Driving adoption

Noppers, Ernst Harm

Publication date:
2018

Chapter 3

The adoption of sustainable innovations: The role of instrumental, environmental, and symbolic attributes for earlier and later adopters

Chapter 3 has been published as Noppers, E. H., Keizer, K., Bockarjova, M., & Steg, L. (2015). The adoption of sustainable innovations: The role of instrumental, environmental, and symbolic attributes for earlier and later adopters. *Journal of Environmental Psychology, 44*, 74-84.

1. Introduction

Technological developments have brought us products and services that have a relatively low impact on the environment. For example, electric cars have no tailpipe emissions, energy-efficient appliances use less energy, and solar panels reduce CO_2 emissions. These sustainable innovations can help mitigating environmental problems. Many governments and environmental interest groups therefore aim to encourage the adoption of sustainable innovations. Yet, sustainable innovations will only realize their full potential if individual consumers are interested in adopting these innovations.

The introduction stage, where the product is relatively new on the consumer market and only few people have yet adopted it, is crucial for the uptake of sustainable innovations. At this stage it is 'do or die' for innovations: they will either be adopted by a first small group of people which can eventually result in adoption by a 'critical mass', or they will hardly be adopted by consumers and perish (Rogers, 1962, 2003). When consumers show interest in a sustainable innovation and the sustainable innovation is adopted by a considerably large group of consumers at the early stages of its introduction, producers are more likely to be positive about its market potential. As a result, production numbers may increase and benefit from economies of scale, ultimately lowering production costs per unit. Furthermore, because of the more prosperous prospects, producers are likely to be more willing to invest in the further development of the innovation and its infrastructure, which will enhance their attractiveness (cf. Rogers, 2003). Having a first group of consumers purchasing and using innovations is thus essential not only for the initial uptake of innovations, but also for the further diffusion of the innovation. It is therefore important to understand what motivates consumers to adopt sustainable innovations at the early introduction stage.

A typical example of a sustainable innovation at its early introduction stage is the full battery electric car, which was recently introduced on the consumer market and is still owned by very few people. To illustrate, in 2013 sales of full battery electric cars were under 1% of the total consumer cars sold in 2013 in most countries, for instance 0,7% in the Netherlands (RAI, 2013), 0.8% in France, 0.3% in the USA, 0.2% in Germany, and 0.1% in the UK (Shahan, 2014). Norway has a relatively high percentage of full battery electric cars sold (5.8%, Shanan, 2014), which is however still a small share of total cars sold. How do consumers evaluate electric cars and how does this affect their likelihood to adopt an electric car at this crucial early introduction stage? More importantly, do consumers who might consider adopting an electric car at the early introduction stage differ in their motivations to adopt an electric car from consumers who consider adopting an electric car at later stages? To answer these questions we will first discuss which attributes of an electric car might influence its adoption. Second, we discuss how we can identify consumers who are more likely to consider adopting an electric car at earlier stages (i.e. "earlier adopters") and consumers who only might consider adopting an electric car at later stages (i.e. "later adopters"). Next, we examine whether the evaluations of the attributes of an electric car and the impact of these evaluations on adoption likelihood is influenced by the extent to which a consumer is a potential earlier or later adopter, which could give important insights for how to effectively market sustainable innovations, particularly at the early introduction stage.

1.1 Attributes of sustainable innovations

Research revealed that three types of attributes are particularly important for the adoption of sustainable innovations: instrumental, environmental, and symbolic attributes. *Instrumental attributes* reflect the perceived functional outcomes of ownership and use of a sustainable innovation (Dittmar, 1992; Noppers et al., 2014). For example, full battery electric cars have a limited driving range due to its battery. *Environmental attributes* reflect the perceived outcomes of owning and using a sustainable innovation for the environment (Noppers et al., 2014). For example, no harmful gases or particles are emitted while driving an electric car. *Symbolic attributes* of sustainable innovations reflect the perceived outcomes of the ownership and use of the sustainable innovation for one's (self-)identity and social status (Dittmar, 1992; Noppers et al., 2014, Schuitema et al., 2012; Sirgy, 1986). For example, owning an electric car can signal who or what a person is (e.g. Heffner, Kurani & Turrentine, 2007). These three attribute types have been conceptualized as distinct factors affecting adoption of electric cars (e.g., Axsen et al., 2012, Noppers et al., 2014, Korcaj, Hahnel & Spada, 2015), and studies empirically supported the theoretical distinction between the three types of attributes (e.g., Noppers et al., 2014; Steg, 2005).

Several studies revealed that more positive evaluations of the instrumental attributes (Korcaj et al., 2015; Schuitema et al., 2012) and environmental attributes of sustainable innovations (Korcaj et al., 2015; Noppers et al., 2014) enhance the likelihood of adopting sustainable innovations. Besides, the likelihood of adopting sustainable innovations is enhanced by positive evaluations of the symbolic attributes of the sustainable innovation (Korcaj et al., 2015; Noppers et al., 2014; Schuitema et al., 2012), although consumers do not always seem to recognize that symbolic factors motivate them to adopt sustainable evaluations (cf. Johansson-Stenman & Martinsson, 2006; Korcaj et al., 2015; Noppers et al., 2014). These three attributes not only predicted adoption likelihood of sustainable innovations that are visible to others (e.g. electric cars), but also of sustainable innovations that are less visible to others (e.g. local renewable energy systems). Furthermore, an interaction was found between evaluations of symbolic attributes and instrumental attributes affecting interest in sustainable innovations. Evaluations of the symbolic attributes predicted interest in sustainable innovations more strongly when consumers expected the sustainable innovations to have some instrumental drawbacks, which reflects a so-called costly signal effect (Noppers et al., 2014). Such a costly signal effect can be explained by attribution theory: when using sustainable innovations is somewhat costly because of, for example, instrumental drawbacks, the use of sustainable innovations is more likely to be attributed to the identity of the user and less likely to be attributed to situational factors (Bem, 1972; Jones & Davis, 1965). Someone who uses a sustainable innovation even thought this is somewhat costly must be a person who truly wants to do so. This suggests that when an electric car is believed to have some drawbacks, it can more strongly signal the identity of the owner. People may anticipate this signaling function when considering the adoption of sustainable innovations. This suggests that some instrumental drawbacks can strengthen the relationship between evaluations of symbolic attributes and the adoption likelihood of sustainable innovations. As sustainable innovations typically have instrumental drawbacks at the introduction stage, symbolic attributes could be an important factor stimulating adoption likelihood, particularly at this introduction stage. Yet, it appeared that this costly signal effect particularly influenced consumers' interest in sustainable innovations, but not consumers' intention to buy sustainable innovations (Noppers et al., 2014). The question remains how robust this costly signal effect is and whether this effect is limited to interest in sustainable innovations, or whether it can also affect intention to buy sustainable innovations. Moreover, the costly signal may not be relevant for all consumers. For instance, earlier adopters may be more driven by a costly signal than later adopters, and therefore more willing to adopt a sustainable innovation at the earlier introduction stages. We aim to address these questions in the present study.

