

## Article

# The Effects of a First-Time Experience on the Evaluation of Battery Electric Vehicles by Potential Consumers

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**Abstract:** In some countries, such as Norway, there is significant growth in the proportion of battery electric vehicles (BEVs) among new registrations. This is not the case in Germany, where less than 1% of all newly registered vehicles are electric cars. This disparity raises the questions of whether the performance factors of current BEVs (e.g., driving range) are able to compete with petrol-powered cars and how they are perceived by potential customers. Using marketing methods, car manufacturers can influence attitudes towards products and increase purchase intentions. Most prior studies used experiments in different settings to find out the perceived value of BEVs among potential customers, taking into account a longer perspective. There are no prior studies on the influence of short test drives on the value perception of BEVs. The main objective of this article was to explore and assess the effects of a first-time experience on the evaluation of BEVs by potential consumers in the German market (around the city of Münster, in the North Rhine-Westphalia region). We utilized the concept of a sensory marketing approach in the form of a short (10–15 min) test drive experiment. The results showed that perceptions, in terms of acquisition costs and acceleration/driving pleasure in particular, are developing positively. Other increasing values are maintenance and energy costs, engine/battery reliability, range in km, and driving comfort. In addition, the perception of all other performance factors has developed positively. Also, willingness to buy a BEV increased after the short test drive. The experiment shows that short test drives with BEVs are a suitable means to support the widespread promotion of electric cars.

**Keywords:** R&D; battery electric vehicles; short test drives; first-time experience; consumer experience

## 1. Introduction

In light of environmental protection issues, there is a growing interest in reducing pollution by finding alternative ways of living. For this reason, car manufacturers are considering the long-term goal of limiting the production of traditional petroleum-driven cars and focusing on the development of electric vehicles (EVs) or battery electric vehicles (BEVs). Thus, there is a growing interest in their market potential. Many car users are aware of some benefits of using electric vehicles, although there are still many doubts about their overall value. There are many reasons for such a situation and many factors influencing the perceived value of EVs [1,2]. A better understanding of these factors will provide insights for both theorists and managers, especially marketers responsible for product development and its introduction into new markets.

Some factors influencing customer experience and enhanced perceptions of product value are broadly discussed in the literature [3]. Most studies utilized experiments in various settings to find out the perceived value of BEVs among potential customers, taking into account a longer perspective of 3 to 12 months [4–7]. To the best of our knowledge, there are no prior studies of the effects of short test drives on BEV value perception or purchase intention.

It is of the utmost importance to attract and persuade potential customers to start using these cars by providing additional kinds of resources to customer consumption and value-generating processes. Gronroos suggests that companies should use their relations with customers to sway the value creation processes [8]. Some authors stress the importance of customer involvement in value co-creation practices [9–12] while others argue for the utilization of sensory stimulation to influence customer intentions to purchase a product [13]. This issue has been analyzed via sensory marketing [14,15], exploring the involvement and influence of different senses on customer experiences with respect to the value of a product or service. Prior studies have used stated preference information to identify preferences towards BEVs and their characteristics, with some also stressing latent attitudes that influence individual choices [5,16]. Stated preference information is needed when exploring new vehicles that are not widely available on the market. Nevertheless, stated preference experiments on BEVs, where potential customers articulate their attitudes without having any real experience of the product, leads to skepticism instead of an increased perception of product value, and therefore may lead to a lowered intent to purchase. According to Li et al. [17], purchase intention is very important to the popularization of BEVs and the development of the industry.

The German market for BEVs is growing, although the pace is still slow despite governmental financial support to companies and individuals who order electric cars or plug-in hybrids [18]. According to initial results, the demand for such cars is behind expectations [19]. Instead of searching for factors that hamper widespread acceptance of battery electric vehicle technology in Germany, we aimed to answer the question of how companies can influence BEVs' value perception and increase purchase intention. In order to answer this question, our study explored and assessed the effects of a first-time experience on the evaluation of BEVs by potential consumers in the German market (around the city of Münster, in the North Rhine-Westphalia region). Compared to previous studies, ours is the first to use short test drives to determine customers' BEV perception and purchase intention. Data collected from our short test-driving experiments was processed with SPSS using statistical measures.

The structure of the paper is as follows. First, we present the theoretical background related to BEV performance factors influencing customer value perception. Second, the methodology of data collection, utilizing a test-driving experiment and its processing using statistical methods, is provided. Third, we present the results and discuss the contribution of the paper together with theoretical and managerial implications, as well as the study's limitations and future research prospects.

