preferences and controversies relating to BEVs	Data: open-ended responses to BEV perception questions Analysis: content analysis and thematic categorization	Data: stated preference choice experiment Analysis: discrete choice model, with lifestyle and BEV preference coefficients
2) Identify processes of social influence relating to BEV preference formation	Data: narratives of social interactions relative to BEVs Analysis: narrative analysis of social influence processes, categorized by RLI framework	Data: participant rating of social interaction influence Analysis: statistical and regression analyses to characterize "high influence" social interactions

3.3. Methods and Research Instruments

Prior to the semi-structured interviews, a short web-based screener survey was designed to collect data from a large sample of employees from this workplace. The invitation was sent to all ~500 employees by e-mail, offering a chance to win a nominal monetary reward. The survey itself elicited details of the respondent's transportation patterns, experience with the BEV Study, BEV-related social interactions with other coworkers, and household details. The primary purpose of this screener survey was to generate a pool of potential interview participants and allow researchers to select a diverse sample for more in-depth study through interviews.

A sub-set of this survey sample was selected for semi-structured interviews, which blended structure and open-endedness. In other words, each interview followed a similar structure and touched on the same talking points, but the interviewer allowed flexibility to maintain a natural dialog with the participant and elicit details of their personal narrative (McCracken, 1988). Each interview addressed current vehicle ownership and transportation behavior, BEV perceptions and experience, social network mapping, BEV-related social interactions, rating of social influence, and future vehicle purchase intention. Of course, the nature of our "sample" is constrained in the sense of location (one worksite in the U.K.). In an attempt to improve the usefulness of our results in relating to the larger population of car buyers in U.K. and in developed countries more broadly, we followed a "purposeful selection" method to ensure a high degree of heterogeneity among sample participants (Maxwell, 2005, p88). We intentionally recruited our interviewed sub-sample to include participants that varied widely by age, education, income, employment type, prior experience with BEVs, technical background, household size, attitudes and lifestyles. That said, we are still careful to avoid inappropriate generalization of our results.

To collect social network data from each respondent, we utilized a sociogram construction exercise developed by Hogan et al. (2007). This approach provides a clear structure with discrete steps, and has been successfully implemented with a sample of car-buying households

in California (Axsen and Kurani, 2011). First, a name generation tool is used to elicit names of "somewhat close" and "very close" alters (based on the participant's—or ego's—perceptions of social proximity). Participants then write these names onto "sticky" tags that they then arrange on a large poster board representing social proximity, and social groups. As part of this exercise, participants identified alters that they perceived as engaging in technology-oriented or pro-environmental lifestyles.

Next, participants reported details of any BEV-related social interactions that occurred with coworkers, family, friends, or any other acquaintances or strangers, as well as any other sources of BEV-related information or influence such as media. Participants were then asked to rate the influence that each of these social and technical experiences had on their BEV perceptions and preferences. Here, we utilized an influence rating exercise which was previously implemented with a California sample of car buyers (Axsen and Kurani, 2011). Each elicited experience was placed on a "sticky" tag and arranged by participants on a different poster board using a continuum ranging from no or low influence to high influence over the participant's BEV perceptions.

Finally, participants were asked to summarize their assessment of BEV technology. This assessment was supplemented with a discrete choice experiment. Each participant completed a series of nine binary choices, each presenting a BEV and conventional vehicle with varying attributes. Table 2 depicts the experimental design which specified four vehicle attributes with three different levels, yielding a 3^4 factorial design that was simplified into a "main-effects only" orthogonal fractional factorial design of 9 choice sets (using SPSS software). The four attributes only related to the BEV: purchase price (£U.K.), all-electric range (miles), time required for complete recharge (hours), and acceleration capability (% change from conventional vehicle).

The goal of our stated choice experimental design was to select attributes and attribute levels that: i) are realistic representations of the range of differences between BEVs and conventional vehicles in the near term market, ii) stimulate interview participants to consider and discuss their valuation of BEV attributes, and iii) produce a simple enough choice model that will result in significant coefficient estimates with a relatively small sample size. For reference, Hidrue et al. (2011) provide a summary of the attributes of 11 currently produced BEV models. Together, our chosen four attributes and levels represent key differences between BEVs and conventional vehicles, where available and forthcoming BEVs are generally more expensive, less powerful, allow a shorter range between "refueling" and required more time to refuel than comparable conventional vehicles. Our selection of BEV attributes and levels is also quite similar to stated preference experiments conducted over the past three decades (e.g., Calfee, 1985; Ewing and Sarigollu, 2000; Potoglou and Kanaroglou, 2007), as summarized by Hidrue et al. (2011).

In the choice sets, each participant first stated the next likely vehicle purchase (petrol or diesel), and used this vehicle as the "conventional vehicle" for the choice set. Although this experimental design included some of the major private-functional attributes that differentiate a BEV from a conventional vehicle, many other attributes are likely missing. Implicitly, these missing attributes are represented by the BEV-constant in estimated discrete choice models. Also known as "lurking variables", these missing attributes may include other private-functional attributes such as perceived fuel costs, symbolic benefits, and societal attributes such as greenhouse gas and air quality impacts. As noted above, content analysis from open-ended interview questions provides additional insight into participant perceptions and valuation of these lurking variables.

Table 2
Attribute levels in BEV choice experiment (3^4 factorial design).

	Vehicle choice	
	Conventional vehicle (CV)	Battery electric vehicle (BEV)
Price (UK£)	CV price	(1) 100% CV price (2) 110% CV price (3) 125% CV price
Acceleration	CV acceleration	(1) 75% CV acceleration (2) 100% CV acceleration (3) 125% CV acceleration
Electric range (miles)	400 miles	(1) 75 miles (2) 125 miles (3) 175 miles
Recharge/refuel time (hours)	5 minutes	(1) 5 hours (2) 10 hours (3) 15 hours

4. Results

4.1. Sample

In June 2011, 191 employees completed the screener survey. From these responses, we selected a diverse sub-sample of 21 employees to complete semi-structured interviews. This sub-sample included eight employees that drove the 2010-generation BEV (as a BEV Study participant), eight that did not drive the vehicle but saw it or experienced it as a passenger, and five that did not see or directly experience the 2010-generation BEV but did talk with at least one coworker about it. The size of elicited social networks included between 17 and 56 "close" alters per participant. We expected that on average, employees at this worksite would be of higher income, higher education and with more technological training than average car buyers in the U.K. Our purposive selection approach attempted to mitigate such bias by including a wide range of participants by age, income level, employment type, technical background, household size, attitudes and lifestyles.

