Article:
Schuitema, G, Anable, J orcid.org/0000-0002-4259-1641, Skippon, S et al. (1 more author) (2013) The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. Transportation Research Part A: Policy and Practice, 48. pp. 39-49. ISSN 0965-8564

https://doi.org/10.1016/j.tra.2012.10.004

Running head: INTENTION TO ADOPT ELECTRIC VEHICLES

The Role of Instrumental, Hedonic and Symbolic Attributes in the Intention to Adopt Electric Vehicles

Geertje Schuitema[a]

Jillian Anable[a]

Stephen Skippon[b]

Neale Kinnear[c]

Author's note

[a]Centre for Transport Research, University of Aberdeen, Elphinstone Road, Aberdeen, AB24 3UF, UK

[b]Shell Global Solutions (UK), Shell Technology Centre Thornton, P.O. Box 1, Chester, UK, CH1 3SH, UK

[c]Transport Research Laboratory, Crowthorne House, Nine Mile Ride, Wokingham, Berks RG40 3GA, UK

Correspondence concerning this article should be addressed to Geertje Schuitema, Aarhus University, Business and Social Sciences, Department of Business Administration, Haslegaardsvej 10, 8210, Aarhus V, Denmark, g.schuitema@asb.dk (e-mail), +45 8948 6494 (phone), +45 8615 3988 (fax)

Highlights

- Hedonic/ symbolic attributes mediate affect of instrumental attributes on EV adoption
- People with a pro-environmental identity have positive perceptions of EV attributes
- Higher intentions to adopt plug-in hybrid electric vehicles than battery-electric vehicles
- Plug-in hybrid electric vehicles perceived as more positive than battery-electric vehicles
- Results important for marketing strategies because people align self-identity with purchases

Abstract

The aim of the present study is to understand how private car drivers' perception of vehicle attributes may affect their intention to adopt Electric Vehicles (EVs). Data are obtained from a national on-line survey of potential EV adopters in the UK. The results indicate that instrumental attributes are important largely because they are associated with other attributes derived from owning and using EVs including pleasure of driving (hedonic attributes) and identity derived from owning and using EVs (symbolic attributes). We also find that people who believe that a pro-environmental self-identity fits with their self-image are more likely to have positive perceptions of EV attributes. In addition, perceptions of EV attributes were found to be only very weakly associated with car-authority identity.

Keywords: electric vehicle, perception of vehicle attributes, pro-environmental self-identity

The Role of Instrumental, Hedonic and Symbolic Attributes in the Intention to Adopt Electric Vehicles

1. Introduction

Worldwide climate-change abatement strategies tend to involve the electrification of light duty road transport to achieve the transport sector's share of carbon-oxide reduction targets. However, uptake of Electric Vehicles (EVs) will depend heavily on how consumers perceive them. People often tend to be sceptical when new technologies such as EVs are introduced, as they are generally seen as novel technologies of which mass-market consumers have very little experience or knowledge (A. Gärling and Thøgersen, 2001). Consequently it is important to understand which attributes of this new type of vehicle are most likely to influence peoples' perceptions. In this paper we focus on how perceptions of instrumental, hedonic, and symbolic attributes may influence the adoption of EVs by private consumers. We also examine the role of self-identity, which may influence the attributes on which people focus. In addition, we explore the perceived attributes of different types of EVs and how such attributes are perceived if the EV is considered as a potential main or second car for the household.

1.1 Electric Vehicles

The EV is not a modern invention. In fact, the first vehicles that ran on rechargeable batteries were developed in the 19th century. However, as oil was cheap and widely available, vehicles with a conventional internal combustion engine (ICE) powertrain dominated the market. In the last decade, a growing interest in EVs has been observed and hybrid electric vehicles (HEVs) have already been introduced into the market in significant numbers. HEVs have an ICE powertrain alongside a supplementary electric powertrain consisting of an electric motor driven from a

battery. This enables high efficiency urban driving, since energy that would be lost in braking can be recovered and used to charge the battery. However, the battery is charged entirely via this regenerative braking or directly by the ICE powertrain, so all the HEV's energy originally comes from its liquid fuel. HEVs can therefore be seen simply as a more efficient, conventionally fuelled car.

In contrast, a battery-electric vehicle (BEV) has an all-electric drivetrain powered from a battery, which is recharged from the electricity supply. A plug-in hybrid electric vehicle (PHEV) is a development of the hybrid electric vehicle (HEV). PHEVs have bigger batteries than HEVs, which can be recharged from the electricity supply as well as via the ICE and regenerative braking. PHEVs can operate under electric or ICE propulsion, but generally have a short all-electric range[1]. Generally, mass adoption of BEVs and PHEVs is believed to have the highest potential to make the current transport system more sustainable, but the adoption of BEVs and PHEVs is difficult to predict as their functions differ most strongly from conventional vehicles (IEA, 2009; Proost and Van Dender, 2010). Moreover, PHEVs and BEVs are an excellent potential source for storing electricity, which is possibly beneficial to the current transformations of the electricity grid into a so-called 'smart grid'. In this paper we focus on BEVs and PHEVs only and unless referring to one type specifically, we collectively refer to them as 'EVs'.

1.2 Perceived Instrumental, Hedonic and Symbolic Attributes in Relation to EV Adoption

We define the adoption of EVs as 'consumer adoption', which is a behavioural response to technological innovations, i.e. the purchase or use of these technologies (cf. Huijts, Molin, and Steg, 2012). Most models that predict the adoption of new technologies, assumed that adoption of new technologies is predicted by 'intention to

adopt', which is itself predicted by various factors such as the perception of attitudes of these technologies (Ajzen, 1991; Davis, Bagozzi, and Warshaw, 1989). Both intention to adopt and the actual adoption behaviour are dependent on the same predictors, albeit intention is generally more strongly predicted than adoption behaviour. This implies that intention to adopt EVs is probably stronger related to the perceived EV attributes than the adoption of EVs. In this paper, we will focus on the intention to adopt EVs, as the measurement of the level of actual adoption is not easily achieved.

The intention to adopt new technologies is linked to consumers' innovativeness, which is defined as their tendency to buy new products in a particular product category soon after they appear in the market and relatively earlier than most other consumers (Foxall, Goldsmith, and Brown, 1998). Three main motivational dimensions of consumer innovativeness have been distinguished: instrumental, hedonic, and symbolic (Vandecasteele and Geuens, 2010)[2]. It can be expected that consumers focus most strongly on instrumental attributes when they have instrumental motives to adopt a product. Instrumental attributes refer to the functionality or utility that can be derived from functions performed by new technologies (Dittmar, 1992; Voss, Spangenberg, and Grohmann, 2003). Similarly, hedonic innovativeness probably leads to a strong focus on hedonic attributes, which refers to the emotional experience derived from using new technologies, such as joy or pleasure (Dittmar, 1992; Roehrich, 2004; Voss, et al., 2003), and symbolic innovativeness to a strong focus on symbolic attributes, which is related to a sense of self or social identity that is reflected by, or built from the possession of new technologies (Dittmar, 1992; Roehrich, 2004).

