Observing social influence and consumer preference formation: The case of a U.K. workplace electric-vehicle trial

Submitted to:
International Society of Ecological Economics, 2012

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Abstract

We studied social influence regarding consumer perceptions and preferences in the case of battery electric vehicles (BEVs). The context was a technology-based workplace in the U.K. with around 500 members of staff (employees and contractors), 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. We elicited details about their BEV preferences, experiences with BEVs, and social interactions relating to BEVs. Participants reported a wide variety of perceptions of EV attributes, including environmental benefits and functional drawbacks. Given the novelty of this technology, many of these perceptions were highly uncertain and subject to influence. In particular, the majority of participants indicated their BEV perceptions were "highly influenced" by social interactions with coworkers, friends, or family. Processes of social influence included: diffusion, the sharing of BEV-related information (most frequent but least influential); translation, the discussion of uncertain BEV benefits and drawbacks; and reflexivity, the relating of BEV technology to the individual's lifestyle and self-concept (least frequent, but most influential). Findings suggest that consumer perceptions evolve with technological development and in part through social negotiation. We conclude that in the study of markets for emerging vehicle technology, neglect of social influence processes will underestimate the potential for consumer perceptions and preference to develop and shift.

1. Introduction

Consumer valuation of new products is central to the successful deployment of alternatively fueled and propelled vehicles, such as battery electric vehicles (BEVs). Economic models currently dominate research on transportation choices, representing consumers as "rational individuals" that make deliberative decisions to maximize their individual satisfaction (utility) based on perfect information. However, behavioural 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).

This study explores one particular determinant of consumer purchase behaviour: social influence. Social influence can be defined as occurring when an individual's thoughts, feelings or actions are affected by other people. More precisely, this study focuses on interpersonal influence (as opposed to structural or institutional influence). At least in the case of emerging technologies such as BEVs, consumers tend not to have pre-existing preferences for novel attributes such as electric-drive (Caperello and Kurani, In Press; Kurani et al., 1994). Instead, preferences tend to be constructed in the process of facing novel choice sets (Bettman et al., 1998; Norton et al., 1998), and to be based on more abstract construals than those for less psychologically distant products (Liberman et al., 2007). Further, these perceptions, preferences, and related "controversies" are often negotiated among individuals and social groups (Axsen and Kurani, In Press; Kline and Pinch, 1996).

We presently explore several research questions in the context of a BEV demonstration project implemented at a U.K. workplace in 2010. We report consumer perceptions of BEV benefits, drawbacks and controversies, we explore how these

perceptions are socially negotiated and influenced, and finally we characterize the specific processes of social influence that occur. To do so, we draw from 21 semi-structured interviews that collected quantitative and qualitative data, which we analyze through content analysis, as well as a discrete choice model and statistical regression of reported social interactions.

2. Context

2.1 Markets for electric vehicles

Electric vehicles (EVs) 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 (PHEVs) 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 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 and require regular recharging to operate because they have no internal combustion engine. The present study focuses on a workplace BEV experience project.

EV market research information can take a variety of perspectives—focusing on one or more category of consumers' perceived benefits (or drawbacks). We present a simple typology that distinguishes consumer perceptions using two dimensions: functional vs. symbolic, and private vs. societal (Axsen and Kurani, In Press). Most technical and economic studies focus on the private-functional aspects of EVs, such as the technology's potential to reduce fuel and operation costs or to limit driving range and increase refueling time—in other words, functional benefits or limitations that affect the individual. Alternative-fuel vehicles 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, EVs can be novel in that they may offer societal-functional benefits, such as reduced air pollution, greenhouse gas emissions and oil dependence, 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 decreased oil dependence. Further, consumer perceptions of private, societal, functional and symbolic attributes can substantially change over time through exposure, social negotiation, and development of the technology itself.

The rational actor model depicts consumers as optimizing, deliberative, autonomous and typically isolated, selecting behaviours 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 by definition cannot yield insight into specific processes of interpersonal influence.