Drawing from previous research and relating to the reflexivity perspective summarized in Section 2.3, we expected participant lifestyle details to be particularly relevant to the individual's perceptions of and preferences for pro-environmental technology (Axsen and Kurani, 2012a, 2013a; Axsen et al., 2012). For these reasons, the semi-structured interviews elicited information about three aspects of participant lifestyle: engagement in technology-oriented practices, engagement in pro-environmental practices, and overall lifestyle liminality (openness, flexibility or transitionality). Eleven participants demonstrated a "high" degree of engagement in a technology-oriented lifestyle, such as researching and buying the latest available technologies. Significantly fewer participants demonstrated engagement in pro-environmental lifestyle practices — only one was characterized as highly pro-environmental and six as moderate; most participants described a lack of engagement in pro-environmental lifestyles for themselves, and in their social groups. Four participants were characterized as highly liminal (open to lifestyle change), and nine as moderately liminal, as indicated by being in the midst of a transition in their lives, or generally open to new lifestyle practices.

4.2. Qualitative Perceptions of BEVs

At several points during each interview, the participant was asked to explain their perceptions and assessment of BEV technology. Here, we summarize the most frequently reported benefits, drawbacks and controversies of BEV technology. We categorize each attribute according to the attribute typology described in Section 2.1: private-functional, private-symbolic, societal-functional, and societal-symbolic.

The most frequently cited benefit of BEVs was the potential for reduced environmental impact (Table 3). Most participants specified a particular environmental benefit, such as reduced greenhouse gas emissions or improvements to local air quality. Other participants were less specific and just referred to overall environmental benefit. Other perceived benefits were private-functional, including the ability to save money on fuel costs by displacing diesel or petrol (gasoline) with electricity, as well as improved vehicle performance such as quietness,

Table 3
Perceived benefits of BEVs (by attribute type and frequency mentioned).

Theme	Benefit type	Quote example	n
Environmental	Societal-functional	"We have to do something to save the planet, and I would fully support [BEVs] from that viewpoint."	13
Cheap to run	Private-functional	"You get that feeling that it doesn't cost anything really."	8
Quiet	Private-functional	"And I like the lack of noise… nothing much to hear."	8
Home recharge	Private-functional	"You haven't got to worry about…filling up at the petrol station."	6
Fast acceleration	Private-functional	"I actually enjoyed [the acceleration] at first, at 20 miles/h."	4
Smooth	Private-functional	"I was just surprised how smooth it was."	3
Easy parking	Private-functional	"Easier for parking."	3
Fun/new	Private-symbolic	"My overall impression was: fun!"	2
Job creation	Societal-functional	"I think it's job creation opportunities…that's quite good."	1
Pressure car companies	Societal-symbolic	"It's putting a new player in the market…putting pressure on the traditional [automakers] to clean up their act."	1

Table 5
Reported BEV controversies (by attribute type and frequency mentioned).

Theme	Controversy type	Quote example	n
Lifecycle impact?	Societal-functional	"The electricity to charge the vehicle is coming from a power station which pumps CO_2 into the air."	17
Battery life?	Private-functional	"The battery life of some of these things is very marginal. They last for a couple of years and then you might have to replace the battery."	8
Public charging?	Private-functional	"In a modern city, I saw no evidence of a charging facility for [EVs]."	6
Too quiet?	Societal-functional	"They're so quiet [which] from safety perspective…can be a bad thing."	2
Fuel savings?	Private-functional	"Whether they're cost effective, I would be completely undecided."	2
Sporty?	Private-symbolic	"I don't know if they [can] produce…a sporty version of an electric car yet."	1

smoothness of the driving experience, and surprisingly impressive initial acceleration. A few participants valued the ability to recharge at home, avoiding the "time and effort" associated with visiting a petrol station.

Nearly all the perceptions of BEV limitations or drawbacks were private-functional in nature (Table 4). The most frequently mentioned drawback was the perceived lack of range relative to conventional vehicles — the electric range of the 2010-generation BEVs used in the BEV Study was less than 60 miles in practice. Some participants mentioned that a limited range would restrict their ability to take part in important activities, such as camping or mountain biking, or visiting distant friends or family. Several participants stated that a BEV's range would need to be well over 200 miles to warrant serious consideration. Another performance related drawback was the perceived lack of acceleration of the 2010-generation BEV, particularly at higher speeds on motorways. Some noted this as a safety concern, and others simply did not like the feeling of driving a slow vehicle.

The translation perspective (summarized in Section 2.3) explains how consumer perceptions of emerging technologies are initially subject to interpretive flexibility — when there is controversy as to what benefits the technology provides or should provide (Pinch and Bijker, 1984). Several such controversies are observed for BEVs. The most frequently cited controversy has to do with the lifecycle environmental impacts of BEV use (Table 5). As stated by Jasper: "I'm not entirely convinced of the green argument." Considerations include uncertainty regarding the carbon-intensity of the source of electricity, and the environmental impacts of manufacturing and disposing of advanced automotive batteries. Other key controversies include the longevity (and cost of replacement) of the BEV batteries, as well as the availability and emergence of public recharge stations.

An unexpected insight from the interviews was that participants also varied in their perceptions of BEV technology as relatively static or dynamic. Participants with a more dynamic perspective tended to be optimistic, e.g., more easily excusing functional drawbacks of the 2010-generation BEV as "teething problems" that would be overcome in the future development of BEVs. For example, Aiden states that "[EVs] are the future. I think there's no way about it, they're going to improve…you're going to see a lot more electric cars." In contrast, some participants with a more static view of BEV technology tended towards a pessimistic view. They frame their current perceptions of functional limitations as representing lasting or insurmountable problems with BEV technology in general.

4.3. Quantitative Preferences for BEVs

The above qualitative summary categorizes a variety of participant perceptions. We also conducted a discrete choice analysis to provide a quantitative perspective on participants' interests in BEVs. This stated choice analysis estimates the relative magnitude of consumer preferences for various BEV attributes—albeit for a constrained number of attributes—and for BEVs in general (through the constant term). This choice analysis is exploratory in nature — drawing from the nine choice observations collected from each interviewee (189 choices total). Given that this is a relatively small sample size, we warn that model estimates should be interpreted with caution. We did successfully estimate two multinomial logit models as portrayed in Table 6 (using

Table 4
Perceived drawbacks of BEVs (by attribute type and frequency mentioned).