In general, car use and car ownership are typically associated with instrumental,

hedonic, and symbolic attributes (e.g., Anable and Gatersleben, 2005; Bergstad et al., 2011; Steg, Vlek, and Slotegraaf, 2001; Steg, 2005; Turrentine and Kurani, 2007). More specifically, it has been suggested that the adoption and use of EVs is influenced by instrumental, hedonic, and symbolic attributes of EVs (Heffner, Turrentine, and Kurani, 2006; Kurani, Turrentine, and Heffner, 2007; Skippon and Garwood, 2011).

There is an abundance of empirical evidence suggesting that the potential adoption of EVs will indeed depend on their instrumental attributes: purchase price, running costs, reliability, performance, driving range, and recharging time are all factors that are likely to influence the adoption of EVs (e.g., Beggs, Cardell, and Hausman, 1981; Bunch et al., 1993; Chéron and Zins, 1997; Graham-Rowe et al., 2012; Skippon and Garwood, 2011). However, few studies to date have investigated how the likelihood of adoption of EVs are influenced by perceptions of hedonic and symbolic attributes. Interviews with 25 households in the USA showed that the symbolic meaning of HEVs played a role in their decision to buy one (Heffner, Kurani, and Turrentine, 2007) - owning an HEV was seen as a way to express one's identity. For example, HEV ownership was seen as symbolic of "making a difference", maturity, intelligence and awareness, or as a way to stand out in the crowd. Skippon and Garwood (2011) found that after a relatively brief experience with BEVs, people attributed clear symbolic meanings to them: BEVs signalled that their users were high in agreeableness, conscientiousness, and openness to experience. A study in the UK reported that after 40 households experienced the use of a PHEV or BEV for 7 days, participants felt good from driving such a vehicle or felt less guilty about driving because of the environmental benefits associated with it (Graham-Rowe et al., 2012). However, for others, driving an EV was experienced as

embarrassing; they did not think the vehicles looked as nice as other cars, and they felt ashamed that they could not drive as quickly or confidently as other road users.

Most studies have either focussed on the separate roles of instrumental, hedonic, and symbolic attributes for the adoption of EVs, or aimed at finding their relative importance. However, Dittmar (1992) argues that a simple instrumental-symbolic/hedonic dichotomy is misplaced, because instrumental attributes fulfil a communicative function. Just like any other car, owning and using an EV has a clear functional role in that a variety of activities become possible: people can drive to work or a shop, stay in touch with friends or move goods from A to B. Dittmar argues that these use-related features combine functional and symbolic/hedonic elements: a car enables activities, but also communicates the freedom of the owner to do so (symbolic function) and give rise to emotional states and experiences (hedonic function). A quote from interviews conducted by Grahame-Rowe et al. (2012, p.148) illustrates this argument: ‘‘It was going really, really slow and I was getting overtaken by buses, lorries. I mean, when I came off the slip road I had to put my hazard lights on because I was getting beeped and all sorts, flashed (…). It was embarrassing.’’ This example illustrates how an instrumental function of an EV, i.e. speed, caused this participant’s embarrassment, implying that there is a symbolic element in the speed at which a car is driven. Hence, it can be conjectured that the effect of perceived instrumental attributes on intention to adopt EVs is mediated by the perceived symbolic and hedonic attributes of these vehicles.

1.3 Self-Identity in Relation to EV Adoption

Assuming that the perceived EV attributes play a role in the adoption of EVs, it is relevant to look into how individuals differ in their perception of these attributes. Self-image congruency theory (Sirgy, 1982, 1986) appears to be useful in explaining

how the perception of EV attributes differs amongst individuals. This theory posits that consumers who perceive a product's image to be consistent with their self-image are likely to adopt a positive attitude to this product, and subsequently are more likely to purchase it. This occurs because the likelihood that a specific product will satisfy their symbolic needs is higher when the product is congruent with their self-image. Indeed, it was shown that self-image congruency can explain consumer's preference for a car brand (Kressmann et al., 2006), car purchase intentions (Ericksen, 1996), and satisfaction with the purchased car (Jamal and Al-Mari, 2007).

A key reason why it is important that a product's image matches one's self-image is that people are motivated to indicate their social position and express their identity to others. In order to be able to do this, it is important to seek new product information (reflecting consumer novelty seeking; Manning, Bearden, and Madden, 1995) and to influence others' attitudes about the product (reflecting opinion leadership; Grewal, Mehta, and Kardes, 2000). A combination of consumer novelty-seeking and opinion leadership reflects someone as a car-authority. Consequently, it can be argued that the extent to which a person believes he or she seeks new information and influences others reflects the extent to which that person sees himself or herself as a car-authority, i.e. has a strong car-authority identity. Those with a strong car-authority identity may be most likely to be attracted to an EVs because they are generally seen as vehicles that are equipped with new and advanced car technologies, representing the future and modern technologies. On the other hand, they may be the least likely to support this notion if they are unconvinced about the performance, reliability, and overall benefits of this new technology. (cf. Heffner et al., 2007).

Another important characteristic of EVs that potential buyers might relate to is

the "green" image that EVs have, as they are believed to contribute to sustainable road transport and facilitate the electricity storage of renewable electricity sources. Whitmarsh and O'Neill (2010) define pro-environmental identity as a specific form of social identity, and refer to the extent to which people see themselves as pro-environmental (cf. Cook, Kerr, and Moore, 2002).

Owning an EV might be needed to establish a social-identity, implying that owning an EV can have a symbolic benefit for people with either a strong car-authority identity or a pro-environmental identity (cf. Grewal et al., 2000). Therefore, it could be predicted that people who identify themselves strongly either as a car-authority or as a pro-environmental person will have more positive perceptions of symbolic attributes of EVs. Assuming that the perceived instrumental and hedonic functions of EVs are correlated with the perceived symbolic attributes, we also conjecture that those who identify themselves strongly as a car-authority or pro-environmental person will have more positive perceptions of these attributes of EVs.

If people consider themselves to be a car-authority and a pro-environmental person, they might find the adoption of EVs particularly attractive, as they could potentially identify positively with EVs in two ways. Hence we anticipate an interaction effect of car-authority identity and pro-environmental identity: Those with a strong car-authority identity and strong pro-environmental identity perceive all of the instrumental, hedonic and symbolic attributes of EVs to be positive.

1.4 The Present Study

We focus on determinants of intention to adopt the two types of EVs described above: Plug-in Hybrid Vehicles (PHEVs) and Battery Electric Vehicles (BEVs). PHEVs and BEVs have different instrumental attributes, such as purchase cost and driving range. In addition, the hedonic and symbolic attributes of PHEVs may differ

from BEVs. For example, people may expect a PHEV to accelerate faster than a BEV, which would influence their perception of the vehicles' hedonic attributes; or a BEV may be seen as a clean EV leading to different perceptions of its symbolic attributes.