In contrast, social models of consumption explicitly represent the "social embeddedness" of consumer behaviour and decision-making (Jackson, 2005), looking at individuals acting as part of a household, community and social network (Peattie, 2010). Presently, we seek to account for individual and social aspects of consumer preferences

for EVs, including the roles of interactions with other individuals, as well as media and sources of information. In this effort, we look at the formation of existing EV perceptions and preferences, as well as the uncertainty and potential dynamics of those preferences.

2.2 A conceptual framework of social influence

Our conceptual framework identifies and integrates three processes of influence pertaining to new products: diffusion, translation, and reflexivity. Respectively, these processes address increasingly complex topics 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, In Press).

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).

Secondly, 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 its meaning and content, and these interpretations may influence further technological development (Pinch and Bijker, 1984). So, while diffusion brings awareness to the individual, it is through translation that he or she begins to assess and personalize the product's attributes.

Through the third process, 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 behaviour (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 (Giddens, 1991; Spaargaren, 2003). Reflexivity is the dynamic, continuous, self-aware process through which one defines and expresses oneself. For example, consideration and adoption of an EV 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 either the new product 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 term 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, marriage/divorce), has access to a diverse social network, and/or has access to resources such as time and money. 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).

While previous research highlights the importance of distinguishing between each process (Axsen and Kurani, In Press), we now further hypothesize that the three processes represent a sort of continuum, where diffusion, translation, then reflexivity, are respectively of decreasing frequency in occurrence, but of increasing importance with regards to influence on the individual's preferences.

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 Trial." The BEV Trial utilized two first-generation electric cars (four-seater, small hatchbacks)—by "first generation" we mean a prototype model that is less technologically advanced and less reliable than a second or third generation model. These BEVs were powered by 30 kW electric motors with lithium-ion batteries in place of the conventional internal combustion engine and fuel tank. These BEVs had an on-board charger enabling them to be charged with a standard U.K. 13A, 240V domestic power sources, and could be fully charged in about 6 hours.

This workplace context provided several unique opportunities for innovative research on 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 including those that did not take part in the BEV Trial. 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 Trial 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.

Clearly, this project context and elicited sample was not intended to be representative of U.K. car buyers. Instead, we sought to include participants from a breadth of backgrounds, lifestyle practices, degrees of exposure to EV technology, and social network structures. To identify which aspects of a given participant's social network was stimulated by the BEV Trial, 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 can get a sense of influence across the workplace.

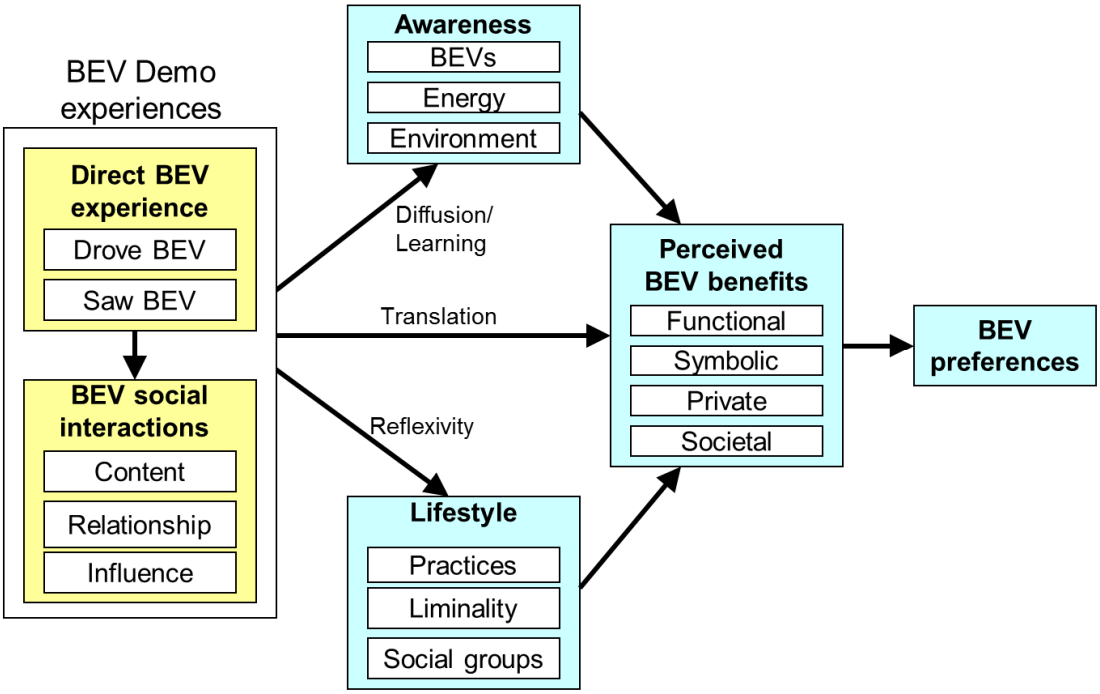
In this paper, all participant names are pseudonyms, and all participants spoke on behalf of their personal perceptions and preferences, not those of their employer.