Theme	Drawback type	Quote example	n
Limited range	Private-functional	"Range anxiety…I experienced it first-hand."	15
Expensive	Private-functional	"They're too expensive for me to buy one or consider buying one."	10
Recharge access	Private-functional	"I don't think I'd consider buying an electric car until there's a better network to charge up."	10
Poor acceleration	Private-functional	"There was a danger that someone could actually run into the back of you…that was rather uncomfortable."	6
Too restrictive	Private-symbolic	"Certainly quite restrictive on the type of journey that you could go on."	4
Requires change	Private-symbolic	"[I'm not] particularly organized…don't know where [I'm] going to be from one day to the next."	3
Too small	Private-functional and Private-symbolic	"My assumption is [that they're] all small vehicles."	3
Noise	Societal-functional	"They're so quiet…from [a] safety [perspective] it can be a bad thing."	3
Recharge time	Private-functional	"How inconvenient is it to sit round for hours waiting for it to charge?"	2
Lack of towing	Private-functional	"I want to [be able to] tow."	1
Uncertain technology	Private-functional	"The thing for me then would be the maturity of the technology…reliability [is] the thing to consider."	1

Table 6
Results of discrete choice models (multinomial logit with random effects).

	Vehicle attributes		Attributes w/lifestyle	
	Coeff.	*t*-Stat	Coeff.	*t*-Stat
Price/ln (income)	−0.00135	−3.01**	−0.0140	−3.03**
ln (Refuel time)	−0.802	−1.71	−0.803	−1.16
ln (Range)	4.22	3.05**	4.35	3.01**
Acceleration	0.0664	2.83**	0.0686	2.80**
BEV constant	6.03	1.59	5.44	1.39
BEV × Liminal lifestyle			6.00	2.24*
BEV × Technology lifestyle			−2.35	−1.10
BEV × Environmental lifestyle			1.79	0.89
Random effects	4.33	2.86**	3.49	2.80**
Observations	189		189	
Groups (participants)	21		21	
Max log-likelihood	−55.40		−51.29	
LL ratio[a]	0.577		0.608	
Willingness to pay (UK£)[b]				
One mile extra range	£34.88[c]		£34.72[c]	
One percent increase acceleration	£55.10		£55.02	
BEV w/liminal lifestyle			£9167.28	

[a] Ratio of log-likelihood of full model to log-likelihood of model with no coefficients.
[b] Quotient of attribute coefficient divided by vehicle price coefficient, assuming that household income = £72,000.
[c] Change from 100 miles to 101 miles range.
* $p < 0.05$.
** $p < 0.01$.

LIMDEP econometric software). Each model includes a random effects coefficient (normally distributed) to account for correlation among repeated choices elicited from each respondent (9 choice sets each). The first model includes the main attributes with "refuel" time and vehicle range transformed into non-linear variables (natural log or "ln"). We use log-linear transformations because previous research suggests that car buyers perceive such attributes with diminishing marginal value (Brownstone et al., 2000). The second model adds consideration of the respondent's lifestyle, including engagement in technology-oriented lifestyle (at least "high"), engagement in pro-environmental lifestyle (at least "moderate") and degree of lifestyle liminality (at least "high"). All coefficient estimates are of the expected sign, however, only the coefficients with asterisks are statistically significant ($p < 0.05$), that is: price, range, acceleration, and the coefficients interacting with the BEV constant with liminal lifestyle.

Table 6 also portrays the average willingness-to-pay (WTP) for each unit of the attributes with statistically significant coefficient estimates, by dividing the coefficient by the purchase price coefficient (holding household income level constant at UK£72,000). These WTP values are useful in that they: i) quantify the magnitude of consumer preferences for BEV attributes and BEVs in general, ii) allow comparison of aggregated BEV valuation with previous choice models conducted in other contexts, and iii) allow us to get a sense of differences in consumer valuation by lifestyle category. The estimated WTP of about UK£35 for an extra mile of driving range is similar to a previous study finding WTP of US$35 to $75 with a U.S. sample (Hidrue et al., 2011). Further, participants were on average willing to pay an extra UK£55 per percentage increase in acceleration compared to a conventional vehicle.

The BEV-specific constant is positive in all three models, suggesting a positive valuation of BEV technology (with specified attributes held constant) — though the constant is not statistically significant, likely due to the relatively small sample size. This WTP varies with participant lifestyle (Model 2) — those with a liminal (open) lifestyle have the highest (and only statistically significant) WTP of UK£9167. Recall that the notion of reflexivity (Section 2.3) predicts that lifestyle liminality is related to acceptance of new practices and technologies (as this means that participant perceptions are more open to influence). These WTP estimates of "liminal participants" are higher than the UK£2000 premium that a majority would pay for a BEV in an earlier U.K. study (Skippon and Garwood, 2011) but comparable to a previous U.S. study estimating a WTP of US$6000 to $16,000 for EVs (Hidrue et al., 2011). Interestingly, we find no significant difference in BEV valuation for participants with pro-environmental or technology-oriented lifestyles, the former of which could be due to the low prevalence of such individuals in this study. Though, the magnitudes and signs of these coefficients, if significant, would indicate that the BEVs are most highly valued by liminal participants, followed by pro-environmental participants, and least by technology-oriented participants.

In summary, for this sample there are some positive values associated with BEVs, at least among those participants with liminal lifestyles, once any functional limitations of range, recharge time and acceleration are controlled for. These choice model results show that BEV attribute valuation in this smaller U.K. sample is comparable to others studies, e.g., a larger U.S.-based sample. In addition, we see quantitative evidence of the potential importance of consumer lifestyle and openness (liminality) in accepting BEV technology.

4.4. BEV-related Experiences

To explore our second research question, we look to the sources of participant perceptions, preferences and controversies. As a starting point, Fig. 2 portrays the BEV-related experiences rated by each participant as being "highly influential" regarding their BEV preferences. Experiences are broken into four categories: technology, media, work-related projects and social interactions.

Direct experiences with the technology included driving a BEV or plug-in hybrid vehicle, riding in one as a passenger, or seeing one. Eleven participants reported driving a BEV, mostly the 2010-generation BEV as part of the BEV Study, as well as two participants who had driven a relatively more advanced BEV. Ten participants rated their driving experience as being highly influential. Seven participants reported experiences of seeing some sort of EV; two of these experiences were rated as highly influential. For example, Craig observed an unknown coworker driving the BEV Study vehicle very slowly in "limp home mode" — where the BEV is automatically constrained to a very low driving speed once the battery reaches a low state of charge. This experience supported Craig's perception of BEVs as being slow, impractical vehicles.

A total of thirteen participants reported some sort of media-based experience. Six mentioned a common source: a popular, comedic automotive TV program called "Top Gear". This program is generally perceived to have a negative view of EV technology: "they're very, very anti-new technologies". For example, Hugh explains that "amongst Top Gear fans, the message is that you're an idiot [if you want an EV]."