1.2 Consumers' adoption stage

An important question is how to identify earlier and later adopters. The theory on diffusion of innovations by Rogers (1962; 2003) can help to classify consumers in groups that differ in their likelihood of adopting an innovation at a particular stage. Diffusion of innovation theory

(Rogers, 1962, 2003) distinguishes five consumer segments based on their relative timing of adopting an innovation, which differ in some key characteristics, and provides a rough estimation of the size of each segment. 'Innovators' are the first to adopt an innovative product, and are expected to represent 2.5% of the group adopting the innovation. They are characterized as consumers who dare to take risks in their adoption decisions and are well informed about developments in the relevant product domain. The somewhat larger group of 'early adopters' is characterized as opinion leaders, and is believed to comprise about 13.5% of the adopter population. Early adopters envision potential advantages of innovations and adopt innovations partly to earn respect from others. The 'early majority' is characterized as consumers who need to believe that the innovation has advantages before they adopt, and are expected to represent about 34% of adopters. The 'late majority' is characterized as consumers who are skeptical and cautious, and only adopt an innovation when it has been on the market for some time and offers obvious advantages. They are believed to comprise about 34% of adopters. Finally, 'traditionalists' (or laggards) are characterized as risk-averse and dislike change, and only adopt an innovation when conventional alternatives are no longer available. They are expected to comprise about 16% of adopters.

As yet, most studies examined what drives adoption of sustainable innovations among consumers in general, without differentiating between possible earlier or later adopters (e.g., Korcaj et al., 2015; Noppers et al., 2014). Although some studies on adoption of innovations studied experiences with using an electric car during a test-driving period (e.g. Burgess et al., 2013; Caperello & Kurani, 2012), or studied specific phenomenon that are typical for early adoption stages, like uncertainty about the characteristics of innovations (Egbue & Long, 2012) or range anxiety in driving electric vehicles (Franke et al., 2012), they did not compare evaluations of these attributes across groups. Therefore, little is known about what drives adoption of sustainable innovations for individuals who might consider adopting a sustainable innovation at earlier introduction stage, and importantly, whether this differs from what motivates individuals who might consider adopting a sustainable innovation at later stages.

It has been suggested that earlier adopters are likely to have more favorable evaluations of the attributes of an electric car (e.g. Gärling & Thøgersen, 2001), which may increase adoption likelihood. Are earlier adopters indeed more positive about the attributes of an electric car at the early introduction stage compared to later adopters, and is this true for different attributes? A recent study by Peters and Dütschke (2014) suggests that evaluations of attributes of electric cars may differ across groups. They distinguished four groups: actual users of an electric car, people who were interested in electric cars and intended to purchase an electric car in the next five years, people who were interested in an electric car but did not intend to buy one, and people who were not interested and had no intention to purchase and electric car. They found that some instrumental attributes (i.e., safety, comfort, loading capacity) and some environmental attributes (i.e., environmental consequences) were evaluated more positively by actual users and those who were more likely to adopt an electric vehicle compared to the less committed groups. However, this study did not include symbolic attributes, and did not systematically compare adoption stage groups as defined by Rogers (2003). Notably, they focused on interest and intentions to adopt at the current moment, and did not consider timing of adoption of innovations, which is key to Rogers' diffusion of innovation theory, as we described above. Hence, the question remains whether potential earlier and later adopters differ in their evaluations of the different attributes of electric cars. We aim to address this knowledge gap in our study.

Furthermore, earlier and later adopters could differ in the extent to which evaluations of instrumental, environmental, and symbolic attributes affect their likelihood of adopting an electric car. For instance, although earlier adopters could believe innovations have some instrumental drawbacks compared to conventional products, they may be less affected by unfavorable instrumental attributes than later adopters and therefore face a lower barrier for adoption. Alternatively, earlier adopters may base their adoption decision more on attributes that they evaluate relatively favorable. In addition, the costly signal effect could be particularly relevant for earlier adopters, as they may be more motivated to express their identity and status via sustainable innovations. This could help explain why earlier adopters are more likely to consider adopting a sustainable innovation relatively early compared to other consumers despite (or even because) it may have some instrumental drawbacks. Research suggests that groups that differ in their likelihood of adopting an electric vehicle differ in what drives their intentions to purchase and use an electric car (Peters & Dütschke, 2014). However, this study did not explore differences in adoption stage groups, and did not include evaluations of symbolic attributes of electric cars. We will explore whether potential earlier and later adopters differ in the extent to which their evaluations of the instrumental, environmental, and symbolic attributes affect their likelihood to adopt the sustainable innovation. This may have important implications for the promotion of sustainable innovations, for example whether it is sensible to target different adopter segments with different propositions, or whether similar promotion strategies may be effective across different adopter segments.

1.3 The present study

Adopter segments have typically been identified after the diffusion of an innovative product was completed (Rogers, 2003). However, from a marketing perspective it would be particularly interesting to identify potential earlier and later adopters ex ante, for instance to tailor marketing strategies to consumers' motivations for adopting the innovation. In this paper, we employ a novel measure of adoption stage, which distinguishes expected earlier and later adopters ex ante. As timing of adopting innovations is most likely to differ across product categories, for instance someone who adopts innovative cars relatively early may be late in adopting innovative fashion clothing (cf. Goldsmith & Hofacker, 1991; Gatignon & Robertson, 1985), we measure the extent to which people identify with a specific adopter segment regarding adopting innovative cars (i.e., the product category comprising electric cars). We did measure adopter segment regarding innovative cars, to avoid too much overlap between our independent measure (adoption stage) and dependent measures (interest in and intention to purchase an electric car), which would evidently be strongly related.

We aimed to examine whether and why these adopter groups differ in their likelihood to adopt an electric car. We first investigated whether earlier adopters of innovative cars are indeed more likely to adopt an electric car at the early introduction stage than later adopters of innovative cars are (research question 1). Second, we examined whether earlier and later adopters of innovative cars differ in their evaluations of the attributes of an electric car (research question 2). Third, we examined whether evaluations of the attributes of electric cars and adoption stage predicted the likelihood of adopting an electric car, following our reasoning above (research question 3). More specifically, via regression analyses, we tested to what extent adoption likelihood is predicted by (1) evaluations of the instrumental, environmental, and symbolic attributes, and adoption stage, (2) the interaction between evaluations of the instrumental, environmental, and symbolic attributes on the one hand, and adoption stage on the other hand, to test whether evaluations of attributes predict adoption likelihood differently for different adopter groups, (3) the costly signal effect (i.e., the interaction between instrumental and symbolic attributes), and (4) whether the costly signal effect differs across adopter groups (i.e., a 3-way interaction between instrumental attributes, symbolic attributes, and adoption stage).