## 2. Literature Review and Hypotheses

### 2.1. Growing Importance of the BEV Market

There is a growing debate over the potential of electric vehicles to reduce global and local emissions as well as whether they can ensure a relevant future market for car sales worldwide [20–22]. Some of the main potential advantages of the widespread use of BEVs are lower greenhouse gases and cleaner air, leading to healthier living conditions through the reduction of local [23,24]: Electric engines manage to convert 95% of the used energy into power, whereas petrol engines convert just 65%. Electric engines are easier to produce, but their batteries are problematic due to long charging times and a short range in km [23,25].

In 2012, the German government announced the goal of one million electric vehicles registered on German roads by the year of 2020. Moreover, governmental support for research and development

should secure a leading position for the German automotive industry [26]. More than 800,000 people are employed in the field, accounting for a turnover of 407 billion EUR [27].

Electric mobility provides an opportunity to improve greenhouse emissions and protect public health by making the air cleaner [23]. In 2017, less than one percent of all newly registered cars were BEV. The majority of cars are powered by gasoline [28]. A slight rise in BEV purchases in 2017 is also connected to government subsidies introduced in 2016. Individuals and companies can get additional payments when ordering an electric car or a plug-in hybrid [29]. With 54,274 cars (hybrid and fully electric) financed since May 2015, the demand is behind expectations [28]. The monetary path towards BEV market growth is viewed negatively. For example, Dudenhöffer et al. [25] evaluated the matter of the environmental bonus and drew unfavorable conclusions with respect to the German market. Firstly, some of the money Germans spend on BEVs is not flowing into the German companies because they are buying imported cars. Secondly, the artificial price appeal can have a positive short-term effect, but after suspending the subsidies, the opposite outcome can occur, and the demand declines drastically. A better application of government funds is to encourage the development of competitive products and technologies [25].

As mentioned above, BEV registrations in Germany are lower than one percent. In Norway, a different picture can be observed. In 2017, 3 out of 10 newly registered cars were powered by electric energy only. Another 29% of the currently registered vehicles are plug-in hybrids [30]. Looking at Norway, massive support by the government can be observed [31,32]. Norway provides free parking in cities and allows the use of bus lanes for BEV drivers. People that are using BEV also do not have to pay toll charges. The most significant impact is due to the waiver of value-added tax, which means a price reduction of 25% [33]. Looking at these advantages, it becomes clear that the high registration numbers are a result of artificial benefits that are provided by the government. Germany can choose the same path; however, different possibilities should be evaluated before burdening taxpayers with such an investment. Bobeth and Matthies [34] indicate that the public debate over electric vehicles in Germany is often related to the negative factors instead of their advantages. Moreover, they refer to the fact that, through ignorance and inexperience, only a small group of innovators are using this technology in Germany. Most people are unwilling to invest in the new technology until it becomes more popular. A sufficiently large number of innovators, or early adopters, can serve as proof for the rest of the population that the technology is suitable for everyday use.

Marketing departments have the opportunity to take appropriate measures to increase the volume of BEV purchases. One promotional option is to offer potential customers an initial test drive to demonstrate the advantages of BEVs. Due to a gap in the literature on the impact of short test driving, however, the effectiveness of this approach must still be determined. Thus, our main research question was to investigate the influence of a short test-drive experience on the perceived characteristics of battery electric vehicles in the German market. To answer this question, an experiment was needed that contained a test drive with an electric car.

In the next section, the current literature is reviewed to identify positive and negative performance factors that distinguish electric-powered cars from fuel-powered cars.

## 2.2. Positive Performance Factors of BEVs

### 2.2.1. Environmentally Friendly

The discussion about ecological balance is ongoing and remains a crucial point regarding the acceptance of BEV. Consumers question the energy source of electric-powered engines. Some may not be in favor of purchasing a BEV because the energy is produced from coal mines, which are causing harm to the environment [35]. Regarding Germany, this concern seems to be valid: In 2016, only 29% of energy production came from renewable resources [36].

Ellingsen et al. [37] discovered that more greenhouse gas emissions are produced by the production of electric cars than by the production of vehicles with combustion engines. BEV production results in

60% more CO<sub>2</sub> emissions, compared to the production of fuel-powered cars. The main reasons for this are the battery and other electronic components [38]. However, the emissions from BEVs during usage are relatively lower. BEVs reach a breakeven point in terms of environmental friendliness between 44,000 and 70,000 km, depending on the size and model [37]. Hence, a positive result can only be reached in the long run, by using electricity produced with low emission methods. Peng et al. [39] estimate a positive effect in the total lifecycle of a BEV that equates to up to 72% lower emissions compared to cars with combustion engines.