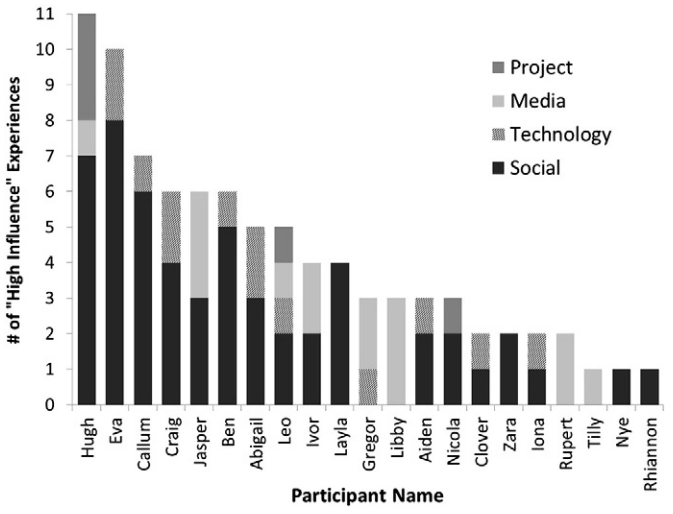

Fig. 2. Comparing the frequency of "high influence" social interactions to other types of experiences.

Another participant explains that he takes Top Gear's message with a "pinch of salt," but the program "does still make you think about things and influences your opinion on it." Other participants identified different automotive-themed magazines and TV programs as information sources, as well as general newspapers and programs, journal articles, and websites (e.g., BBC news and internet forums).

Across the 21 interviews, participants reported a total of 170 EV-related social (interpersonal) interactions. The majority of interview participants (17) rated at least one EV-related social interaction as being of "high influence." Fig. 3 depicts the number of social interactions reported by each participant. On average, eight interpersonal interactions were reported by each participant, the number ranging from 1 to 15. Of these interactions, about half occurred with a very close alter, a third occurred with a somewhat close alter, and about 14% occurred with a casual acquaintance (neither somewhat nor very close — thus, not initially identified in the participant's sociogram). Fig. 3 depicts interactions by relationship role category, where just over half occurred with coworkers.

4.5. Qualitative Descriptions of Interpersonal Influence

To explore the particular processes of interpersonal influence that can shape participant perceptions of and preferences for BEVs, we summarize our qualitative analysis of participants' narratives of social influence. We relate these narratives to the three RLI processes introduced in Section 2.3: diffusion, translation and reflexivity. We have classified all 170 BEV-related social interactions reported by participants according to these three categories (which are not mutually exclusive).

Processes of diffusion are characterized as the sharing of information from a sender to a receiver. Such information is relatively simple, and influence typically occurs through a change in awareness — the receiver becomes aware of the BEV, and/or increases his or her basic understanding BEVs. The process of diffusion itself does not typically include an evaluation of BEVs. Although 62% of the reported 170 social interactions are categorized as diffusion, only 41% are categorized as only diffusion (not also as translation or reflexivity).

Consider a simple example. Ben diffused information regarding his participation in the BEV Study by posting a message on his Facebook (social media) account: "drove an electric vehicle home tonight!" That instance was a one-way flow of information from Ben to an unknown number of receivers (his Facebook "friends"). Ben did not evaluate the technology, but merely provided information about what he was doing. People that read Ben's message became aware of Ben's experience, and for some of his alters this information may have been novel, indicating that BEVs were becoming available. In short, episodes of diffusion tend to be simple — they were often described by the participant (ego) as "showing off" the BEV, with little or no following dialog.

Processes of translation are by definition more complex and sophisticated than diffusion — the ego and alter somehow discuss and inform their respective personal evaluations of the BEV (including the preferences described in Sections 4.2 and 4.3), rather than just sharing information about the BEV's functions. Such interactions tend to be bi-directional or multi-directional (as opposed to one-way diffusion), and influence occurs by affecting the individual's BEV preferences and potentially their certainty regarding these preferences. About 53% of interactions reported in this study are classified as including elements of translation — and 29% of interactions are classified as translation only (not also categorized as diffusion or reflexivity). Examples of translation fall into four sub-themes: accessing expertise, accessing another's experience with BEVs, stimulating new thoughts or consideration of novel viewpoints, and seeking resolution to controversies regarding the technology (e.g., Table 5). For example, Ivor learned about the impacts of BEV range limitations from a colleague: "I think he only just managed to get home on the charge from that car…he said he would see the charge going down as he goes up the hill…. I came to the conclusion that it wasn't the car for me." Ivor reported that his preference was shaped by this social interaction.

Processes of reflexivity help to relate BEV technology to the individual's lifestyle and self-concept. Such experiences occur significantly less frequently than diffusion or translation — only 11 social interactions (6.5%) from the present study are categorized as reflexivity. However, such interactions have the potential to be more influential — affecting not just the individual's perceptions of BEV technology, but also of their own life and identity. As stated by Iona: "a car represents what I can achieve" — and social interactions can serve to negotiate such representations. Here, we identify three sub-themes of reflexivity; engaging with lifestyle, countering lifestyle, and openness to lifestyle change. Recall that the choice model in Section 4.3 revealed that participant valuation of BEVs varied by lifestyle openness or liminality.

For some participants, reflexive interactions can help them understand the BEV in a way that engages their present or desired lifestyle and self-concept. An example is Iona's interaction with her former work mentor, a BEV Study participant that demonstrated how a BEV might be integrated into their respective lifestyles. In the following account, Iona iterates between evaluating the BEV and comparing her similarity in lifestyle to her former mentor:

> "She showed me in the garage where it was plugged in, how she charged it up. The overarching message was about having to plan your journeys so carefully. Neither of us are particularly organized, we don't know where we're going to be from one day to the next. But otherwise…we're both quite optimistic, open minded sort of people…she's, sort of, pro-environment as well. And I think she would actually be happy to buy an electric vehicle if she didn't have this issue of unplanned journeys."

This reflexive, social interaction helped Iona relate the BEV to her own lifestyle and the trade-off between environmental benefits and functional limitations. A further example was demonstrated by Callum who was in the midst of a significant life transition (and thus, highly liminal) — moving into a new home with his partner. In talking with his partner and thinking of BEVs, he began to see his transition in residence and relationship as an opportunity to re-arrange his lifestyle. He could "see a gap where [BEVs] could fit into [his] life" — such as creating a multi-car household with his partner to accommodate a limited-range BEV. As with translation, processes of social reflexivity can shape participant perceptions and preferences — but in these cases, the participant's lifestyle is also being shaped or reinforced.