2. Method

2.1 Sample and procedure

A Internet-based questionnaire study was conducted among a large Dutch sample drawn from a commercial panel (Panel Inzicht, www.panelinzicht.nl) during June 2012. The questionnaire aimed at, among others, gathering data on individual evaluations of various attributes of electric cars, the likelihood of adopting a full electric car, and the adoption stage regarding innovative cars. The sample (N = 2974) was randomly drawn and stratified according to gender, age, income and education, and is therefore fairly representative of general Dutch adult population (CBS, 2011) and of driver license holders (BOVAG-RAI, 2012; see Appendix). The mean age of participants was 47 (SD = 14.0); 50% was male. Participants first indicated with which adopter segment regarding innovative cars they identified most. Next, they read a brief description of full battery electric cars, in which we explained that we would use the shorter phrase "electric car" to refer to the full battery electric car. Subsequently, participants filled out the questionnaire including questions on evaluations of the attributes of an electric car, and two indicators reflecting adoption likelihood: interest in an electric car, and intention to buy an electric car. Items relevant for the present paper are shown in Table 1.

2.2 Measures

Attributes reflecting instrumental, environmental, and symbolic attributes were selected on the basis of prior research (Dittmar, 1992; Noppers et al., 2014; Steg, Vlek, & Slotegraaf, 2001; Steg, 2005; Vrkljan & Anaby, 2011). Participants evaluated 13 *instrumental attributes* of electric cars, reflecting instrumental costs (7 items) and benefits (6 items) of the use and ownership of an electric car (see Table 1 for an overview of all items). Responses on all items were given on a 6-point scale, varying from ''totally disagree'' to ''totally agree''. Items measuring costs were reverse-coded, so that higher scores reflect more favorable judgments. Cronbach's alpha (α = .71) reflected that the 13 items formed a reliable scale, so scores on the items were averaged to form the evaluation of instrumental attributes scale. On average, participants rated the instrumental attributes of electric cars slightly below the scale mean (M= 3.39, SD = .54), suggesting that they were on average slightly negative about the instrumental attributes of an electric car.

Table 1: Items reflecting instrumental, environmental, and symbolic attributes of electric cars and interest in and intention to buy an electric car.

	M (SD)
Instrumental attributes (Cronbach's α = .71)	**3.39 (.54)**
To what extent do you think that the following characteristics are advantages or disadvantages of an electric vehicle?	
An electric car is relatively expensive to purchase (R)	
An electric car has an insufficient range for me (R)	
It is unpredictable how fast a battery can go flat when driving an electric car (R)	
Driving an electric car would require me too much of adjustment in the use of the car (R)	
Existing infrastructure (e.g. charging, maintenance) does not sufficiently facilitate driving an electric car (R)	
An electric car cannot be charged fast enough (R)	
An electric car has to be charged frequently (R)	
An electric car is cheap in use	
An electric car has low maintanance costs	
Driving an electric car offers convenience	
An electric car is comfortable	
It is possible to charge an electric car when it is not used for a longer period	
An electric car drives smoothly	
Symbolic attributes (Cronbach's α = .85)	**2.72 (1.06)**
To what extent do you think that the following characteristics are advantages of an electric vehicle?	
An electric car gives me status	
An electric car enables me to distinguish myself from others	
I can show who I am with an electric car	
An electric car fits me	
An electric car makes a personal statement	
Environmental attributes (Cronbach's α = .85)	**4.73 (1.01)**
How much would you agree that the use of electric cars in general would contribute to the solution of problems mentioned below?	
Air pollution in residential areas caused by traffic	
Environmental pollution caused by traffic	
Climate change due to the emission of greenhouse gases from traffic	
Depletion of natural resources like oil	
Interest in electric car: I am interested in an electric car	**3.42 (1.55)**
Buying intention (Cronbach's α = .79)	**2.54 (1.28)**
I would now buy an electric car	
I would consider an electric car when purchasing a (next) car	

(R) Items were reverse coded

Evaluations of *environmental attributes* of the electric car were measured with 4 items, reflecting perceived outcomes of owning and using an electric car for the environment (see Table 1). Again, responses were given on a 6-point scale, varying from ''totally disagree'' to ''totally agree''. Mean scores on the 4 items were computed (α = .85); on average participants had favorable evaluations of the environmental attributes of electric cars (M = 4.73, SD = 1.01).

Participants evaluated 5 *symbolic attributes* of the electric car, reflecting positive outcomes of owning and using an electric car for one's (self-)identity and social status (see Table 1) on a 6-point scale, varying from ''totally disagree'' to ''totally agree''. Cronbach's alpha (α = .85) reflected that the 5 items formed a reliable scale, so scores on the items were averaged to form the evaluation of symbolic attributes scale. On average, participants rated the symbolic attributes somewhat below the scale mean (M = 2.72, SD = 1.06), suggesting that on average participants think that an electric car does not strongly signal one's identity and social status.

As the electric car is still at the introduction stage and only few people already adopted an electric car, we used two indicators of adoption likelihood: interest in an electric car, a measure which does not involve a commitment to adopting an electric car, and intention to buy an electric car, which reflect a commitment to adopting an electric car (cf., Bockarjova & Steg, 2014). *Interest in an electric car* was assessed by asking participants to what extent they agreed with the statement "I am interested in an electric car". Reponses were given on a 6-point scale, varying from ''totally disagree'' to ''totally agree'' (M = 3.42, SD = 1.55). The *intention to buy an electric car* was measured with 2 items (see Table 1). Again, responses were given on a 6-point scale, varying from ''totally disagree'' to ''totally agree''. The scores on the 2 items were averaged into an adoption intention scale (α = .83). Participants were on average somewhat unlikely to buy an electric car (M = 2.54, SD = 1.28).

Our measure of consumer's adoption stage is based on the description of characteristics of the adopter segments proposed by Rogers (2003; see Introduction section). More specifically, participants were asked to select the characterization of a certain adopter segment that fitted them best. Following Rogers (1962, 2003), characterizations of five adopter segments were included: innovator, early adopter, early majority, late majority, and traditionalist; see Table 2 for the description of the categories. The distribution of the adopter segments in our sample fairly matched the theoretical distribution proposed by Rogers (1962, 2003, see Table 2). Research showed that this is a valid measure of one's adoption stage regarding innovative cars, as the measure is significantly correlated with general consumer innovativeness, knowledge about alternative fuel vehicles, and intention to adopt electric vehicles (Bockarjova, 2013).

Table 2: Adopter segments for innovative cars.