3.2 Methods and research instruments

Figure 1 depicts the methodological framework, which utilized the BEV Trial context to explore the stated research topic, and in particular the three social influence processes reviewed in Section 2.2. The BEV Trial is presumed to have generated two types of experiences among 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 by: 1) affecting awareness through

diffusion, 2) affecting their personal evaluation 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 behaviour from elicited preferences, due to the lack of an actual BEV market.

Figure 1: Methodological framework



Due to the complexity of this research topic, we utilized a multi-method research design (McCracken, 1988), combining several complementary research instruments. First, a short web-based screener survey was designed to collect data from a large sample of Shell employees from this worksite. 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 Trial, 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 subset of this survey sample was selected for semi-structured interviews, which blended structure and open-endedness. Each interview followed a similar structure and touched on the same talking points, but the interviewer allowed flexibility to maintain a natural dialogue with the participant and elicit details of their personal narrative (McCracken, 1988). Each interview addressed current vehicle ownership and transportation behaviour, BEV perceptions and experience, social network mapping, BEV-related social interactions, rating of social influence, and future vehicle purchase intention.

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 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 EV-related information or influence such as media. Participants

were then asked to rate the influence each of these social and technical experiences had over 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 EV 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 (£UK), all-electric range (miles), time required for complete recharge (hours), and acceleration capability (% change from conventional vehicle).

Table 1: Attribute levels in EV 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

Together, all four attributes 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. In the choice sets, each participant first stated the next likely vehicle purchase, 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 important attributes are likely missing. Implicitly, these missing attributes are represented by the BEV-constant in estimated multinomial-logit 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. Qualitative data from the semi-structured interviews provide insight into these additional attributes.

4. Results

4.1 Sample

In June 2011, 191 employees completed the screener survey. From these responses, we selected a diverse subsample of 21 employees to complete semi-structured interviews. This subsample included eight employees that drove the first-generation BEV (as a BEV Trial 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 first-generation BEV but did talk with at least one coworker about it. This subsample included a wide range of ages, income levels, employment types, attitudes and lifestyles. The size of elicited social networks included between 17 and 56 "close" alters per participant.

The interviewer specifically elicited information about three aspects of lifestyles: engagement in technology-oriented practices, engagement in pro-environmental practices, and overall lifestyle liminality (openness, flexibility or transitionality). Drawing from previous research, we expected these lifestyle considerations to be particularly relevant to an individual's EV preferences (Axsen and Kurani, In Press). 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 describe 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 Assessment of EVs

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 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 2). Most participants specified a particular environmental benefit, such as reduced greenhouse gas emissions or improvements to local air quality. Others 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 with electricity, as well as vehicle performance such as quietness, smoothness of the driving experience, and surprisingly impressive initial acceleration. A few participants placed value on the ability to recharge at home, avoiding the "time and effort" associated with visiting a petrol station.

Nearly all the perceptions of BEV drawbacks were private-functional in nature (Table 3). The most frequently mentioned drawback was the perceived lack of range relative to conventional vehicles—the electric range of the first-generation BEVs used in the BEV Trial 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 first-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.