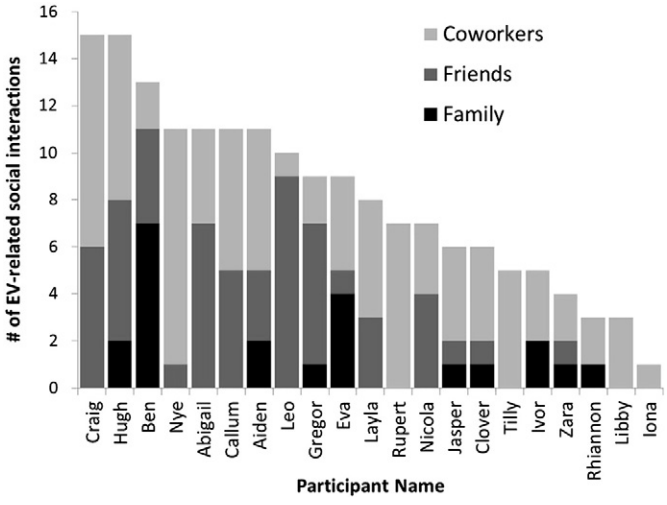

Fig. 3. Comparing the frequency of social interactions by relationship role.

4.6. Quantitative Analysis of Social Influence

The preceding qualitative summary illustrates the distinctions between diffusion, translation and reflexivity processes — particularly in how these processes can shape participant perceptions and valuation of BEVs. Participant narratives suggest that social interactions may be more influential when engaging the ego's personal evaluation of the BEV (translation), or their lifestyle and self-concept (reflexivity). We test this hypothesis by statistically analyzing results from the experience-rating exercise described in Section 3.2. An ordinal logistic regression analysis was employed to tease out (and control for) the explanatory power of several characteristics of the 170 reported social interactions (using JMP statistical software). Table 7 presents two models specifying the rated influence of each social interaction as the dependent variable (with three ordinal levels: high, moderate and low influence). The full model incorporates all tested explanatory variables, and the reduced model incorporates only those variables that proved statistically significant ($p < 0.05$) following a stepwise estimation procedure.

As hypothesized, results indicate that a social interaction is more likely to be rated as higher influence by the ego if the interaction addressed the ego's evaluation of the technology (translation), or the ego's lifestyle and self-concept (reflexivity). Influence also seems to relate to the degree of engagement in technology-oriented lifestyles with both the ego and alter. Specifically, influence is higher if the ego does not have a technology-oriented lifestyle (and thus, presumably has more to learn), and higher if the alter does have such a lifestyle (and thus, presumably has more expertise to share). As found in previous exploratory research, influence does not significantly relate to ego–alter relationship by social proximity or role category (Axsen and Kurani, 2011).

Although role category did not emerge as statistically significant in these logistic regression models, role does seem to relate to the direction of influence by type of process. Table 8 presents cross-tabulations of social interactions by each influence process, and by the alter's role category. If the alter was a coworker with the ego, then the diffusion of information was more likely to flow to the ego. Conversely, if the alter was a friend or family-member, information was more likely to diffuse to the alter. A similar pattern can be seen for processes of translation — with the ego's BEV evaluation being influenced more by coworkers, whereas interactions with non-coworkers tended to influence the alter's BEV evaluation. Both patterns seem logical from the perspective of relative experience or expertise — coworkers in this study context were more likely to be familiar with BEVs than friends or family-members. As explained by Nye: "I'd consider [coworkers'] opinions because these people probably have quite good ideas of mobility…that's probably why they're pretty [influential]."

A different pattern is observed for reflexivity. Interactions are more likely to be classified as reflexivity if the alter was a family-member. There seemed to be little difference in the proportions of reflexive interactions with coworkers or friends as alters. Although the sample size of reflexive interactions is low (and thus, we must interpret differences with caution), this pattern suggests that processes of reflexivity may engage different aspects of the ego's social network than processes of diffusion or translation. In particular, BEV-related experience or expertise may not be as important for the ego when addressing something as personal as lifestyle. In summary, the interview participants' (ego's) BEV awareness and evaluation was more likely to be influenced by coworkers, whereas links to lifestyle occurred more often with family.

Table 7
Ordinal logistic regression explaining the influence of social interactions (170 social interactions).

Factor (reference)	Full model	Reduced model
Intercept 1	−0.248	0.062
Intercept 2	1.712**	1.938**
Characteristics of (person being influenced)		
EV Study participant	0.535	
Liminal lifestyle	0.247	
Technology-oriented lifestyle	−1.685**	−1.594**
Characteristics of alter (source of influence)		
EV Study participant	1.028*	
Technology-oriented lifestyle	1.559**	1.507**
Relation with alter		
Role category (family)		
Friend	−0.417	
Coworker	−0.634	
Proximity (very close)		
Somewhat close	−0.337	
Casual	−0.186	
Characteristics of interaction		
Diffusion	0.632	0.791*
Translation	1.374**	1.455**
Reflexivity	2.420**	2.356**
Observations	170	170
Pseudo R-square	0.1944	0.1707
Log-likelihood	−150.36	−154.80

* $p < 0.05$.
** $p < 0.01$.

Table 8
Social influence processes by role category.

Process	Alter's role category			Total
	Coworker	Family	Friend	
Diffusion				
To ego**	30 (34%)	4 (15%)	5 (9%)	39
To alter**	23 (26%)	15 (56%)	39 (71%)	77
Translation				
To ego*	49 (56%)	10 (37%)	20 (36%)	79
To alter	28 (32%)	11 (41%)	20 (36%)	59
Reflexivity (to ego)	4 (5%)	4 (15%)	3 (5%)	11
Total	88 (100%)	27 (100%)	55 (100%)	170

Note: process categories are not mutually exclusive — role categories are mutually exclusive.
* $p < 0.05$.
** $p < 0.01$.

5. Discussion

We followed a multi-method approach to explore two research objectives, eliciting participant perceptions of BEVs and assessing how these perceptions can be shaped by social influence. We provide qualitative and quantitative perspectives for each question — we feel that these perspectives are complementary because we are able to identify and describe a wide range of perception and influence patterns (some of which we cannot identify *a priori*), in addition to statistically teasing out more aggregated patterns across the group of participants. We remind the reader that our insights are inherently limited by our present focus on members of staff at one particular worksite in the U.K. However, we do feel that our method has produced useful insights into our research questions. Overall, we find further evidence that consumer preferences for an emerging pro-environmental technology like BEVs are not necessarily pre-formed or static (as assumed in neoclassical economic models of human behavior). Instead, preferences can be constructed through learning and exposure, preferences can be unstable and uncertain, and preferences can be negotiated in part through social interactions. Further, we do observe evidence of, and important differences between, the three processes of social influence explained in the RLI framework and depicted in Fig. 1.