### 2.2.2. Driving Comfort and Acceleration

The experience of driving an electric car is unique: BEV users experience increased driving comfort due to less noise [6]. Furthermore, comfort is improved because most electric engines do not require a gearbox. Driving is smooth, without the interruption of gear changes [40]. Another positive aspect of BEVs is the acceleration, especially during lower speeds. Dynamic handling is perceived positively by BEV drivers [41].

### 2.2.3. Total Cost of Ownership

A further factor is the cost of owning of a BEV. The purchase price is only one part of the total cost of ownership (TCO), which also includes operating expenses. By using this approach, an economic judgment of electric vehicles can be made [42]. TCO includes the cost of energy, depreciation, insurance, taxes, and subsidies [43].

Potential customers estimate a higher TCO compared to fuel-powered vehicles. This assumption was examined in a study by Wu et al. [44]. The results are highly dependent on the size of the car and the distance driven per year. The purchasing cost is currently higher, and the operating cost is lower for BEVs. It can be concluded that the more kilometers driven, the more cost effective the electric vehicle will be. Consumers tend to focus only on the purchasing cost. A marketing label that provides information on savings per annual distance driven could improve perceptions of the technology. Furthermore, since lower-class vehicles are purchased for less, these can presumably offer a cost advantage faster than luxury cars [44].

As noted above, a main reason the purchasing price for BEVs is high is the battery packs. Higher ranges and more power lead to increased costs [45]. However, this increase can be seen positively [46–48]. Between 2013 and 2015, the prices for lithium-ion batteries decreased by 31%, and future decreases can be expected [49].

Depending on the models, operating costs are less than 50% compared to fuel-powered cars [50]. Lower fixed and variable costs are connected to BEVs' lower service and maintenance requirements, mainly because of the simpler electric engine [43]. Moreover, no taxes have to be paid, unlike with conventional vehicles [51].

## 2.3. Negative Performance Factors

### 2.3.1. Range

Range is defined as the distance a vehicle can drive without recharging. This performance factor is crucial, because cars powered solely by electricity currently cannot provide a range equal to that of fuel-powered cars. In addition, recharging takes more time than refilling a car with gasoline. In consequence, the consumer has less flexibility [35].

There are several aspects affecting a vehicle's range. The weight of the vehicle influences the efficiency of the car. Therefore, if a battery has a bigger capacity, the range is extended, but the effectiveness goes down. Another critical factor is driving style. Most BEVs' recharge their batteries when slowly braking, using regeneration [52]. Consequently, a smooth driving style, including moderate acceleration, is most favorable. Moreover, speed has a significant impact. High speeds are less efficient. For example, traveling at 120 instead of 70 km/h reduces the range by more than 50% [53].

Heating systems are another crucial point, especially in winter. A car with a combustion engine uses the heat of the powertrain, whereas a BEV requires a process to produce heat, which can reduce the potential distance up to 30% [54].

Fetene et al. [55] conducted an experiment using big data from BEVs. They revealed a discrepancy between the range mentioned by the car brands and the actual range reached in a normal consumer environment. The range stated by the manufacturers could be reached at 14 °C and a constant speed at 52 km/h. These values seem to be unrealistic and also depend on the weather conditions, patterns of driving, and other environmental factors. Modifications within the testing procedures are recommended, including realistic driving experiments by authorities [55].

### 2.3.2. Infrastructure and Charging

Another essential factor is the charging possibilities, which can provide flexibility and comfort [23]. According to the information provided by the manufacturer, the Volkswagen Golf-E requires a charging time of 17 h at a standard socket, whereas the charging time is estimated at 5 h and 20 min using their wallbox. If a customer has the opportunity to connect to a DC charger, 80% of the battery volume can be reached within 45 min [56]. Charging times between 5 and 17 h could be a hindrance, though it is worth noting that most electric cars are charged overnight [57].

The number of charging locations in Germany must be increased [53]. Infrastructure is not only defined as places to charge but also by the way these points are arranged [58]. Bonges and Lusk argue that they should be equipped with four ports, serving four parking spaces, to maximize efficiency [59].

A lack of standardization is also a problem [23]. Ko and Hahn [60] suggest using a battery swap mechanism that eliminates problems like lengthy charging and other negative aspects connected to recharging.