Adopter segment	Description	% in sample
1. Innovators	I am a type of person who closely follows new technological developments and who dares taking risks by being the first to purchase an innovative car.	1.9%
2. Early adopters	I am a type of person who envisions potential advantages in an innovative cars and who is one of the first to make use of these advantages and to profit from those.	8.0%
3. Early majority	I am a type of person who is interested in innovative cars but at the same time is pragmatic. First I would like to take time and be persuaded about the advantages that an innovative car possesses. My decisions are (mainly) based on the recommendations of existing users.	42.2%
4. Late majority	I am a type of person who is not thrilled by innovative cars, but who rather appreciates security. It is safe to purchase an innovative car when it has been on the market for some while and offers obvious advantages.	38.1%
5. Traditionalists	I am a type of person who is traditional and has little affinity with innovative cars. I do not like changes in life and I purchase an innovative car only when the existing model I use is not produced anymore.	9.8%

3. Results

3.1 Earlier and later adopters' adoption likelihood and evaluations of the attributes of an electric car

We first examined whether adopter groups differed in their likelihood of adopting an electric vehicle. An ANOVA revealed that earlier adopters were more interested in electric vehicles than later adopters were, $F(4, 2969) = 56.54$, $p < .001$, $\eta^2_p = .071$. Planned contrasts revealed that participants from earlier adoption stages were significantly more interested in electric cars than participants from the subsequent adoption stages, with the exception that innovators and early adopters did not significantly differ in their interest in an electric car[1]. Moreover, an ANOVA revealed that earlier adopters had a stronger intention to adopt an electric car than later adopters, $F(4, 2969) = 20.71$, $p < .001$, $\eta^2_p = .027$.

Planned contrasts revealed that participants from earlier adoption stages had a stronger intention to buy an electric car than participants from the subsequent adoption stages, with the exception that innovators and early adopters did not significantly differ in their intention to adopt an electric car[2]. Taken together, the results indicate that our measure of adoption stage regarding innovative cars is related to the likelihood of adopting an electric car at the early introduction stage.

Next, we investigated our second research question, whether earlier and later adopters differed in their evaluations of the attributes of an electric car. An ANOVA showed that evaluations of symbolic attributes significantly differed across adoption stages, $F(4, 2969) = 51.05$, $p < .001$, $\eta^2_p = .064$. Planned contrasts revealed that participants from earlier adoption stages evaluated the symbolic attributes of the electric car significantly more positive than participants from the subsequent adoption stages, with the exception that innovators and early

[1] Early adopters (*M* =4.13, *SD* = 1.47, 95% CI [3.94, 4.32]) were on average more interested in an electric car than the early majority (*M* =3.69, *SD* = 1.48, 95% CI [3.61, 3.77]: *Contrast* = .44, p < .001, Cohen's *d* = .30. The early majority was more interested in an electric car than the late majority (*M* = 3.16, *SD* = 1.51, 95% CI [3.07, 3.25]): *Contrast* = .53, p < .001, Cohen's *d* = .35, and the late majority was more interested in an electric car than traditionalists were (*M* = 2.58, *SD* = 1.46, 95% CI [2.41, 2.75]): *Contrast* = .58, *p* = .001, Cohen's *d* = .39. No significant difference in interest in an electric car was found between innovators (*M* = 3.87, *SD* = 1.76, 95% CI [3.48, 4.27]) and early adopters (*M* =4.13, *SD* = 1.47, 95% CI [3.94, 4.32]): *Contrast* = -.25, p = .258.

[2] Early adopters (*M* =2.95, *SD* = 1.35, 95% CI [2.79, 3.12]) had a stronger intention to buy an electric car than the early majority (*M* =2.65, *SD* = 1.26, 95% CI [2.58, 2.72]: *Contrast* = .30, p = .001, Cohen's *d* = .23. The early majority had a stronger intention to buy an electric car than the late majority (*M* = 2.42, *SD* = 1.25, 95% CI [2.34, 2.49]): *Contrast* = .23, p = .052, Cohen's *d* = .18, and the late majority had a stronger intention to buy an electric car than traditionalists (*M* = 2.13, *SD* = 1.25, 95% CI [1.99, 2.28]): *Contrast* = .29, *p* = .001, Cohen's *d* = .23. No significant difference in intention to adopt an electric car was found between innovators (*M* = 2.97, *SD* = 1.51, 95% CI [2.64, 3.30]) and early adopters (*M* =2.95, *SD* = 1.35, 95% CI [2.79, 3.12]): *Contrast* = .02, p = .918.

adopters did not significantly differ in their evaluation of the symbolic attributes[3] (see Figure 1). Evaluations of instrumental attributes slightly differed across adoption stages, $F(4, 2969) = 3.62$, $p = .006$, $\eta^2_p = .005$. Planned contrasts showed that only the late majority ($M = 3.41$, $SD = 0.55$, 95% CI [3.37, 3.44]) was somewhat more positive about instrumental attributes of an electric car than the traditionalists were ($M = 3.30$, $SD = 0.55$, 95% CI [3.23, 3.36]): *Contrast* = .11, $p = .002$, Cohen's $d = .2$, while participants in the other adoption stages did not significantly differ from participants in a subsequent adoption stage. Evaluations of environmental attributes of electric cars did not differ across adoption stages, $F(4, 2969) = 0.95$, $p = .435$. Taken together, our results showed that potential earlier adopters were more positive about the symbolic attributes of electric cars than later adopters were. Potential earlier and later adopters did not differ in their evaluations of the environmental attributes, and hardly differed in their evaluations of the instrumental attributes.

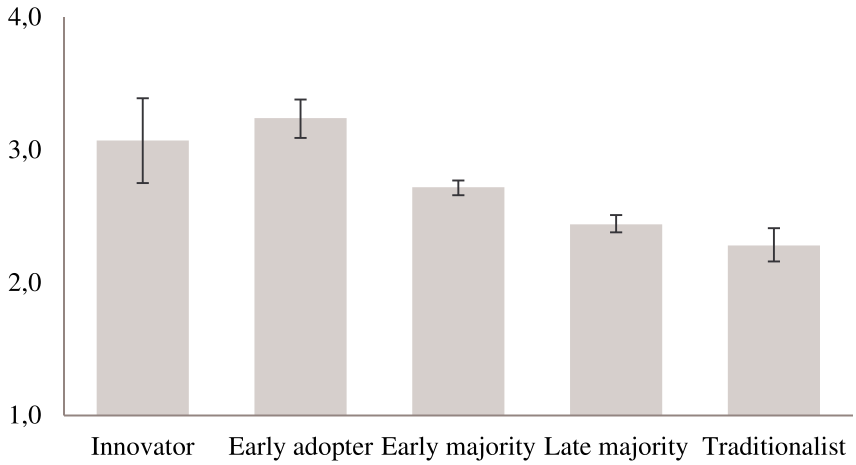

Figure 1: Mean evaluations of symbolic attributes of electric cars across adoption stages

Table 3 shows that evaluations of the attributes correlated positively with interest in and intention to buy an electric car, indicating that more positive evaluations of the attributes increase the likelihood of adopting an electric car. Also, the evaluations of the attributes are positively correlated, meaning that when participants were more positive about one of the attributes they also were likely to evaluate the other attributes more positively. Correlations