Table 2: Perceived benefits of BEVs

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/hour."	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

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 4). 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 charging.

Table 3: Perceived drawbacks of BEVs

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 & 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

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 first-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 EV technology tended towards a pessimistic view. They indicated that their current perceptions of functional limitations represented lasting or insurmountable problems with EV technology in general.

Table 4: BEV controversies

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

4.3 Another view of preferences: A discrete choice exercise

As a complement to the above qualitative summary, we conducted a discrete choice analysis to provide a quantitative perspective on participants' interests in BEVs. This analysis is exploratory in nature—drawing from the 9 choice observations collected from each interviewee (189 choices total). Three estimated multinomial logit models are portrayed in Table 5. The first model includes only the main attributes, assuming linear relationships, and the BEV-constant. The second model transforms the refuel time and vehicle range variables into non-linear variables (natural log or "ln") and offers slightly

improved explanatory power. The third 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 BEV-liminal interaction coefficient.

Table 5 also portrays the average willingness-to-pay (WTP) for each unit of each attribute, by dividing a given coefficient by the purchase price coefficient (holding household income level constant at UK£ 72,000). These values give a sense of the general patterns of consumer preferences, although not all the coefficients are statistically significant. Participant WTP for one less hour of recharge time is fairly low: UK£ 75 to £83 per reduced hour of recharge. On the other hand, WTP of UK£ 28 to 36 for an extra mile of 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£ 46 to 53 per percentage increase in acceleration compared to a conventional vehicle—so a 25% improvement in acceleration would be worth UK£ 1,160 to 1,310 extra in purchase price. This is not inconsistent with the differences in available acceleration and price between models with different engine sizes in the UK market.

Table 5: Results of discrete choice model

	Linear model		Non-linear		Non-linear w/lifestyle	
	Coeff.	*t*-Stat	Coeff.	*t*-Stat	Coeff.	*t*-Stat
Price / ln(income)	-0.0048	-2.54*	0.0019	-2.52*	-0.0064	-3.01**
Refuel time	-0.0338	-0.684				
ln(refuel time)			0.444	-0.76	-0.413	-0.85
Range	0.0121	2.42*				
ln(range)			0.622	2.49*	1.88	2.71**
Acceleration	0.0226	2.21*	0.0103	2.13*	0.0268	2.33*
BEV constant	2.72	1.83	2.290	1.10	2.84	1.13
BEV x Liminal lifestyle					2.38	4.37**
BEV x Tech lifestyle					-0.96	-1.93
BEV x Enviro lifestyle					0.72	1.58
Observations	189		189		189	
Max log-likelihood	-83.50		-83.10		-69.68	
LL ratio [a]	0.363		0.366		0.468	
Willingness to pay (UK£) [b]						
One hour less recharge. time	£78.55		£82.46[c]		£75.55[c]	
One mile extra range	£28.27		£35.72[d]		£32.53[d]	
One % increase acceleration	£52.54		£50.79		£46.48	
BEV constant (base)	£6,323.42		£5,811.58		£4,938.71	
BEV w/liminal lifestyle					£9,076.86	
BEV w/tech lifestyle					£3,266.06	
BEV w/environmental Lifestyle					£6,183.06	

[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 household income = £72,000.
[c] Change from 10 hours to 9 hours recharge time.
[d] Change from 100 miles to 101 miles range.
* $p < 0.05$ ** $p < 0.01$

The BEV constant is positive in all three models, corresponding to a WTP of £UK 4,900 to 6,300 over a conventional vehicle, with all specified attributes held constant. That is, if the conventional vehicle and BEV version have identical range, acceleration, and refuel time, participants on average were willing to pay substantially more for the BEV version. These WTP estimates are higher than the UK£ 2000 premium that a majority would pay for a BEV in an earlier UK study (Skippon and Garwood, 2011) but comparable to a previous U.S. study estimating a WTP of US$ 6,000 to 16,000 for EVs

(Hidrue et al., 2011). In other words, for this sample there are strong positive values associated with EVs, once any functional limitations of range, recharge time and acceleration are controlled for. This WTP varies with participant lifestyle (Model 3)—those with a liminal (open) lifestyle have the highest WTP (~UK£ 9,100), followed by those with a pro-environmental lifestyle (~UK£ 6,200), then participants with technology-oriented lifestyles (~UK£ 3,300). EV technology seems to appeal more to participants with a liminal lifestyle mind and/or environmental lifestyle, but not to participants that are interested in technology more generally.