### 2.3.3. Top Speed, Durability, and Security

Various performance and safety factors influence the acceptance of BEVs. For most electric vehicles, the top speed is between 120 and 160 km/h. Without this limitation, the range would decrease rapidly, because of high energy consumption at higher speeds [61]. In most countries, this factor is negligible, because maximum speeds on highways are limited. In Germany, however, this is not the case: Car drivers are allowed to drive as fast as they want in some areas. As a result, speed limitation can be a hindrance for some potential customers.

Durability is another important factor. One battery pack can survive a driving distance of 120,000 km or more. Assuming a car is driven 14,000 km annually, this capacity would be enough for more than eight years [62].

There are two security issues that must also be mentioned. Firstly, a noiseless ride can cause safety problems. If other road users cannot hear a car, they may collide with it. Indeed, studies show an increased risk of accidents [63]. Some producers offer an artificial sound feature to solve the problem. Secondly, there is the risk of battery failure in vehicle crashes: High voltage can be a safety hazard if the integrity of a battery cell is compromised [64].

## 2.4. BEV User Model

As can be seen, there are advantages and disadvantages to the current BEV technology. Environmental-friendliness, driving comfort, total cost of ownership, acceleration, and driving pleasure are perceived as positive factors while security, durability, top speed, charging infrastructure, and charging times tend to be negative factors, when compared to gasoline-powered cars.

Several studies connected to the topic of electric mobility focus on hybrid vehicles. Their results were not incorporated in the present study. Based on our review of the literature, we developed a BEV consumer model (Figure 1). The illustration gives an overview of the factors that influence the adaptation towards electric cars. A more detailed description of the components is provided below.



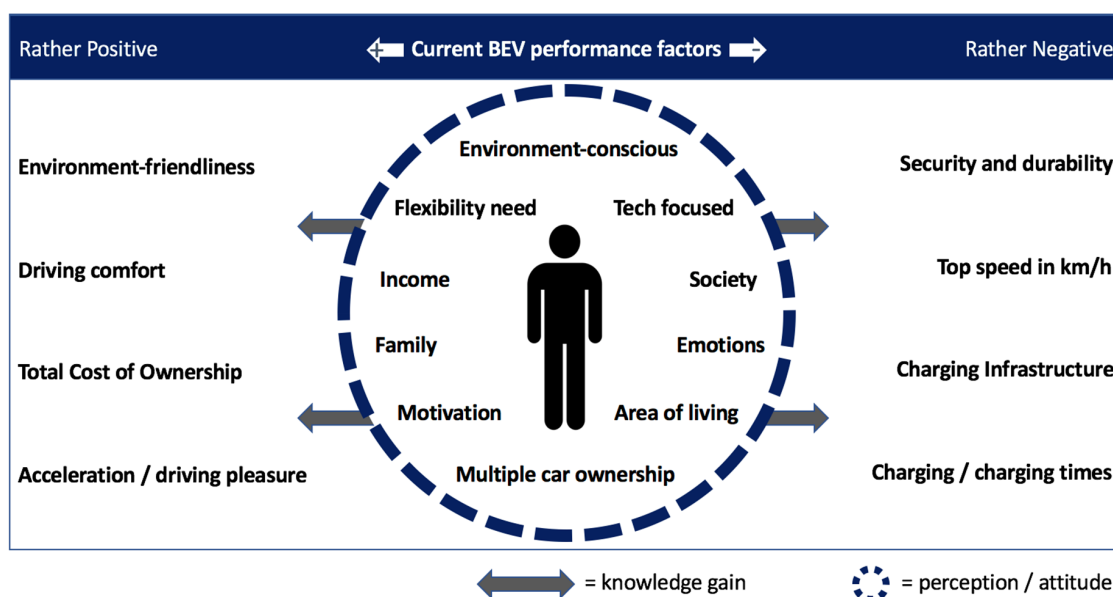


Figure 1. BEV consumer behavior model.

The widespread acceptance of BEVs is dependent on the performance of the vehicles that are offered on the market. If one considers the current state of the technology, various characteristics (performance factors) of BEVs can be classified as positive or negative, as compared to conventional vehicles equipped with an internal combustion engine. For example, the limited range can be classified as negative. If specific characteristics are favorable, the widespread acceptance of this technology will be faster. If features are rather negative, they can also be called hindrance factors, as they impede growth.

Potential users of electric cars have a certain perception of BEVs and their performance characteristics. This attitude is a key factor. An attitude is a learned tendency to react to an object or situation positively or negatively, which means that in similar situations, a person behaves the same way. Attitudes are based on previous experiences and processed information [65].