[3] Early adopters ($M = 3.33$, $SD = 1.11$, 95% CI [3.20, 3.46]) were on average more positive about the symbolic attributes than the early majority ($M = 2.85$, $SD = 1.02$, 95% CI [2.79, 2.91]: *Contrast* = .48, p < .001, Cohen's $d = .45$. The early majority was more positive about the symbolic attributes than the late majority ($M = 2.54$, $SD = 1.02$, 95% CI [2.48, 2.60]): *Contrast* = .32, p < .001, Cohen's $d = .30$, and the late majority evaluated the symbolic attributes of an electric car more favorable than the traditionalists did ($M = 2.30$, $SD = 1.02$, 95% CI [2.18, 2.42]): *Contrast* = .23, $p = .001$, Cohen's $d = .24$. No significant difference in evaluation of symbolic attributes was found between innovators ($M = 3.25$, $SD = 1.15$, 95% CI [2.98, 3.52]) and early adopters ($M = 3.33$, $SD = 1.11$, 95% CI [3.20, 3.46]): *Contrast* = -.08, p = .606.

are not very high, however, suggesting that the attributes indeed reflect different factors, in line with previous studies (Noppers et al., 2014; Steg, 2005).

3.2 Predicting the likelihood of adopting an electric car

To address our third research question, we investigated to what extent evaluations of the three attributes of electric cars and adoption stage predicted the likelihood of adopting an electric car via two regression analyses, one predicting interest in an electric car and one predicting intention to buy an electric car. Following our reasoning in the Introduction section, in each regression model we included (1) all main effects, that is adoption stage[4] and evaluations of the three attributes, (2) the interactions between adoption stage and evaluations of the three attributes, which reflects whether earlier adopters differed from later adopters in the extent to which evaluations of the attributes predicted their interest in an electric car and intention to buy an electric car, (3) the interaction between evaluations of the instrumental and symbolic attributes, to test whether the costly signal effect predicts adoption likelihood, and (4) the 3-way interaction between evaluations of the instrumental attributes, symbolic attributes, and adoption stage, to test whether the costly signal effect differs across adoption stages. Variables were standardized and mean-centered (see Aiken and West, 1991) to facilitate the interpretation of the results.

Table 3: Bivariate correlations between evaluations of attributes, interest in and intention to buy an electric car.

	Instrumental	Environmental	Symbolic	Interest
Environmental	.29**			
Symbolic	.32**	.22**		
Interest	.42**	.23**	.45**	
Buying intention	.50**	.26**	.43**	.66**

* p < .05, ** p < .01

[4] Adoption stage was reverse coded to facilitate interpretation: a higher value of adoption stage indicated identification with a more early adopter segment. The reversed coded adoption stage variable was treated as a continuous variable in the regression analysis in order to facilitate interpretations of the interaction effects.

3.2.1 Predictors of interest in an electric car

The full regression model predicted 32% of the variance in the interest in an electric car (adjusted R^2 = .32; see Table 4). As expected, earlier adopters were more interested in an electric car than later adopters, as reflected in the significant positive standardized regression coefficient of adoption stage. Also, we found positive main effects of the evaluations of the three attributes of electric cars on interest in an electric car. The more positive participants were about the instrumental attributes and the symbolic attributes, the more interested they were in an electric car. Evaluations of the instrumental attributes and the symbolic attributes were the strongest predictor of interest in an electric car. To a somewhat lesser extent, participants were also more interested in an electric car when they were more positive about the environmental attributes of an electric car.

The 2-way interactions between adoption stage and the evaluations of the attributes reflect whether earlier and later adopters differ in the extent to which their evaluations of the attributes of an electric car predicted their interest in an electric car. The interaction between evaluations of the environmental attributes and adoption stage predicted interest in an electric car, suggesting that earlier adopters' interest in an electric car was somewhat more strongly influenced by evaluations of the environmental attributes of an electric car than later adopters' interest in an electric car (p = .07). The 2-way interactions between symbolic attributes and adoption stage and instrumental attributes and adoption stage were not statistically significant, suggesting that earlier and later adopters did not significantly differ in the extent to which evaluations of instrumental attributes and symbolic attributes predicted their interest in an electric car.

Table 4: Regression model predicting interest in an electric car.

	R2 adjusted	*F*	*df*	*β*[a]	t	*p*	LLCI[b]	ULCI[c]
Interest in electric car	.32	157.52	9,2964			< .001		
Instrumental attributes				.30	17.51	< .001	.27	.33
Environmental attributes				.07	4.49	< .001	.04	.10
Symbolic attributes				.30	18.03	< .001	.27	.34
Adoption stage				.19	11.29	< .001	.16	.22
Symbolic attributes x Adoption stage				.02	1.35	.176	-.01	. 05
Instrumental attributes x Adoption stage				.01	0.70	.489	-. 02	.05
Environmental attributes x Adoption stage				.03	1.80	.072	.00	.06
Instrumental attributes x Symbolic attributes				-.03	-1.96	.050	-.06	-.00
Adoption stage x Instrumental attributes x Symbolic attributes				-.03	-2.30	.022	-.06	-.01

[a] Standardized regression coefficient
[b] Lower Limit 95% confidence interval
[c] Upper Limit 95% confidence interval

Next, we investigated the costly signal effect by examining whether the 2-way interaction between instrumental and symbolic attributes influenced interest in an electric car, and tested whether earlier and later adopters differed in this respect by testing the 3-way interaction between evaluations of instrumental attributes, symbolic attributes, and adoption stage. We found a significant and negative 2-way interaction between evaluations of symbolic and instrumental attributes on interest in an electric car. In line with the costly signal effect, participants' evaluations of the symbolic attributes had a stronger positive impact on their interest in an electric car when they evaluated the instrumental attributes more negatively. We also found a significant 3-way interaction between evaluations of symbolic attributes, instrumental attributes, and adoption stage, suggesting that the extent to which poor evaluations of instrumental attributes enhances the predictive power of symbolic attributes depended on participants' adoption stage. We used the Johnson–Neyman technique for identifying at which values of adoption stage the proposed interaction effect on the interest in an electric car is significant (Hayes & Matthes, 2009; Johnson & Neyman, 1936; Spiller et al., 2013). The Johnson–Neyman point for $p < .05$ ($t = -1.96$) occurred at a value of -.01, approximately the mean value of adoption stage. This suggests that for earlier adopters, positive evaluations of the symbolic attributes more strongly increased their interest in an electric car when they evaluated the instrumental attributes of the electric car relatively negatively. For later adopters, this interaction effect was not statistically significant, meaning that the influence evaluations of the symbolic attributes had on their interest in an electric car did not depend on evaluations of the instrumental attributes. This suggests that the costly signal effect is particularly relevant for earlier adopters. For clarification of the costly signal effect affecting earlier adopters, we display the effects of evaluations of symbolic attributes on interest in an electric car for Innovators (Figure 2) and Traditionalists (Figure 3) at different levels of evaluations of the instrumental attributes of an electric car. Figure 2 shows a strong positive relationship between evaluations of symbolic attributes and interest in an electric car for Innovators who had relatively unfavorable evaluations of the instrumental attributes (i.e., a costly signal). For Innovators who had relatively favorable evaluations of the instrumental attributes the relationship between evaluations of symbolic attributes and interest in an electric car was non-significant. Figure 3 reveals that for Traditionalist, the relationship between evaluations of the symbolic attributes of an electric car and interest in an electric car did not differ for those who were relatively positive about the instrumental attributes and those who were less positive about the instrumental attributes of an electric car.