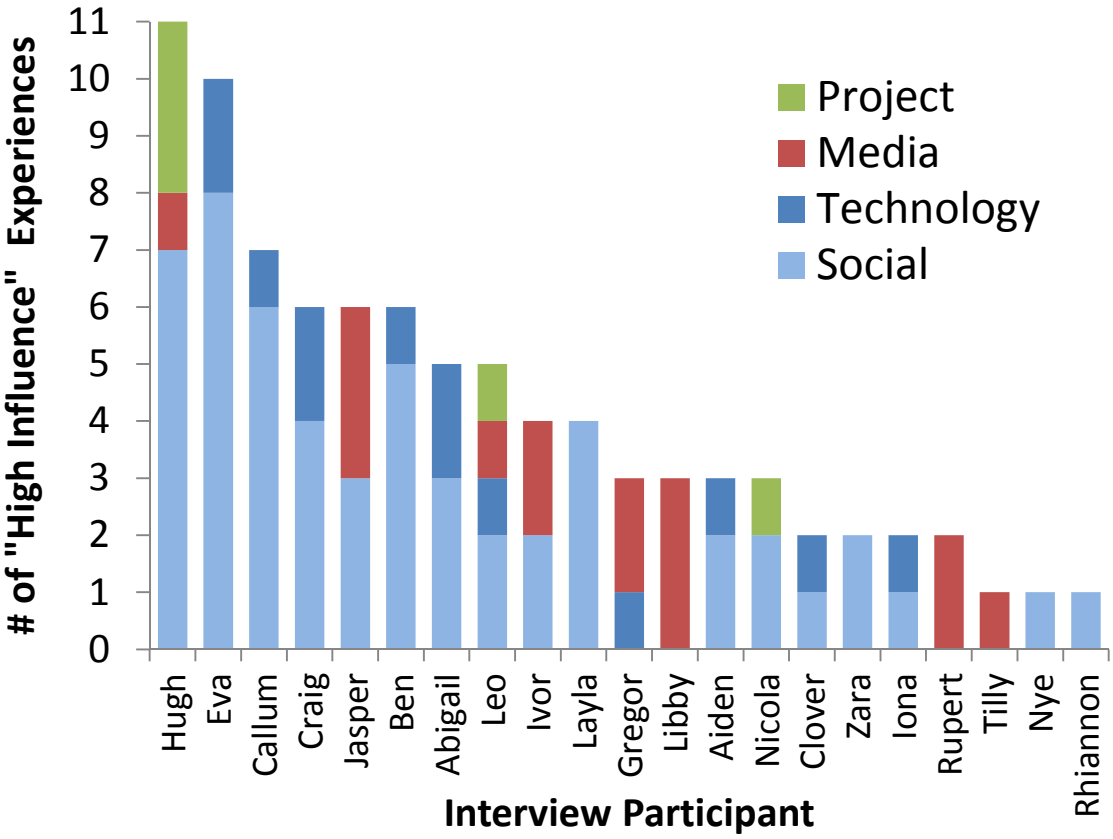
4.4 Sources of EV information

We now turn to exploration of the sources of these perceptions, preferences and controversies. As a starting point, Figure 2 portrays the EV-related experiences rated by each participant as being "highly influential" regarding their EV preferences. Experiences are broken into four categories: technology, media, work-related projects and social interactions.

Direct experience with the technology included driving an EV, riding in one as a passenger, or seeing one. Eleven participants reported driving an EV, mostly the first-generation BEV as part of the BEV Trial, as well as two participants who had driven a relatively more advanced, second-generation 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 Trial 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.