Furthermore, PHEVs and BEVs may be purchased either as a main or as a second car in a multi-car household. Typically, more trips in a household are made with the main car, and the purposes for which main and second cars are used may differ. It is therefore expected that the weights placed on different attributes could differ between EVs used as main and second cars.

First, we will test the hypothesis that there will be differences between the intention to adopt PHEVs and BEVs as main and second cars and if their attributes are perceived differently. We will further examine whether perceptions of instrumental, hedonic and symbolic attributes of PHEVs and BEVs influence the intention to adopt these vehicles as main or second cars. Specifically, we will examine the hypothesis that the effect of perceived instrumental attributes of PHEVs and BEVs on the intention to adopt these vehicles is mediated by perceived hedonic and symbolic attributes.

Next, we will investigate the hypothesis that people who identify themselves strongly as a car-authority or pro-environmental person have more positive perceptions of instrumental, hedonic, and symbolic attributes of PHEVs and BEVs. Moreover, an interaction effect is analysed between car-authority identity and a pro-environmental identity on the perceived instrumental, hedonic and symbolic attributes of PHEVs and BEVs.

2. Method

2.1 Sample

As EVs are generally only likely to be available to purchase as a brand new car over the next five years, participants were included only if they indicated they had purchased a new or nearly new car (< 2 years old) within the last five years in order to best reflect the potential market for these vehicles. In total 2,767 participants completed two waves of a survey. Data from 39 participants was not used, as neither they nor someone else in their household had a valid driving licence. As a result, 2,728 participants were included in the analyses.

Table 1 displays the demographic characteristics of the sample compared to statistics for car-owning individuals and households in the UK. This is not an exact comparison as the project sample included only those car owners who had purchased a new or nearly new car, and figures were not available for this at the UK level. Table 1 demonstrates that, other than the slightly higher income profile, the sample was representative of car owners in the UK.

INSERT TABLE 1 ABOUT HERE

2.2 Procedure

Data collection took place in two on-line survey waves in the UK in October and November of 2010. The first wave consisted of general background questions about car ownership, travel patterns, attitudes to cars, and socio-demographics. At the end of this wave, the information about BEVs and PHEVs as shown in Figure 1, was provided. The same information was repeated at the beginning of the second wave. Questions in the second wave focussed specifically on perceptions, attitudes, and purchase intentions regarding PHEVs and BEVs. An online market research company collected the data. Participants were paid £3.00 if they completed the entire

survey.

INSERT FIGURE 1 ABOUT HERE

2.3 Measures

Table 2 gives an overview of the individual statements, and scales constructed from them, used to measure the independent variables. Perceived instrumental, hedonic, and symbolic attributes were measured with multiple statements asking participants to indicate their degree of agreement applied to PHEVs and BEVs, respectively. Ratings were made on 5-point Likert-type scales[3] ranging from strongly disagree (1) to strongly agree (5). The statements were based on input from a qualitative interview study (Graham-Rowe et al., 2012). The phrasing of the items was the same, except for reference to either a PHEV (plug-in hybrid electric car) or BEV (plug-in fully electric car). Scales were constructed by averaging the ratings. Cronbach's αs of the constructed scales indicated acceptable reliability in all cases (Table 2). Two identity variables were also measured by means of ratings on 5-point Likert-type scales ranging from strongly disagree (1) to strongly agree (5). The selected statements to measure pro-environmental identity were an expansion of those used by Whitmarsh and O'Neill (2010). Car-authority identity was similarly measured with statements from measures of consumer novelty seeking (Manning, Bearden, and Madden, 1995) and opinion leadership (Flynn, Goldsmith, and Eastman, 1996).

INSERT TABLE 2 ABOUT HERE

Intention to adopt PHEVs and BEVs as main and second car was measured on 5-point scales ranging from not at all likely (1) to very likely (5) with 4 single statements: "In the next 5 years, I would choose to have a (a) plug-in hybrid electric car as main car, (b) plug-on hybrid electric car as second car, (c) fully electric car as main car, (d) fully electric car as second car."

3. Results

3.1 Intention to Adopt PHEVs and BEVs and Perception of Their Attributes

A repeated measures analysis of variance (ANOVA) was conducted to investigate the differences in intention to adopt PHEVs and BEVs as main and second car (Table 3). There was a significant main effect of type of EV: Participants had a stronger intention to adopt a PHEV than a BEV ($F (1, 2727) = 433.84$, $p \leq .001$, $\eta^2 = 0.41$). There was also a significant main effect of whether the EV was considered as the main or second car in the household: participants had a stronger intention to adopt EVs as main car than as second car ($F (1, 2727) = 80.06.84$, $p \leq .001$, $\eta^2 = 0.21$). There was a statistically significant interaction effect between these two variables, but the effect size indicated that this interaction was rather small ($F (1, 2727) = 56.97$, $p \leq .001$, $\eta^2 = 0.02$).

As Table 2 shows, PHEV are perceived to exceed BEV on all of instrumental, hedonic, and symbolic attributes. All differences were significant in paired t-tests.

INSERT TABLE 3 ABOUT HERE

3.2 The Role of Instrumental, Hedonic and Symbolic Attributes on Intention to Adopt PHEVs and BEVs

Four separate OLS linear regression analyses were conducted to test the

mediation effect we hypothesised between perceived instrumental, hedonic and symbolic attributes. A bootstrapping procedure was used to estimate the indirect effects in multiple mediation models (Preacher and Hayes, 2004, 2008). For the analyses, 5,000 resamples. 95% bias and accelerated confidence intervals were used.

In the first multiple mediation model the dependent variable was intention to adopt PHEVs as main car, perceived instrumental PHEV attributes were included as the dependent variable and perceived hedonic and symbolic PHEV attributes as mediators. Figure 2 showed that the overall model was significant as well as significant direct effects of perceived instrumental attributes on perceived hedonic (a_1 path) and symbolic attributes (a_2 path). There were also significant direct effects of perceived hedonic (b_1 path) and symbolic attributes (b_2 path) on intention to adopt a PHEV as main car. Bootstrapping test indicated significant indirect effect of perceived hedonic and symbolic attributes (ab-paths) on intention to adopt PHEVs as main car, confirming our hypothesis that there is a mediation effect. The mediation effect was partial, as the total direct effect of the perceived instrumental attributes on intention to adopt a PHEV as main car (c path) decreased but remained significant when controlling for the mediators (c' path).