5.1. Participant Perceptions, Preferences and Controversies

We elicited a wide variety of BEV perceptions from this sample, which are categorized according to functional-symbolic and private-societal dimensions in Table 9. Most perceived benefits addressed private-functional attributes of BEVs, such as the potential to save fuel

Table 9
Compilation of EV perceptions (frequency mentioned).

	Functional	Symbolic
Private	Benefits: Cheap to run (8) Quiet (8) Convenient to charge (6) Fast acceleration (4) Smooth (3) Drawbacks Limited range (15)[a] Expensive price (10)[a] Lack of charge access (10) Poor acceleration (6)[a] Too small (3) Recharge time (2)[a] Controversies: Battery life? (8) Public charging? (6) Cost-effective? (2)	Benefits: Fun/new image (2) Drawbacks: Too restrictive (4) Controversies: Can be sporty? (1)
Societal	Benefits: Environmental (13) Job creation (1) Drawbacks: Unsafely quiet (3) Controversies: Lifecycle impact? (17) Too quiet? (2)	Benefits: Pressure car companies (1) Drawbacks: None Controversies: None

[a] One of the four attributes specified in the discrete choice model.

costs, the convenience of recharging at home, and the feeling of smooth, quiet driving. Similarly, the most frequently mentioned BEV drawbacks were functional in nature: the limitations in driving range, the high cost of batteries, and present inability to charge at home, work or public locations. Frequently mentioned societal benefits included helping the environment via reductions in local air pollution or greenhouse gas emissions. Environmental concerns are also the most commonly mentioned controversy (or uncertainty): what are the environmental impacts of a BEV from a lifecycle perspective?

We also estimated discrete choice models to produce quantitative estimates of the overall magnitude of participant preferences for BEV attributes and BEVs in general. These models focused particularly on the private-functional attributes: driving range, purchase price, acceleration and recharge time. We observed that participants with liminal (open) lifestyles were associated with a higher willingness-to-pay for BEVs, all else held constant. This positive valuation is an aggregation of all the other perceived attributes listed in Table 9 (and perhaps other attributes that were not mentioned), including perceived environmental benefits, fuel cost savings, technology uncertainty, and symbolic values. However, to focus only on these static perceptions elicited through open-ended questions and a quantitative choice model estimates belies the processes of preference construction and dynamics that we observe through other methods in this study.

5.2. Preference Formation and Social Influence

According to participants, the BEV perceptions, preferences and controversies they articulated at the time of the interviews (as summarized above) were influenced by a variety of experiences. In other words, results of the interviews and choice model summarized above are more of a "snap shot" of preference at one point in time — which have changed under different conditions and will likely change with further experience, interaction and lifestyle change.

About half of the participants were highly influenced by direct experience with BEV technology, and more than one-third of participants were also influenced by media sources, such as automotive television programs and magazines, as well as newspapers and news programs. The majority of participants (17 of 21) reported at least one social interaction as being highly influential over their BEV preferences. Many of these BEV-related social interactions were stimulated by the BEV Study, but many BEV-related interactions also occurred with coworkers that had not driven an EV, as well as inexperienced family-members and friends. Drawing from the RLI framework presented in Section 2.3, we sought to better understand three distinct processes of social influence: diffusion, translation and reflexivity. When statistically controlling for other factors, interactions described as translation or reflexivity were most likely to be rated as highly influential to the participant.

About two-thirds of the 170 reported social interactions are classified as diffusion (and 40% as diffusion only); relatively simple BEV-related information was passed in at least one direction, affecting awareness without directly affecting BEV preferences. Instances of diffusion included "showing off" and the sharing of BEV facts and experiences. Qualitative observation and statistical analysis suggest that BEV-related information is more likely to flow from those with experience or expertise (e.g., employees at a technology research center) to others, rather than vice versa — a tendency that corresponds with the basic theory of diffusion (Rogers, 2003). Thus, the relative degree of BEV-expertise seems to correspond with the direction of diffusion between two individuals. However, as noted, instances of diffusion seem to be less influential than other types of social influence, which is consistent with a previous study of social influence relating to plug-in hybrid vehicles in California (Axsen and Kurani, 2012a).

Processes of translation involve explicit evaluation of the BEV technology; the interaction somehow addresses an individual's BEV preferences, such as those preferences we quantified with aggregated discrete choice models. Instances of translation were generally rated as being of higher influence than instances of diffusion, and were reported as slightly less frequent (about half of reported interactions, or one-third as translation only). This added influence is logical, where discussions of BEV benefits, limitations, and controversies are typically more engaging than a one-way flow of awareness. Further, translation likely requires more cognitive involvement and thus, occurs less frequently. Several sub-themes of translation emerged from the interviews: where some participants were accessing EV-related expertise or experience from others, or accessing novel insights into EV attributes. As expected by the theory of translation (Kline and Pinch, 1996; Pinch and Bijker, 1984), some participants used such interactions to discuss or resolve important controversies, such as the uncertain ability of BEVs to reduce lifecycle environmental impacts. Interestingly, processes of translation imply that consumer preferences, say valuation of BEV driving range as estimated in Table 6, can be shaped and developed through experience and social interaction — thus, such quantification would be more accurately represented as dynamic rather than static coefficients. The direction of translation influence tended to resemble that of diffusion, more often flowing from coworkers, and more often towards friends or family — though translation was more likely to be multi-directional than for diffusion.

Processes of reflexivity are by definition the most complex of the three that we explore — directly engaging the participant's lifestyle and self-concept. Previous research has demonstrated the importance of consumer lifestyle in the valuation of pro-environmental technology (Axsen and Kurani, 2012a; Axsen et al., 2012; Spaargaren and Van Vliet, 2000), and our present choice model showed how overall valuation of BEVs vary by lifestyle openness or liminality. In instances of reflexivity, the BEV and its attributes are considered in terms of how they align or conflict with the participant's lifestyle, or potentially help to shift their lifestyle in a desired direction, e.g., towards being more pro-environmental. Occurrences of reflexivity were most likely to be rated as influencing BEV preferences, and were also least frequent (7% of reported interactions). Further, reflexivity seems to engage different relationship role categories than diffusion or translation — more often involving family rather than coworkers or friends. Results from this case study suggest that while coworkers at a technology-oriented worksite may be more likely to diffuse BEV-related information to the participant, or influence their BEV-assessment, aspects of lifestyle

are more readily discussed with family-members. One plausible explanation is that family-members are more familiar with the participant on a personal, lifestyle level — an idea to test in future empirical research.