Figure 2: Number of "high influence" experiences by type

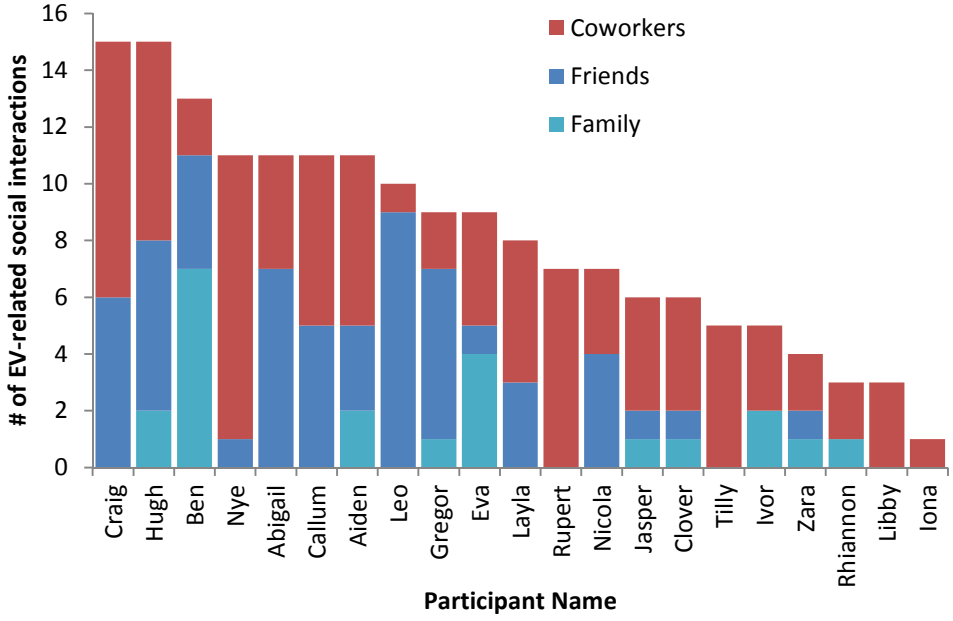


A total of thirteen participants reported some sort of media-based experience. Six mentioned a common source: a popular, comedic automotive TV program called "Top Gear". This program is generally perceived to have a negative view of EV technology: "they're very, very anti-new technologies". For example,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

different automotive-themed magazines and TV programs, 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." Figure 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 one to 15. Of these interactions, about half occurred with a very close alter, a third occurred with a somewhat close alter, and about 14 percent occurred with a casual acquaintances (neither somewhat nor very close—thus not initially identified in the participant's sociogram). Figure 3 depicts interactions by relationship role category, where just over half occurred with coworkers.

Figure 3: Number of interpersonal interactions by relationship role



4.5 Qualitative analysis of social influence

To explore the specific processes of social influence, we first summarize our qualitative analysis of participants' narratives of social influence which relate to the processes of diffusion, translation and reflexivity introduced in Section 2.2.

Processes of diffusion are characterized as the sharing of information, from a sender to a receiver. Such information is relatively simple, and any influence 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 include an evaluation of BEVs. Although 62 percent of the 170 social interactions are categorized as diffusion, only 41 percent are categorized as only diffusion (not also as translation or reflexivity).

Consider a simple example. Ben diffused information regarding his participation in the BEV Trial by posting a message on his Facebook account: "drove an electric vehicle home tonight!" That instance was 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 potentially this information was novel for some of Ben's alters, 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 dialogue.

Processes of translation are more complex and sophisticated than diffusion—the ego and alter somehow discuss and inform their personal evaluation of the BEV, rather than just sharing information about its functions. Such interactions tend to be bi-directional or multi-directional (as opposed to one-way), and influence occurs by

affecting the individual's BEV preferences and potentially their certainty in these preferences. About 53 percent of interactions reported in this study are classified as including translation—and 29 percent 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 4).

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 percent) 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; engaging with lifestyle, countering lifestyle, and openness to lifestyle change.

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 Trial participant that demonstrated how a BEV might be integrated into their 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 and. 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 unplugged 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—moving in 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.