Multiple mediation models were also estimated to explain intention to adopt a PHEV as second car (Figure 3), and a BEV as main car (Figure 4) and second car (Figure 5). All three models were significant and the direct effects were positive and significant, indicating that the perceived instrumental attributes were significantly related to perceived hedonic and symbolic attributes, which in turn were significantly related to intention. The indirect effects were also significant for all models, implying significant meditation effects. For the intention to adopt a BEV as main or second car the mediation effect was partial but for the intention to adopt a PHEV as second car,

the mediation effect was full.

INSERT FIGURES 2, 3, 4 and 5 ABOUT HERE

The amount of explained variance differed between the models: for intention to adopt a PHEV or BEV as main car 24% and 27% was explained, respectively, whilst for intention to adopt PHEVs or BEVs as second car 8% and 11% was explained, respectively. Following the method of Alf and Graf (1999) to calculate the confidence interval around R^2s, we tested whether the percentage of explained variance differed significantly between the two models that explain intention to adopt PHEV or BEV as main car or as second car. The difference between the variance explained in intention to adopt a PHEV as the main and second car was significant ($\Delta R^2 = 0.17$; 95% CI = 0.13, 0.20), as the confidence interval excludes zero. Similarly, the difference between intention to adopt a BEV as main and second car was significant ($\Delta R^2 = 0.16$; 95% CI = 0.12; 0.19). This suggests that the perceived instrumental, hedonic, and symbolic attributes are more important determinants of the intention to adopt a PHEVs or BEV as main car than as second car.

It should be noted that in the mediation models both mediators were strongly and positively correlated ($r_{PHEV} = 0.65$ and $r_{BEV} = 0.72$). This has some implications for the interpretation of the results, as multicollinearity makes it difficult to draw conclusions about the unique contribution of each meditator. Hence, we did analyses to test the mediation effect of each mediator separately, revealing that the single mediation paths were significant. Thus, our overall conclusion is that perceived hedonic and symbolic attributes mediate the relationship between perceived instrumental attributes and intention to adopt PHEVs and BEVs both as main and

second car. We cannot, however, draw conclusions about the size of the unique contributions of both mediators and thus not which one is most influential.

3.3 The Role of Identities on the Intention to Adopt PHEVs and BEVs

We expected that perceptions of PHEV and BEV attributes would be related to an individual's self-image, pro-environmental identity and/or car-authority identity. The bivariate correlations in Table 4 indicated that both pro-environmental identity and car-authority identity were positively correlated with the perceived instrumental, hedonic or symbolic attributes of PHEVs and BEVs. Pro-environmental identity correlated more strongly with the perceived car attributes (ranging from 0.36 – 0.49) than car-authority identity (ranging from 0.05 – 0.11) (Table 4). The latter thus suggests that car-authority identity is only weakly correlated to the perceived car attributes.

INSERT TABLE 4 ABOUT HERE

Next we examined the relative importance of pro-environmental identity and car-authority identity for the perceived car attributes and a potential interaction effect. In Table 5, six OLS multiple linear regression analyses are reported, the dependent variables being the PHEV and BEV instrumental, hedonic, and symbolic attributes. In each analysis, pro-environmental identity and car-authority identity were entered in the first step. In a second step, their interactions were entered. However, since the interaction terms only accounted for at most 1% of the variance, the results for the second step are not reported.

INSERT TABLE 5 ABOUT HERE

The analyses showed that there were significant effects of pro-environmental identity on the perceived car attributes. The more strongly respondents identified themselves to be pro-environmental, the more positively they perceived instrumental, hedonic, and symbolic attributes of PHEVs and BEVs.

There was also a general pattern indicating a positive effect of car-authority identity on the perceived attributes of PHEVs and BEVs. However, the effects were small and not significant in all cases.

4. Discussion and conclusion

The main aim of the present study was to examine how the intention to adopt battery-electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV) is influenced by the perception of their instrumental, hedonic, and symbolic attributes. More specifically, we hypothesised that the relationship between perceptions of instrumental attributes and intention to adopt PHEVs and BEVs would be mediated by perceptions of hedonic and symbolic attributes. The results confirmed full mediation in case of the intention to adopt a PHEV as a second car, and partial mediation in all other cases, suggesting that instrumental attributes are indeed important for the intention to adopt EVs because they influence emotional responses to EVs (hedonic function) and are used to form and express an identity (symbolic function).

Previous studies have tended to focus on the role of instrumental attributes when considering the potential adoption of EVs, particularly relating to purchase price, driving range and recharging time, assuming that they would be the most important determinants of adoption (e.g., Beggs, et al., 1981; Bunch, et al., 1993; Chéron and Zins, 1997). Our study confirms that instrumental attributes are indeed

important for the potential adoption of EVs, but the results also indicate that the direct influence of instrumental attributes is not very strong. Instrumental attributes are largely found to be important because of their influence on perceptions of hedonic and/or symbolic attributes of EVs. Overall, instrumental attributes are likely to differ in the extent to which they have a hedonic and symbolic function. Our study does not allow us to examine this, but future research should focus in more detail on how and the extent to which perceived instrumental attributes fulfil hedonic and symbolic functions both for cars and for other categories of material goods.

Overall, our results suggest that intention to adopt PHEVs and BEVs is stronger if people have a positive perception of their instrumental, hedonic, and symbolic attributes. There are however differences between both types of EV. BEVs are limited in terms of certain instrumental attributes, particularly their driving range, compared to PHEVs. This is also reflected in the evaluation of both vehicles: participants had more negative perceptions of the instrumental, hedonic, and symbolic attributes of BEVs and a lower intention to choose them compared to PHEVs. Our results suggest that the negative perceptions of hedonic and symbolic attributes can be explained by the fact that people link the limited instrumental attributes of BEVs to less joy and pleasure in owning and driving a BEV and a negative social identity. As a result, they are less likely to adopt a BEV than a PHEV.

Even though a (partial) mediation effect of symbolic and hedonic attributes on instrumental attributes was found for both main and second cars in the household, differences were found between main and second cars. This is most evident in the significant difference in the amount of variance explained, suggesting that overall perceptions of all the car attributes, not only instrumental attributes, were less important for the adoption of second cars than main cars. We cannot conclude from

our data why this may be, but we speculate that it may be explained because there are often fewer requirements such as range and size placed on the second car in the household.

Moreover, in the case of the adoption of a PHEV as a second car, symbolic and hedonic attributes fully mediated the effect of instrumental attributes, thus suggesting that adopting a second car is not directly determined by functional or practical considerations. It is possible that additional factors that are important when adopting a second car were not captured in the instrumental, hedonic and symbolic attributes that we measured. For example, purchase price, limited parking space, family size, household financial situation or the influence of a partner (who may be the most frequent driver of a second car) could play a role as well.

One limitation of our results is the correlation between the two mediators, perceived hedonic and symbolic attributes. As a result, the unique contribution of each mediator could not be estimated. Hence, the results remain tentative. Another limitation is the use of single items to measure intention to adopt; single items are generally assumed to be less reliable measures than multiple-item measures, although some argue otherwise (e.g. Bergkvist and Rossiter, 2007).