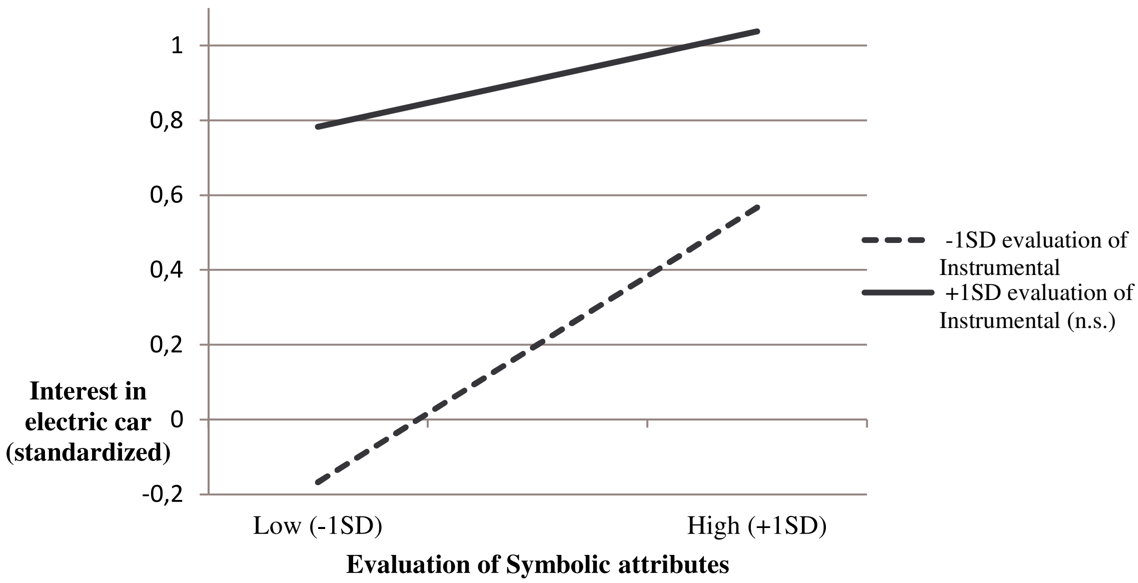

Figure 2: Relationships between evaluations of symbolic attributes and interest in an electric car for Innovators with relatively favorable and unfavorable evaluations of the instrumental attributes of an electric car

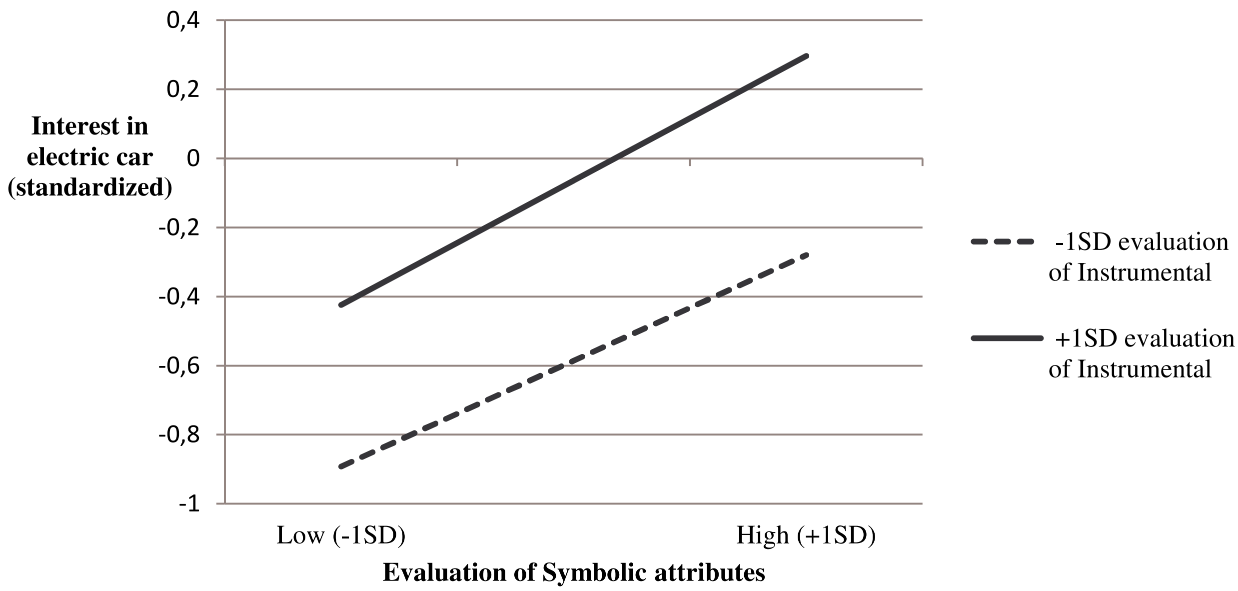

Figure 3: Relationships between evaluations of symbolic attributes and interest in an electric car for Traditionalists with relatively favorable and unfavorable evaluations of the instrumental attributes of an electric car

3.2.2 Predictors of intention to buy an electric car

The full regression model predicted 35% of the variance in intention to buy an electric car (R^2 = .35, adjusted R^2 = .35; see Table 5). As expected, earlier adopters had a stronger intention to buy an electric car than later adopters did, as reflected in the significant negative regression coefficient of adoption stage. Also, we found positive main effects of the evaluations of the three attributes of electric cars on intention to buy an electric car: the more positive participants were about the attributes, the stronger their intentions to buy an electric car. Evaluations of the instrumental attributes were the strongest predictor of intention to buy an electric car, followed by the evaluations of the symbolic attributes. Evaluations of the environmental attributes were the weakest predictor of the intention to buy an electric car.

Next, we examined differences between earlier and later adopters in the extent to which their evaluations of the attributes of an electric car predicted their intention to buy an electric car by inspecting the 2-way interaction effects between adoption stage and the evaluations of the attributes. All 2-way interactions were not statistically significant. This implies that evaluations of instrumental attributes, environmental attributes, and symbolic attributes predicted intention to buy an electric car in a similar way for earlier and later adopters.