4.6 Quantitative analysis of social influence

The preceding analysis suggests 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 quantitatively tested 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 6 presents two models specifying the rating influence of each social interaction as the dependent variable (with three ordinal levels: high, moderate and low influence). The full model incorporates all 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 ego's lifestyle and self-concept (reflexivity). Further, instances of reflexivity appear to be particularly influential, as indicated by the larger coefficient estimates.

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 (and thus presumably has more expertise to share). As found in previous exploratory research, influence does not strongly relate to ego-alter relationship by social proximity or role category.

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 process. Table 7 presents cross-tabulations of social interactions by each influence process, and by the alter's role category. If the alter was a coworker, 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.

Table 6: Logistic regression of social influence (170 social interactions)

Factor (reference)	Full model	Reduced model
Intercept 1	-0.248	0.062
Intercept 2	**1.712****	**1.938****
Characteristics of ego		
EV study participant	0.535	
Liminal lifestyle	0.247	
Technology-oriented lifestyle	**-1.685****	**-1.594****
Characteristics of alter		
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 7: Social influence processes by role category

	Alter's role category			
Process	Coworker	Family	Friend	Total
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 (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

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 difference 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.

5. Summary and discussion

A wide variety of BEV perceptions were elicited from this sample, which are categorized according to functional-symbolic and private-societal dimensions in Table 8. Most perceived benefits addressed private-functional attributes of BEVs, such as the potential to save fuel 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 inability to charge at home, work or public locations. Societal attributes were also frequently mentioned, including 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?

The choice modeling exercise produced quantified estimates of participants' evaluations. When controlling for range, purchase price, acceleration and recharge time, participants overall held a positive valuation of EVs; they were willing-to-pay UK£ 3,000 to 9,000 extra for a BEV version of their next vehicle—this valuation was higher for participants with open (liminal) lifestyles and those with relatively pro-environmental lifestyles. This positive valuation is an aggregation of all the other perceived attributes listed in Table 8 (and perhaps other attributes that were not mentioned), including perceived environmental benefits, fuel cost savings, technology uncertainty, and symbolic values. The elicited controversies are also an important component of participant perceptions, e.g. uncertain environmental impacts.

According to participants, these perceived benefits, drawbacks and controversies were influenced by a variety of information sources. About half the participants reported that their preferences were highly influenced by direct experience with BEV technology, such as driving or viewing the first-generation BEV, or another EV model. More sophisticated technologies, e.g. second-generation BEVs (which some participants had experienced), seemed to be received positively, whereas less developed BEVs, e.g. the first-generation BEV used in BEV trial were more likely to be viewed negatively. 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.

Returning to one focus of the paper, the majority of participants (17 of 21) reported at least one social interaction as being highly influential over their BEV preferences. These social interactions occurred across between individuals of varying levels of social proximity and relationship roles—neither of which proved statistically associated with influence. Many of these BEV-related social interactions were stimulated

by the BEV Trial, and in about one-fifth of these interactions the alter (the individual that the interviewed participant spoke with) had been a BEV Trial participant. 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 conceptual framework presented in Section 2.5, we also sought to better understand three distinct processes of social influence: diffusion, translation and reflexivity. When controlling for other factors, interactions described as reflexivity were most likely to be rated as highly influential, followed by translation, then diffusion.

Table 8: Compilation of EV interpretations (frequency)

	Functional	Symbolic
Private	**Benefits:**	**Benefits:**
	Cheap to run (8)	Fun/new image (2)
	Quiet (8)	**Drawbacks:**
	Convenient to charge (6)	Too restrictive (4)
	Fast acceleration (4)	**Controversies:**
	Smooth (3)	Can be sporty? (1)
	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)	
Societal	**Benefits:**	**Benefits:**
	Environmental (13)	Pressure car companies (1)
	Job creation (1)	**Drawbacks:**
	Drawbacks:	None
	Unsafely quiet (3)	**Controversies:**
	Controversies:	None
	Lifecycle impact? (17)	
	Too quiet? (2)	

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

About two-thirds of the 170 reported social interactions are classified as diffusion (and 40 percent 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.