A secondary aim was to explore how self-image influences individuals' perceptions of instrumental, hedonic, and symbolic attributes of EVs. Two specific identities were considered: the extent to which people see themselves as pro-environmental (pro-environmental identity), and the extent to which people see themselves as an authority on cars (car-authority identity). The results partly confirmed our expectations: those who identified themselves as pro-environmental had more positive evaluations of the instrumental, hedonic, and symbolic attributes of PHEVs and BEVs, which is in line with previous research findings (Jansson, Marell,

and Nordlund, 2010). People who believe that a 'green' image fits with their self-image are more likely to have positive perceptions of EVs. However, the prospective environmental benefits of EVs are not straightforward. They depend, for instance, on the carbon intensity of electricity generation; the ratio of urban to extra-urban driving undertaken; and even the time of day when recharging occurs (since the carbon intensity of the energy supplied varies diurnally with overall demand) (Perujo and Ciuffo, 2010). Since people with limited knowledge of environmental issues may easily change their attitudes towards EVs (De Best-Waldhober, Daamen, and Faaij, 2009), their 'green' image of EVs may be vulnerable to change which could influence their adoption rates.

Car-authority identity was only weakly correlated with the perceived attributes of both vehicles. This suggests that those who seek information about cars and advise others have neither strong positive nor strong negative perceptions of the EV attributes. While a weak correlation between car-authority identity and perceived EV attributes was unexpected, it is an important research finding since it suggests that those people who are key influencers of others' opinions in relation to cars have yet to be convinced about the merits of EVs. Also, there was no interaction effect between pro-environmental identity and car-authority identity on the perception of car attributes suggesting that those with a strong car-authority identity remain sceptical even if they claim to also be pro-environmental. It also suggests that a strong pro-environmental identity alone is enough to generate positive perceptions of EVs.

Finally, this study has some important practical implications, as it identified those who are most likely to be the early adopters of EVs and which EV attributes are important for them, albeit addressed here in a Western European context. The results

suggest that perceptions of instrumental, hedonic, and symbolic attributes of PHEVs are preferable to BEVs. Interestingly, the attributes covered were more important when considering the adoption of an EV main car than as second car. Our results also stress the importance of the pleasure of driving and the symbolic meanings of EVs for early adopters of these vehicles. This is particularly the case for people who see themselves as pro-environmental, implying that the 'green' image of EVs is essential for the positive perception and early adoption of EVs. This is important knowledge for marketing strategies, such as social labelling techniques, as people tend to align their self-identity with their purchase behaviours (cf. Cornelissen, Dewitte, Warlop, and Yzerbyt, 2007).

Foot

1. Engineers often distinguish between PHEVs and range-extended electric vehicles (REEVs) or extended-range electric vehicles (E-REVs). We refer to them all as PHEVs, as the technical distinctions between them are usually not recognised by consumers.
2. A fourth dimension was distinguished as well: cognitive innovativeness, which is defined as the desire for new experiences aimed at stimulating the mind (Venkatraman and Price, 1990). Vandecasteele and Geuens (2010) argue that the cognitive dimension differs from the functional, hedonic or symbolic dimension because the cognitive dimension is a more theoretical construct, i.e., there are hardly or no new technologies that can be identified as technologies that are primarily adopted based on a cognitive motivation. Also the technology that is the topic of this paper, the electric vehicle, is not typically bought to stimulate the mind. Hence, the cognitive dimension is ignored here.
3. We make the assumption that ratings on Likert scales can be treated as interval-level data and analysed using parametric statistics. This assumption is common in attitude measurements (Kline, 2000; Nunally, 1978).

Acknowledgements

We are grateful to the UK Energy Technologies Institute (ETI) for commissioning and funding the ETI Plug-in Vehicle programme. The aim of this programme is to investigate the business case for the mass market deployment of electric and plug-in hybrid electric vehicles in the UK and determining what energy infrastructure would be required. Any views expressed herein are those of the authors and not necessarily those of the ETI. The findings in this paper reflect work undertaken as one part of the programme, but do not necessarily reflect the actual modelling or analyses undertaken within the wider ETI programme.

References

Ajzen, I. (1991) The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50, 179-211.

Alf, E. F. and Graf, R. G. (1999) Asymptotic confidence limits for the difference between two squared multiple correlations: A simplified approach. Psychological Methods, 4, 70-75.

Anable, J. and Gatersleben, B. (2005) All work and no play? The role of instrumental and affective factors in work and leisure journeys by different travel modes. Transportation Research Part A, 39, 163-181.

Beggs, S., Cardell, S., and Hausman, J. (1981) Assessing the potential demand for electric cars. Journal of Econometrics, 17, 1-19.

Bergkvist, L. and Rossiter, J.R. (2007) The predictive validity of multiple-item versus single-item measures of the same constructs. Journal of Marketing Research, 44, 175-184.

Bergstad, C. J., Gamble, A., Hagman, O., Polk, M., Gärling, T., and Olsson, L. E. (2011) Affective-symbolic and instrumental-independence psychological motives mediating effects of socio-demographic variables on daily car use. Journal of Transport Geography, 19, 33-38.

De Best-Waldhober, M., Daamen, D., and Faaij, A. (2009) Informed and uninformed public opinions on CO2 capture and storage technologies in the Netherlands. International Journal of Greenhouse Gas Control, 3, 322-332.

Bunch, D. S., Bradley, M., Golob, T. F., Kitamura, R., and Occhiuzzo, G. P. (1993) Demand for clean-fuel vehicles in California: A discrete-choice stated preference pilot project. Transportation Research Part A: Policy and Practice, 27, 237-253.

Chéron, E. and Zins, M. (1997) Electric vehicle purchasing intentions: The concern over battery charge duration. Transportation Research Part A: Policy and Practice, 31, 235-243.

Cook, A. J., Kerr, G. N., and Moore, K. (2002) Attitudes and intentions towards purchasing GM food. Journal of Economic Psychology, 23, 557-572.

Cornelissen, G., Dewitte, S., Warlop, L., and Yzerbyt, V. (2007) Whatever people say I am, that's what I am: Social labeling as a social marketing tool. International Journal of Research in Marketing, 24, 278-288.

Davis, F.D., Bagozzi, R.P., and Warshaw, P.R. (1989) User acceptance of computer technology: A comparison of two theoretical models. Management Science 35, 982-1003.

Dittmar, H. (1992) The social psychology of material possessions: to have is to be. Weathsheaf: St. Martin's Press.

Ericksen, M. K. (1996) Using self-congruity and ideal congruity to predict purchase intention: A European perspective. Journal of Euro-Marketing, 6, 41-56.