Table 5: Regression model predicting intention to buy an electric car

	R2 adjusted	*F*	*df*	*β*[a]	t	*p*	LLCI[b]	ULCI[c]
Buying intention	.35	176.63	9,2964			< .001		
Instrumental attributes				.40	23.91	< .001	.37	.44
Environmental attributes				.09	5.73	< .001	.06	.12
Symbolic attributes				.26	15.79	< .001	.23	.29
Adoption stage				.10	5.84	< .001	.06	.13
Symbolic attributes x Adoption stage				-.01	-0.83	.409	-.04	. 02
Instrumental attributes x Adoption stage				.02	1.22	.224	-.01	.05
Environmental attributes x Adoption stage				.01	0.58	.559	-.02	.04
Instrumental attributes x Symbolic attributes				.05	3.18	.001	.02	.08
Adoption stage x Instrumental attributes x Symbolic attributes				-.02	-1.69	.091	-.05	.01

[a] Standardized regression coefficient
[b] Lower Limit 95% confidence interval
[c] Upper Limit 95% confidence interval

We again found a significant and positive 2-way interaction between evaluations of symbolic and instrumental attributes on the intention to buy an electric car. This time, however, participants' evaluations of the symbolic attributes had a stronger positive impact on their intention to buy an electric car when they evaluated the instrumental attributes more positively, which does not support the costly signal effect. The 3-way interaction between evaluations of symbolic attributes, instrumental attributes, and adoption stage was weak. Although the 3-way interaction was not statistically significant by conventional standards (p = .09), we did explore it in some more depth. The Johnson–Neyman point for $p < .05$ ($t = 1.96$) occurred at a value of .65, somewhat above the mean value of adoption stage, and suggests that for earlier adopters the interaction effect was not statistically significant, meaning that the influence of evaluations of the symbolic attributes on intention to buy an electric car of earlier adopters did not depend on their evaluation of the instrumental attributes. Yet, for later adopters, evaluations of the symbolic attributes more strongly predicted their intention to buy an electric car when they evaluated the instrumental attributes of an electric car more positively.

4. Discussion

This paper investigated differences in motivations to adopt a sustainable innovation between potential earlier and later adopters. We used an electric car as typical example of a sustainable innovation at the early introduction stage. First, we examined whether earlier adopters and later adopters differed in their likelihood of adopting an electric car and in their evaluations of the attributes of an electric car. Second, we investigated to what extent evaluations of the three attributes of electric cars and adoption stage predicted the likelihood of adopting an electric car, and whether earlier and later adopters differed in how evaluations of the attributes of an electric car steered their likelihood of adopting an electric car.

Results revealed that earlier adopters were more interested in electric cars, and had a stronger intention to purchase an electric car than later adopters did. This further supports the validity of our measure of adoption stage. Also, we found that earlier adopters evaluated the symbolic attributes of an electric car more positively than later adopters, which indicates that earlier adopters more strongly think that an electric car gives them status and that an electric car shows who they are than later adopters. However, earlier and later adopters did not differ in their evaluations of the environmental attributes and hardly differed in their evaluations of the instrumental attributes of an electric car. Respondents identified as potential earlier adopters thus evaluate the symbolic attributes more positively than respondents identified as potential later adopters, which could be a reason why earlier adopters are more likely to consider adopting an electric car than later adopters are.

Our results further showed that earlier adopters, as well as later adopters, were more interested in an electric car and had a stronger intention to buy an electric car when they evaluated the symbolic attributes, instrumental attributes, and environmental attributes of an electric car more positively, as reflected in the significant main effects of evaluations of all three attributes. This suggests that all consumers, irrespective of adoption stage, are more likely to adopt an electric car when owning and using an electric car is for instance believed to be more comfortable and less expensive, says more positive things about a person, and has more environmental benefits. These findings are in line with findings from earlier studies (e.g. Noppers et al., 2014; Korcaj et al., 2015; Schuitema et al., 2012). Evaluations of the instrumental attributes and symbolic attributes were the strongest predictor of adoption likelihood, while evaluations of the environmental attributes was a less strong predictor of adoption likelihood.

Extending previous research, our results suggest that there are some small, but interesting differences in motivations to adopt an electric car for earlier and later adopters. First, evaluations of the environmental attributes somewhat more strongly predicted interest in electric cars of earlier adopters than later adopters, as reflected in a 2-way interaction. This suggests that perceived positive environmental consequences of adopting an electric car are more appealing to earlier adopters. This interaction effect was however marginally significant only and had a relatively small effect size; future research is needed to test the robustness of this effect. Moreover, we did not find this interaction effect for intention to buy an electric car.

Furthermore, we replicated the costly signal effect reported by Noppers et al. (2014), showing that evaluations of the symbolic attributes of an electric car predicted interest in an electric car more strongly when people evaluated the instrumental attributes somewhat less favorable. Yet, extending earlier studies, this costly signal effect appeared to be qualified by adoption stage, as the effect was only statistically significant for earlier adopters and not for later adopters. This suggests that the costly signal is particularly appealing to earlier adopters, as only for them symbolic attributes more strongly predicts interest in electric cars when they expect some instrumental drawbacks. However, when we look at intentions to buy an electric car there are indications that the costly signal effect could even be reversed for later adopters. Specifically, we found that positive evaluations of the symbolic attributes predicted intention to purchase an electric car somewhat better when participants evaluated the instrumental aspects more positively, but this effect was only statistically significant for later adopters, while the overall 3-way interaction effect was not statistically significant. More generally, the effect sizes of the 3-way interactions were relatively small, therefore having only a small impact on adoption likelihood.

In sum, we replicated and specified the costly signal effect as reported by Noppers et al. (2014) as predictive of individual interest in, yet not intention to adopt, an electric car for earlier adopters. An important remaining question is why costly signal effects occur. As indicated in the Introduction, one possible explanation could be that the adoption and use of sustainable innovations is more likely to be attributed to the identity of the user and less likely to be attributed to external factors, in case the sustainable innovation has some instrumental drawbacks. However, there is probably a limit to the extent to which a person is willing to incur costs for a costly signal effect to take place (Noppers et al., 2014). If the costs are too high, it is not likely that they will boost the effects of positive evaluations of symbolic attributes on adoption. This may account for the fact that we only found a costly signal effecting interest in an electric car and not intention to buy an electric car. Showing interest in an electric car with some drawbacks may be suitable for costly signaling, because in this case people do not need to incur any real costs, as interest is a less strong commitment than the intention to buy an electric car. Indeed, we found some support for this reasoning as instrumental attributes seem to have a stronger impact on intention to buy an electric car than on interest in an electric car, suggesting that the instrumental aspects are more influential when it concerns indicators that more closely resembles actual adoption. Similar results were found by Bockarjova and Steg (2014), who found that perceived costs of using an electric car more strongly predicted close indicators of the adoption of an electric car (i.e., overall evaluation of electric cars and intention to purchase electric cars) compared to distant indicators of adoption (i.e., long-run electric car acceptability and policy acceptability). So when push comes to shove, the instrumental drawbacks may be still too high to boost the effects of positive evaluations of symbolic attributes on adopting an electric car. Possibly, an electric car is for this reason an ideal second car: it gives owners the opportunity to signal one's identity and status effectively by posing a costly behavior with a possibility to bypass its functional drawbacks given the presence of the first household car. Future research is needed to explore the exact process behind the costly signal effect.