5.3. Preference Dynamics for Pro-environmental Products

In summary, our study of one U.K. worksite supports the notion that participant preferences for BEVs can be highly varied, uncertain, and subject to interpersonal influence. In particular, preferences were influenced by social interactions with coworkers, friends and family — most of whom had no direct experience with BEVs. Further, these social interactions vary by content, degree of influence and process of influence. In the study of markets for emerging pro-environmental technologies, neglect of social influence processes will ignore or underestimate the potential for consumer perceptions and preference to develop and shift. That is, the assumptions of static, exogenous consumer preferences assumed in neoclassical economics can strongly bias estimates of market potential for new, pro-environmental technologies. This study also demonstrates the potential strengths of a mixed-method approach, including the integration of quantitative and qualitative insights, and of drawing from social theory rather than simply amending the rational actor model.

Although specific results from this study should not be freely generalized to other samples and contexts of pro-environmental technologies, products and practices, our main findings provide useful insights. Consumer perceptions and preferences for novel products and practices can be highly varied and uncertain, and such perceptions can be influenced by interpersonal influence. The identified processes of diffusion, translation and reflexivity are also likely to occur in other contexts, albeit to different degrees. Our present findings are consistent with previous empirical research exploring: different processes of social influence for plug-in hybrid vehicles (Axsen and Kurani, 2012a), how values for new technology can change in different social contexts (Axsen and Kurani, 2013b), and the importance of consumer lifestyle in the valuation of new, pro-environmental technologies (Axsen et al., 2012). The specific preferences and directions of preference change will, of course, vary by context, including the nature of the sustainable consumption behavior in question, as noted in Section 2.1. More research is required to better understand preference formation in these other contexts. Better understanding and representing processes of social influence and preference formation should thus be important priorities for the fields of ecological economics and environmental studies more generally.

6. Conclusions and Implications

To improve understanding of consumer valuation of pro-environmental products we explore processes of social influence and preference formation. We apply a novel conceptual framework based on social theory (reflexive layers of influence) to an empirical case study of consumer experience with battery electric vehicles (BEVs) at a U.K. workplace. The present study context is inherently constrained (in sample and location), but we feel that are our multi-method approach provides quantitative and qualitative insights into consumer preferences and social influence using data from semi-structured interviews. Many participants not only value BEVs for environmental and some private benefits, but also perceive important functional limitations. Many of these perceptions are uncertain, especially the frequently mentioned controversy as to whether BEVs have the ability to reduce lifecycle environmental impacts. We find evidence that these perceptions are subject to change, particularly through social interactions.

We characterize observed social interactions according to three distinct processes of social influence, which vary by frequency and degree of influence over the participant's BEV evaluation. Diffusion is the social process of sharing information relating to the technology (without evaluation), and is the most common but typically least influential form of social interaction. Translation is the process of socially discussing and negotiating personal evaluation of (or preference for) BEVs — such interactions are slightly less common and tend to be slightly more influential than instances of diffusion. Reflexivity relates BEV technology to the participant's lifestyle and self-concept. This is a less common, but typically influential process of social influence. Reflexivity does not relate to technological expertise, but may be associated with the commonality of lifestyle between the individuals in the interaction.

To better understand consumer valuation of emerging pro-environmental products such as BEVs, solar panels, and efficient appliances, as well as pro-environmental practices such as cycling and transit use, researchers and policymakers need to better understand the formation and dynamics of preferences. This study provides one set of insights from one case study of BEVs. Some of these insights may apply to other contexts and other products and practices, but more research is certainly needed. Neglect of social influence processes will ignore or underestimate the potential for consumer perceptions and preference to develop and shift. Assumptions of static, exogenous consumer preferences can strongly bias results of market potential for new, pro-environmental technologies. Thus, processes of social influence and preference formation should be more readily incorporated into behavioral research.

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References

Axsen, J., Kurani, K.S., 2010. Reflexive Layers of Influence (RLI): A Model of Social Influence, Vehicle Purchase Behavior, and Pro-Societal Values. University of California, Davis.
Axsen, J., Kurani, K.S., 2011. Interpersonal influence in the early plug-in hybrid market: observing social interactions with an exploratory multi-method approach. Transp. Res. Part D: Transp. Environ. 16, 150–159.
Axsen, J., Kurani, K.S., 2012a. Interpersonal influence within car buyers' social networks: applying five perspectives to plug-in hybrid vehicle drivers. Environ. Plan. A 44, 1057–1065.
Axsen, J., Kurani, K.S., 2012b. Social influence, consumer behavior, and low-carbon energy transitions. Annu. Rev. Environ. Resour. 37.
Axsen, J., Kurani, K.S., 2013a. Connecting plug-in vehicles with green electricity through consumer demand. Environ. Res. Lett. 8, 1–8.
Axsen, J., Kurani, K.S., 2013b. Developing sustainability-oriented values: insights from households in a trial of plug-in hybrid electric vehicles. Glob. Environ. Change 23, 70–80.
Axsen, J., Mountain, D.C., Jaccard, M., 2009. Combining stated and revealed choice research to simulate the neighbor effect: the case of hybrid-electric vehicles. Resour. Energy Econ. 31, 221–238.
Axsen, J., TyreeHageman, J., Lentz, A., 2012. Lifestyle practices and pro-environmental technology. Ecol. Econ. 82, 64–74.
Bettman, J., Luce, M., Payne, J., 1998. Constructive consumer choice processes. J. Consum. Res. 25, 187–217.
Borgatti, S.P., Mehra, A., Brass, D.J., Labianca, G., 2009. Network analysis in the social sciences. Science 323, 892–895.
Brownstone, D., Bunch, D.S., Train, K., 2000. Joint mixed logit models of stated and revealed preferences for alternative-fuel vehicles. Transp. Res. B 34, 315–338.
Bruun, H., Hukkinen, A., 2003. Crossing boundaries: an integrative framework for studying technological change. Soc. Stud. Sci. 33, 95–116.
Bunch, D.S., Bradley, M., Golob, T.F., Kitamura, R., Occhiuzzo, G.P., 1993. Demand for clean-fuel vehicles in California: a discrete-choice stated preference pilot project. Transp. Res. A Policy Pract. 27, 237–253.
Calfee, J., 1985. Estimating the demand for electric automobiles using fully disaggregated probabilistic choice analysis. Transp. Res. B 19B, 287–301.
Caperello, N., Kurani, K.S., 2012. Households' stories of their encounters with a plug-in hybrid electric vehicle. Environ. Behav. 44, 493–508.
Carrasco, J.A., Hogan, B., Wellman, B., Miller, E.J., 2008. Collecting social network data to study social activity-travel behavior: an egocentric approach. Environ. Plan. B: Plan. Des. 35, 961–980.
Ewing, G., Sarigollu, E., 2000. Assessing consumer preferences for clean-fuel vehicles: a discrete choice experiment. J. Public Policy Mark. 19, 106–118.
Galis, V., Gyberg, P., 2011. Energy behaviour as a collectif. Energy Effic. 4, 303–319.