Flynn, L.R., Goldsmith, R.E., Eastman, J.K. (1996) Opinion leaders and opinion seekers: Two new measurement scales. Journal of the Academy of Marketing Science, 24, 137-147.

Foxall, G. R., Goldsmith, R. E., and Brown, S. (1998) Consumer psychology for marketing. London: Int. Thomson Business Press.

Gärling, A. and Thøgersen, J. (2001) Marketing of electric vehicles. Business Strategy and the Environment, 10, 53-65.

Graham-Rowe, E., Gardner, B., Abraham, C., Skippon, S., Dittmar, H., Hutchins, R., et al. (2012) Mainstream consumers driving plug-in battery-electric and plug-in

hybrid electric cars: A qualitative analysis of responses and evaluations. Transportation Research Part A: Policy and Practice, 46, 140-153.

Grewal, R., Mehta, R., and Kardes, F. R. (2000) The role of the social-identity function of attitudes in consumer innovativeness and opinion leadership. Journal of Economic Psychology, 21, 233-252.

Heffner, R. R., Kurani, K. S., and Turrentine, T. S. (2007) Symbolism in California's early market for hybrid electric vehicles. Transportation Research Part D: Transport and Environment, 12, 396-413.

Heffner, R. R., Turrentine, T. S., and Kurani, K. S. (2006) A Primer on Automobile Semiotics. Davis: Institute of Transport Studies, University of California.

Huijts, N. M. A., Molin, E. J. E., and Steg, L. (2012) Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. Renewable and Sustainable Energy Reviews, 16, 525-531.

IEA (2009) Transport energy and CO2: Moving towards sustainability. Paris: International Energy Agency.

Jamal, A. and Al-Mari, M. (2007) Exploring the effects of self-image congruence and brand preference on satisfaction: The role of expertise. Journal of Marketing Management, 23, 613-629.

Jansson, J., Marell, A., and Nordlund, A. (2010) Green consumer behavior: determinants of curtailment and eco-innovation adoptio. Journal of Consumer Marketing, 27, 358 - 370.

Kline, P. (2000) Handbook of Psychological Testing, 2nd Edition. London, England: Routledge.

Kressmann, F., Sirgy, M. J., Herrmann, A., Huber, F., Huber, S., and Lee, D.-J. (2006) Direct and indirect effects of self-image congruence on brand loyalty. Journal of Business Research, 59, 955-964.

Kurani, K. S., Turrentine, T. S., and Heffner, R. R. (2007) Narrative self-identity and societal goals: Automotive fuel economy and global warming policy. In S. Daniel and S. C. James (Eds.), Driving Climate Change (pp. 217-238) Burlington: Academic Press.

Manning, K.C., Bearden, W.O., and Madden, T.J. (1995) Consumer innovativeness and the adoption process. Journal of Consumer Psychology, 4, 329-345.

Nunally, J.O. (1978) Psychometric Theory. New York, NY: McGraw-Hill.

Perujo, A. and Ciuffo, B. (2010) The introduction of electric vehicles in the private fleet: Potential impact on the electric supply system and on the environment. A case study for the Province of Milan, Italy. Energy Policy, 38, 4549–4561.

Preacher, K.J. and Hayes, A.F. (2004) SPSS and SAS procedures for estimating indirect effects in simple mediation models. Behavior Research Methods, Instruments and Computers, 36, 717-731.

Preacher, K.J. and Hayes, A.F. (2008) Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behavior Research Methods 40, 879-891.

Proost, S. and Van Dender, K. (2010) What sustainable road transport future? Trends and policy options. Paris: OECD.

Roehrich, G. (2004) Consumer innovativeness: Concepts and measurements. Journal of Business Research, 57, 671-677.

Sirgy, J. M. (1982) Self-image in consumer behaviour: a critical review. Journal of Consumer Research, 9, 287-300.

Sirgy, J. M. (1986) Self-Congruity. New York, USA: Praeger.

Skippon, S.M. and Garwood, M. (2011) Responses to Battery Electric Vehicles: UK consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance. Transportation Research Part D: Transport and Environment, 16, 525-531.

Steg, E. M., Vlek, C., and Slotegraaf, G. (2001) Instrumental-reasoned and symbolic-affective motives for using a motor car. Transportation Research Part F, 4, 151-169.

Steg, L. (2005) Car use: lust and must. Instrumental, symbolic and affective motives for car use. Transportation Research Part A, 39, 147-162.

Turrentine, T. S. and Kurani, K. S. (2007) Car buyers and fuel economy? Energy Policy, 35, 1213-1223.

Vandecasteele, B. and Geuens, M. (2010) Motivated Consumer Innovativeness: Concept, measurement, and validation. International Journal of Research in Marketing, 27, 308-318.

Venkatraman, M. P. and Price, L. L. (1990) Differentiating between cognitive and sensory innovativeness : Concepts, measurement, and implications. Journal of Business Research, 20, 293-315.

Voss, K. E., Spangenberg, E. R., and Grohmann, B. (2003) Measuring the Hedonic and Utilitarian Dimensions of Consumer Attitude. Journal of Marketing Research, 40, 310-320.

Whitmarsh, L. and O'Neill, S. (2010) Green identity, green living? The role of pro-environmental self-identity in determining consistency across diverse pro-environmental behaviours. Journal of Environmental Psychology, 30, 305-314.

Table 1. Sample characteristics (compared with national UK data)

	Sample	UK data*
Gender		
Male	48.2	54.2
Female	51.8	45.8
Age (average, years)	47.6	47.5
Income ~		
≤ £9,999	3.4	11.0
£10,000 to £19,999	14.7	21.3
£20,000 to £39,999	40.8	39.8
>£40k	41.1	28.0
Employment status		
Full time + Part time	64.6	69.7
Unemployed	1.4	1.2
Retired/ permanently sick	26.1	21.9
Student	2.5	1.2
Home/other	4.7	6.0
Number of cars (private + company)		
1 car		
2 cars	45.2	49.3
3+ cars	42.4	41.3
	12.3	9.4
Households with company cars	12.3	8.7

* Source: UK National Travel Survey (2002-2004). (n = 28,272). Those with a driving licence and access to at least one car in the household.
~ Project sample: valid percentage (for 11% income was unknown). In the NTS sample missing data have been imputed by a number of procedures (NTS (2005). User Guide vol 1: Usage Guide and 2003-2004 Technical Report Part 1. London: Department for Transport).

Table 2. Statements for measuring perceived instrumental, hedonic and symbolic attributes, pro-environmental identity and car-authority identity and descriptives of the constructed scales.