Processes of translation involve explicit evaluation of the BEV-technology; the interaction somehow addresses an individual's BEV preferences. Instances of translation were generally rated as being 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 seems logical, where discussion of BEV benefits and limitations, and BEV preference is typically more engaging than only adding 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. The direction of translation tended to resemble

that of diffusion, more often flowing from coworkers, and more often towards friends or family.

Processes of reflexivity are by definition the most complex of the three we explore—directly engaging the participant's lifestyle and self-concept. In such cases the BEV is considered in terms of how it might align or conflict with the participant's lifestyle, or potentially help to shift their lifestyle in a desired direction, e.g. being more pro-environmental. Occurrences of reflexivity were most likely to be rated as influencing BEV preferences, and are also least frequent (7 percent of reported interactions). Further, reflexivity seems to engage different role categories than diffusion or translation—more often involving family rather than coworkers or friends. Our results suggest that while coworkers at a technology-oriented worksite may be more likely to diffuse BEV-related information to the ego, 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.

In short, we find that participant preferences for BEVs are highly varied, uncertain, and subject to influence. In particular, preferences were influenced by social interactions with coworkers, friends and family—most of which had no direct experience with BEVs. Further, these social interactions vary by content, degree of influence and process of influence. Thus, we suggest that consumer preferences can be dynamic and socially shaped—at least in this case of emerging alternative-fuel vehicle technology. Much more research is needed to improve understandings and representations of consumer preference dynamics for novel technologies. This study demonstrates the potential strengths of a mixed-method approach, including the integration and quantitative and qualitative insights.

6. Conclusions and implications

Analysis of interviews with 21 participants that were exposed to BEVs either directly (driving or seeing the vehicle) or indirectly (via social interactions) indicates that consumer BEV perceptions and preferences are highly varied and uncertain. Many participants value BEVs for environmental and some private benefits, but also perceive important functional drawbacks such as range limitations and purchase expense. But these perceptions are generally uncertain, especially the frequently mentioned controversy as to whether BEVs have the ability to reduce lifecycle environmental impacts (including electricity generation and battery production and disposal).

We find evidence that many of these perceptions are subject to change, and can be influenced by social interactions, direct experience with BEV technology, and media. In particular, the majority of participants were "highly influenced" by at least one social interaction, and one-third of the 170 reported BEV-related were highly influential. About half of participants were highly influenced by direct experiences such as driving the BEV, being a passenger, or seeing a BEV. Also, many participants' BEV perceptions were influenced by a variety of media sources, such as newspapers, websites, and TV programs.

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 EV evaluation: Diffusion is the social process of sharing EV-related information (without evaluation), and is the most common but typically least influential form of social interaction. Information is typically diffused from relative BEV-experts to non-experts. Translation is the process of socially discussing and negotiating personal evaluation of BEVs—such interactions are slightly less common and tend to be slightly

more influential than instances of diffusion. Like diffusion, translation is typically more influential in interactions between individuals with varying BEV expertise—where evaluations of relative non-experts are more likely to be influenced by the relative expert. Reflexivity relates BEV technology to the participant's lifestyle and self-concept. This is the least common, but most 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.

In short, social influence can play an important role in consumers' preference formation. Most significant instances of influence are more aptly referred to as translation or reflexivity rather than diffusion. Participants are not just influenced by learning information about BEVs from another person. More significant influence occurs as a result of the participant "translating" the information into their personal evaluation (translation) or into their own context of lifestyle and self-concept (reflexivity). Further, some social interactions played the role of negotiating "controversies" or uncertainties.

Due to the novelty and uncertainty of BEV development, we suggest that consumers' evaluations can be highly subject to influence—depending on the types of BEVs they see, the people they talk to, and the messages they encounter through media. In the study of markets for emerging vehicle technology, 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 can strongly bias results of market potential for new, pro-environmental technologies. 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.

Acknowledgments

The authors acknowledge funding from the Shell Global Solutions.

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