Giddens, A., 1991. Modernity and Self-Identity: Self and Society in the Late Modern Age. Stanford University Press, Stanford, CA.
Goetzke, F., Rave, T., 2011. Bicycle use in Germany: explaining differences between municipalities with social network effects. Urban Stud. 48, 427–437.
Heffner, R.R., Kurani, K.S., Turrentine, T.S., 2007. Symbolism in California's early market for hybrid electric vehicles. Transp. Res. Part D: Transp. Environ. 12, 396–413.
Hidrue, M.K., Parsons, G.R., Kempton, W., Gardner, M.P., 2011. Willingness to pay for electric vehicles and their attributes. Resour. Energy Econ. 33, 686–705.
Hirschman, E.C., 1981. Symbolism and technology as sources for the generation of innovations. Adv. Consum. Res. 9, 537.
Hitchings, R., 2011. Researching air-conditioning addiction and ways of puncturing practice: professional office workers and the decision to go outside. Environ. Plan. A 43, 2838–2856.
Hogan, B., Carrasco, J.A., Wellman, B., 2007. Visualizing personal networks: working with participant-aided sociograms. Field Methods 19, 116–144.
Jackson, T., 2005. Motivating Sustainable Consumption: A Review of Evidence on Consumer Behaviour and Behavioural Change. Sustainable Development Research Network, University of Surrey, Guildford, Surrey, UK.
Jolivet, E., Heiskanen, E., 2010. Blowing against the wind — an exploratory application of actor network theory to the analysis of local controversies and participation processes in wind energy. Energy Policy 38, 6746–6754.
Kahn, M.E., Vaughn, R., 2009. Green market geography: the spatial clustering of hybrid vehicles and LEED registered buildings. B.E. J. Econ. Anal. Policy 9, 1–22.
Kline, R., Pinch, T., 1996. Users as agents of technological change: the social construction of the automobile in the rural United States. Technol. Cult. 37, 763–795.
Kurani, K.S., Turrentine, T., Sperling, D., 1994. Demand for electric vehicles in hybrid households: an exploratory analysis. Transp. Policy 1, 244–256.
Liberman, M., Trope, Y., Stephan, E., 2007. Psychological distance. In: Kruglanksi, A.W., Higgins, E.T. (Eds.), Social Psychology: Handbook of Basic Principles. Guildford Press, New York, NY.
Lovell, H., 2009. The role of individuals in policy change: the case of UK low-energy housing. Environ. Plan. C 27, 491–511.
Marwell, G., Oliver, P.E., Prahl, R., 1988. Social networks and collective action: a theory of the critical mass 3. Am. J. Sociol. 94, 502–534.
Mau, P., Eyzaguirre, J., Jaccard, M., Collins-Dodd, C., Tiedemann, K., 2008. The 'neighbor effect': simulating dynamics in consumer preferences for new vehicle technologies. Ecol. Econ. 68, 504–516.
Maxwell, J., 2005. Qualitative Research Design: An Interactive Approach. Sage Publications, Thousand Oaks, CA.
McCracken, G., 1988. The Long Interview. Sage Publications, Newbury Park, California.
Noonan, D., Hsieh, L., Matisoff, D., 2013. Spatial effects in energy-efficient residential HVAC technology adoption. Environ. Behav. 45, 476–503.
Norton, B., Costanza, R., Bishop, R., 1998. The evolution of preferences: why 'sovereign' preferences may not lead to sustainable policies and what to do about it. Ecol. Econ. 24, 193–211.
Oliver, P., Marwell, G., Teixeira, R., 1985. A theory of the critical mass 1. Interdependence, group heterogeneity, and the production of collective action. Am. J. Sociol. 91, 522–556.
Paez, A., Scott, D., Volz, E., 2008. A discrete-choice approach to modeling social influence on individual decision making. Environ. Plan. B: Plan. Des. 35, 1055–1069.
Peattie, K., 2010. Green consumption: behavior and norms. Annu. Rev. Environ. Resour. 35, 195–228.
Pinch, T.J., Bijker, W.E., 1984. The social construction of facts and artifacts — or how the sociology of science and the sociology of technology might benefit each other. Soc. Stud. Sci. 14, 399–441.
Potoglou, D., Kanaroglou, P.S., 2007. Household demand and willingness to pay for clean vehicles. Transport. Res. Part D — Transport. Environ. 12, 264–274.
Rogers, E., 2003. Diffusion of Innovations, 5th ed. Free Press, New York.
Shove, E., 2010. Beyond the ABC: climate change policy and theories of social change. Environ. Plan. A 42, 1273–1285.
Shove, E., Warde, A., 2002. Inconspicuous consumption: the sociology of consumption, lifestyles and the environment. In: Dunlap, R., Buttel, F., Dickens, P., Gijswijt, A. (Eds.), Sociological Theory and the Environment: Classical Foundations, Contemporary Insights. Rowman & Littlefield Publishers, Lanham, Maryland.
Skippon, S., Garwood, M., 2011. Responses to battery electric vehicles: UK consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance. Transp. Res. Part D: Transp. Environ. 16, 525–531.
Spaargaren, G., 2003. Sustainable consumption: a theoretical and environmental policy perspective. Soc. Nat. Resour. 16, 687–701.
Spaargaren, G., Van Vliet, B., 2000. Lifestyles, consumption and the environment: the ecological modernization of domestic consumption. Environ. Polit. 9, 50–76.
Steg, L., 2005. Car use: lust and must. Instrumental, symbolic and affective motives for car use. Transp. Res. A Policy Pract. 39, 147–162.
Stets, J., Biga, C., 2003. Bringing identity theory into environmental sociology. Sociol. Theory 21, 398–423.
Train, K., 1980. The potential market for non-gasoline-powered automobiles. Transp. Res. A Policy Pract. 14A, 405–414.
Turner, V., 1969. The Ritual Process: Structure and Anti-Structure. Aldine Publishing, Chicago, IL.
Valente, T., 2005. Network models and methods for studying the diffusion of innovations. In: Carrington, P., Scott, J., Wasserman, S. (Eds.), Models and Methods in Social Network Analysis. Cambridge University Press, New York, New York, pp. 98–116.
van Rijnsoever, F., Farla, J., Dijst, M.J., 2009. Consumer car preferences and information search channels. Transp. Res. Part D: Transp. Environ. 14, 334–342.
Wilson, C., Dowlatabadi, H., 2007. Models of decision making and residential energy use. Annu. Rev. Environ. Resour. 32, 169–203.
Wood, W., Hayes, T., 2012. Social influence on consumer decisions: motives, modes, and consequences. J. Consum. Psychol. 22, 324–328.