Instrumental**	Compared to a normal car, plug-in hybrid electric cars/ plug-in fully electric cars are similar to a normal car in most respects
	*Compared to a normal car, plug-in hybrid electric cars/ plug-in fully electric cars are inferior to normal cars in terms of performance
	Compared to a normal car, plug-in hybrid electric cars/ plug-in fully electric cars are a cheaper option over the longer term
	*Compared to a normal car, plug-in hybrid electric cars/ plug-in fully electric car impractical
	*When driving a plug-in hybrid electric car/ plug-in fully electric car, I would always be worried about running out of charge
	$M_{phev} = 3.14$; $SD_{phev} = 0.85$; $\alpha_{phev} = 0.64$
	$M_{bev} = 2.71$; $SD_{bev} = 0.63$; $\alpha_{bev} = 0.70$
	$t\ (2727) = 37.34$, $p \leq .001$
Hedonic**	Compared to a normal car, plug-in hybrid electric cars/ plug-in fully electric cars are very pleasant to drive
	***Compared to a normal car, plug-in cars are generally a very exciting new technology
	*I would prefer to drive a normal car than a plug-in hybrid electric car/ plug-in fully electric car

	M_{phev} = 3.64; SD_{phev} = 0.61; α_{phev} = 0.69 M_{bev} = 2.34; SD_{bev} = 0.73; α_{bev} = 0.68 t (2727) = 44.26, p ≤ .001
Symbolic**	*Compared to a normal car, plug-in hybrid electric cars/ plug-in fully electric cars not suitable for my lifestyle I would feel proud of having a plug-in hybrid electric car/ plug-in fully electric car outside my house *I would feel embarrassed to drive a plug-in hybrid electric car/ plug-in fully electric car M_{phev} = 3.37; SD_{phev} = 0.74; α_{phev} = 0.71 M_{bev} = 3.07; SD_{bev} = 0.75; α_{bev} = 0.69 t (2727) = 28.32, p ≤ .001
Pro-environmental Identity	Being environmentally responsible is an important part of who I am *I am not the type of person to worry about being `green` Reducing my car`s environmental impact would make me feel good *I would not buy a more efficient car just because it is environmentally friendly M = 3.35; SD = 0.72; α = 0.77
Car-authority Identity	I like magazines / websites about new cars When other people are choosing a car to buy, they turn to me for advice I often seek out information about new cars

	I often influence other people's opinions about cars
	When I am choosing a car, I find myself spending a lot of time checking out different models
	M = 2.88; SD = 0.79; α = 0.83

* Reverse coded in analyses.
** With one exception (marked with ***), all statements were filled out twice, first for a PHEV (plug-in hybrid electric car) then a for a BEV (plug-in fully electric car).

Table 3. Means (M) and standard deviations (SD) of intention to adopt PHEV and BEV as main or second car.

	PHEV		BEV	
	M	SD	M	SD
Main	2.67	1.11	2.36	1.07
Second	2.44	1.17	2.24	1.12

Table 4 Bivariate correlation coefficients between self-image and perceptions of PHEV and BEV attributes

	Pro-environmental identity	Car-authority identity
PHEV instrumental	0.36**	0.09**
PHEV hedonic	0.47**	0.11**
PHEV symbolic	0.49**	0.07**
BEV instrumental	0.40**	0.06**
BEV hedonic	0.49**	0.08**
BEV symbolic	0.48**	0.05*

*p≤.01; **p≤.001

Table 5 Regressions of pro-environmental identity and car-authority identity on perceptions of PHEV and BEV attributes

Model	ß	t	p[a]
PHEV instrumental			
pro-environmental identity	0.36	20.27	≤.001
car-authority identity	0.08	4.24	≤.001
		$F(2, 2764) = 218.73$, $p^a \leq .001$; $R^2 = 0.14$; $\eta^2 = .14$	
PHEV hedonic			
pro-environmental identity	0.47	27.90	≤.001
car-authority identity	0.09	5.13	≤.001
		$F (2, 2764) = 409.50$, $p^a \leq .001$; $R^2 = 0.23$; $\eta^2 = .23$	
PHEV symbolic			
pro-environmental identity	0.49	29.55	≤.001
car-authority identity	0.05	3.08	≤.006
		$F (2, 2764) = 446.21$, $p^a \leq 001$; $R^2 = 0.25$; $\eta^2 = .25$	
BEV instrumental			
pro-environmental identity	0.40	22.86	≤.001
car-authority identity	0.04	2.50	≤.05
		$F (2, 2764) = 267.38$, $p^a \leq .001$; $R^2 = 0.16$; $\eta^2 = .16$	
BEV hedonic			
pro-environmental identity	0.49	29.67	≤.001
car-authority identity	0.06	3.77	≤.001
		$F (2, 2764) = 453.23$, $p^a \leq .001$; $R^2 = 0.25$; $\eta^2 = .25$	
BEV symbolic			
pro-environmental identity	0.48	29.10	≤.001
car-authority identity	0.03	1.97	≤.05
		$F (2, 2764) = 428.59$, $p^a \leq 001$; $R^2 = 0.24$; $\eta^2 = .24$	

[a] Bonferroni correction was used by setting the significance level at p = .006.

	Plug-in cars	
Conventional Hybrid Electric car	**Plug-in Hybrid Electric car**	**Plug-in Fully Electric car**
		
A conventional hybrid electric car, like the Toyota Prius, **has a petrol/diesel engine and an electric motor powered by a small battery**. The battery gets charged when the car is in motion and when the engine is running. **It does not need to be plugged in to an electrical socket to charge the battery**. Battery power is mainly used at lower speeds, like when in traffic, which saves fuel.	A plug-in hybrid is like a conventional hybrid electric car with **both a petrol/ diesel engine and an electric motor.** BUT, the battery is larger and **can be charged by plugging it in to a normal electrical socket** (like you have at home) or dedicated charging point as needed. **If you run out of charge you can continue driving as long as there is petrol or diesel in the tank.** The car will use the electric motor whenever possible to save fuel, but also provides power from the petrol/diesel engine when required.	This is **powered ONLY by a battery** which is charged by plugging it in to a normal electric socket (like you have at home) or dedicated charging point as needed. **No petrol or diesel is therefore required.**

Figure 1. Information about different types of EVs presented to respondents before the second wave in the survey