Another remaining question is why costly signals are most relevant for earlier adopters. It is likely that earlier and later adopter want to signal different things with sustainable innovations. For instance, earlier adopters may want to signal their care for the environment or their progressive identity, which could be signaled even more effectively when adoption has instrumental drawbacks. In contrast, later adopters may want to signal that they make smart investments, which is enhanced when adopting a sustainable innovation advances functionally. Future research is needed to investigate symbolic motives of the earlier and later adopters.

We assessed adoption stage by asking participants to select the description of the adopter segment regarding innovative cars they identified with most. We opted for this conceptualization rather than adoption segment with regard to electric cars to avoid a strong overlap between our independent variable (adoption stage) and dependent variables (interest in and intention to purchase an electric vehicle). Moreover, the conceptualization focused on the product category innovative cars, as adoption stage is likely to differ across products. Our conceptualization of adopter segments seems to be a useful indicator for one's adoption stage, as scores on this measure correlated with likelihood of adopting an electric car: earlier adopters were more interested in and more strongly intended to buy an electric car than later adopters. This indicates that our conceptualization of adoption stage can serve as a method for classifying consumers ex ante. This is crucial for identifying earlier adopters and later adopters and could contribute to identifying consumer motivations for adopting (sustainable) innovations at different adoption stages. Future research is needed to further test the validity of the measure, and examine whether similar results are found across various product domains.

We used electric cars as a typical example of sustainable innovations. Research suggests that adoption likelihood of different sustainable innovations have similar determinants (e.g. Noppers et al., 2014). However, future research is needed to test the generalizability of our findings across different types of sustainable innovations. Furthermore, future research is needed to examine whether similar results would be found for innovations that already have a larger market share, and for products that can no longer be considered a sustainable innovations because they are already adopted by many.

What do our results mean for the marketing of sustainable innovations, particularly at the introduction stage? Symbolic attributes proved to be an important factor encouraging adoption of sustainable innovations, particularly at this early introduction stage as typical earlier adopters were more positive about the symbolic attributes of an electric car. Moreover, positive evaluations of these symbolic attributes more strongly predicted their interest in an electric car when the electric car was perceived to have some instrumental drawbacks. Therefore, focusing marketing efforts on the symbolic attributes of sustainable innovations is likely to be effective, particularly at the early introduction stage where instrumental drawbacks are often present. Symbolic attributes can be enhanced or stressed through marketing campaigns emphasizing positive outcomes of owning and using sustainable innovations for one’s identity and status. However, this probably has to be done in a subtle and implicit way, as establishing a very explicit link between a product and specific identities through marketing communication may backfire (Bhattacharjee, Berger, & Menon, 2014). Moreover, the effects of such marketing strategies may depend on the credibility of the source of the information. Furthermore, our results suggest that manufacturers of sustainable innovations should further improve the instrumental attributes of sustainable innovations, particularly for the later stages of the adoption process. Instrumental drawbacks for later adopters not only directly inhibit intention to adopt electric cars, but also appear to increasingly inhibit positive effects of evaluations of symbolic attributes on adoption. For earlier adopters, instrumental drawbacks inhibit adoption too, but at the same time these instrumental drawbacks seem to boost effects of positive evaluations of symbolic attributes on interest in electric cars for earlier adopters. Yet, improvements in instrumental attributes seem to be needed to promote wide-scale adoption of sustainable innovations. Besides, stressing the environmental benefits of sustainable innovations could enhance adoption of sustainable innovations, possibly even more so in the early introduction phase as earlier adopters seemed to be somewhat more strongly driven by positive evaluations of environmental attributes.

A differentiation in marketing strategy for earlier and later adopters may not be necessary as the extent to which earlier and later adopters differed in their motivations for adopting an electric car was relatively small, shown by the effect sizes of the interactions. Both earlier and later adopters could thus be targeted with similar marketing propositions. Marketers should however keep in mind that earlier adopters may be better persuaded with propositions stressing environmental benefits and costly signals, compared to later adopters.

In sum, earlier and later adopters of innovative cars differ in their evaluations of some of the attributes of an electric car, and subtly differ in what drives their likelihood to adopt an electric car. Compared to later adopters, earlier adopters were more positive about what an electric car says about them, but not more positive about the instrumental and environmental attributes of an electric car. We found some small differences in determinants of adoption likelihood of sustainable innovations for earlier and later adopters: earlier adopters seemed to be more interested in an electric car because of its environmental benefits, but also because of its symbolic attributes when they expect the electric car to have some instrumental drawbacks. At the same time, later adopters do not seem to be motivated by such a costly signal, but are rather triggered to adopt an electric car because of its symbolic attributes when they evaluate the instrumental attributes relatively favorably. Overall, our results imply that symbolic attributes play an important role in the adoption of sustainable innovations. For the crucial early introduction stage of sustainable innovations where these products often have apparent drawbacks it seems fruitful to emphasize the positive symbolic attributes.

Appendix:

Characteristics of the sample and of car owners and the Dutch population.

	Sample	Car owners (%)[a]	Dutch population[b]
Gender (male)	50%	n.a.	50%
Age [c]			
19-25	6%	7%	8%
26-35	16%	15%	16%
36-45	26%	22%	19%
46-55	22%	23%	20%
56-65	16%	18%	17%
65 and older	14%	15%	20%
Education			
primary or lower	8%	n.a.	5%
secondary and vocational	57%	n.a.	60%
college and university	35%	n.a.	34%
Household income [d]			
below €15,900	10%	n.a.	20%
€15,900 - €22,400	15%	n.a.	20%
€22,400 - €30,400	17%	n.a.	20%
€30,400 - €41,000	11%	n.a.	10%
€41,000 - €51,000	15%	n.a.	20%
above €51,000	7%	n.a.	10%
Unknown / not reported	25%	n.a.	---

n.a. – not available.

[a] Source: BOVAG-RAI (2012)

[b] Source: Statistics Netherlands (CBS, 2011)

[c] Data for the Dutch population (Statistics Netherlands, 2011) is provided for the population of age 20 and older.

[d] Data on income is available from Statistics Netherlands (CBS, 2011) for disposable household income deciles (appear in the Table). Our data was gathered for household gross income using the following breakdown: below €15,000; €15,001 - €20,000; €20,001 - €25,000; €25,001-€30,000; €30,001 - €40,000; €40,001 - €50,000; €50,001 - €60,000; €60,001 - €70,000; €70,001 - €95,000; above €95,001.