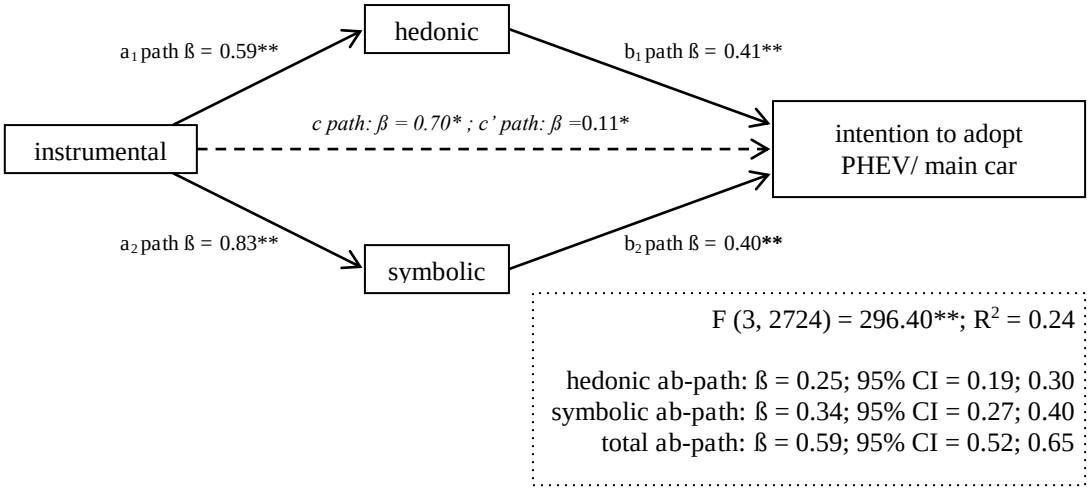

Figure 2. Regression model testing meditation effect from perceived hedonic and symbolic attributes on relationship between perceived instrumental attributes and intention to adopt PHEV as main car; *p ≤.01 **p≤.001

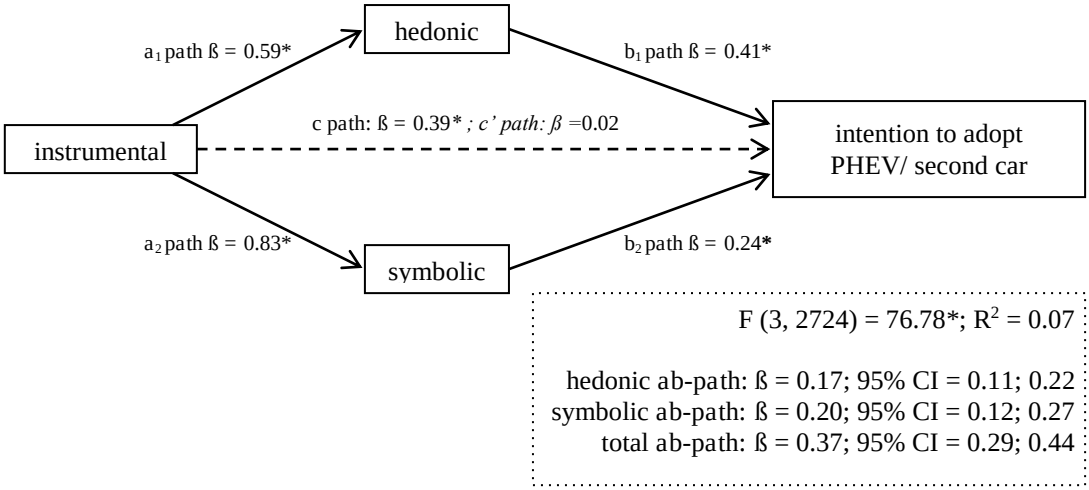

Figure 3. Regression model testing meditation effect from perceived hedonic and symbolic attributes on relationship between perceived instrumental attributes and intention to adopt PHEV as second car; *p≤.001

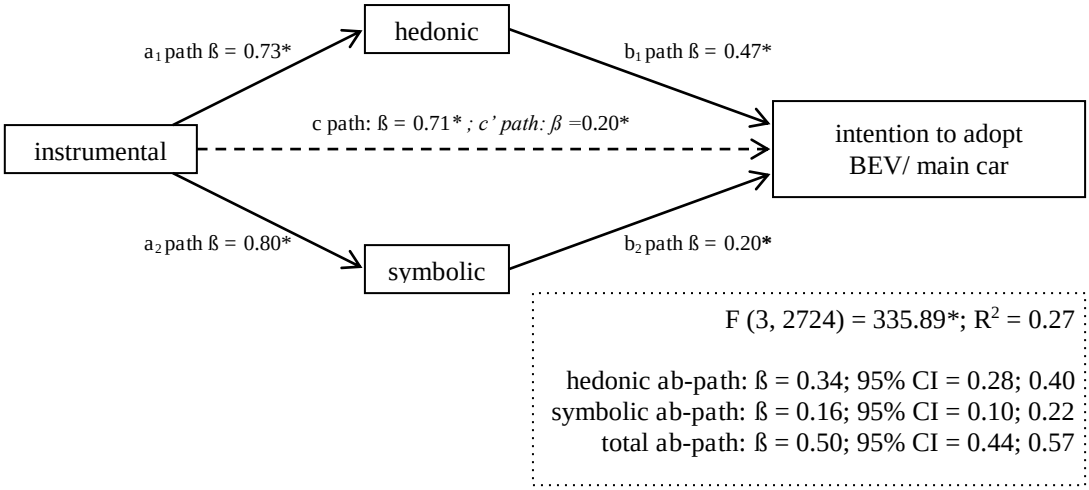

Figure 4. Regression model testing meditation effect from perceived hedonic and symbolic attributes on relationship between perceived instrumental attributes and intention to adopt BEV as main car; *p≤.001

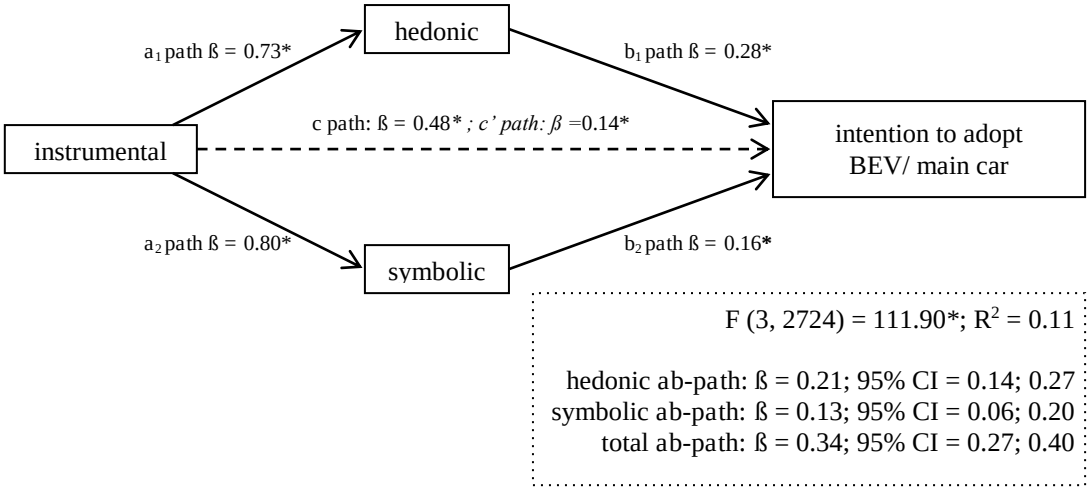

Figure 5. Regression model testing meditation effect from perceived hedonic and symbolic attributes on relationship between perceived instrumental attributes and intention to adopt BEV as second car; *p≤.001