There is a direct link between attitude and purchasing behavior, but certain disruptive factors can weaken the correlation. This may occur when there is a positive attitude towards more than one product or because of situational factors, such as the appearance of promotions. Other factors that can weaken the correlation are limited financial resources and social norms; for example, a person might not buy a sports car because of adverse social reactions [66].

Knowledge can be described as the sum of information that can be recalled from memory in different situations. Consumer knowledge is information that is connected to the consumption or purchase of products. It includes familiarity with products and brands, purchase information (e.g., where to buy), and knowhow about product characteristics and usage [67]. One way to gain knowledge about electric cars is through test drives.

Personal factors, both internal and external (e.g., income), can influence attitude changes towards BEVs. Some, though perhaps not all, influencing factors are explained below.

A study conducted in Norway that compared BEV owners with conventional car owners found differences between the two subgroups. Regarding socio-demographics, electric car owners have a higher income and are younger. Additionally, households using BEV technology have more children [68]. Similarly, Nayum et al. state that high education has a positive influence on BEV adaptation. The same holds for a high income [69].

In contrast, Hidrue et al. (2011) claim that annual income is not a crucial factor. Additionally, they reveal that multiple car ownership is not of importance [70]. Karlsson disagrees, arguing that due to the limited range of electric vehicles, households with more than one car are more likely to be potential consumers because they can have the flexibility of choosing between a long-range combustion engine car and an electric vehicle [71]. Plötz et al. identified the profile of early users of this technology.

According to their results, the potential targets are middle-aged men living in rural areas with their families; they own more than one vehicle and, due to their higher income, can afford a BEV [20].

The scientific literature presents influential variables that include psychological and societal acceptance of the technology. Moons and de Pelsmacker show that positive emotions, resulting, for example, from the awareness of using an environmentally friendly car, have a positive effect on the willingness to adapt to this technology. Negative emotions can have adverse effects [72].

Beside positive emotions, the BEV, as a symbol for green consumer behavior, can have an impact. Castaneda et al. [73] carried out a study with several interesting findings. Social groups can influence ecological behavior by putting pressure on individuals. Social norms are defined in these clusters, and people who are not following their unwritten rules are punished by society. Since electric vehicle users are still a minority, the social pressure on drivers of conventional vehicles is not that strong. Nevertheless, the BEV can function as a symbol to display social status or a unique identity [17]. People showing an environmentally conscious self-identity have a high potential to adapt to BEV. This behavior is also connected to worries about climate change [74]. Environmental awareness has led to a growing importance of green consumer behavior. Marketing departments have to consider this circumstance [75]. Conversely, Prothero et al. [76] discuss an observable gap between attitudes toward sustainability and actual behavior. A United Nations survey shows this paradox: In total, 40% of consumers could imagine buying green products, but only 4% demonstrate this attitude with action [77]. Despite these observations, Axsen et al. demonstrate that consumers who follow a green and technology-oriented lifestyle are more motivated to use electric vehicles [40].

Environmentally aware consumers have an important reason to buy cars that are powered by electric engines. Driving this kind of vehicle reflects their desire to protect the environment. Consumers make their purchase decision with the intention to do something good for society and to weaken the power of the oil industry. Moreover, they are presenting their individuality. In the early stages of technological development, they can show that they are first taking on the role of an innovator [78].

Degirmenci and Breitner measured the importance of environmental performance compared to the price and range of electric vehicles and found that eco-friendliness is weighted with a higher priority [79]. Hence, it may be assumed that people will accept a higher price or a lower range if they can contribute to the protection of the environment. Yet, van Rijnsoever et al. found a gap between attitudes toward environmentally friendly cars and people's actual behavior [80].

It is important to stress that models of customer experience and customer experience management are gaining more and more attention in marketing publications, stressing the concept of sensory or multi-sensory marketing [14,15,81,82]. According to Krishna sensory marketing engages consumers' senses and influences their perception, evaluation, and behavior, usually aiming to increase their purchase intention [14]. Marketing methods in this context describe approaches that are connected to experience with a product or brand [83]. Pine, Pine, and Gilmore stress the importance of the customer in comprehending what an experience means to him or her [84]. It usually happens when a company purposefully creates an experience with the goal of involving customers. This happens when companies provide consumption experiences, communication, and contacts that build an experience in their minds [85,86]. In order to strengthen customer experience and brand awareness, it is best to involve as many senses as possible. According to Hultén [15], in addition to vision, other senses, such as smell, sound, taste, and touch, may "reinforce a positive feeling, following the experiential logic, that generates a certain value to the individual and, in particular, creates a brand image". The involvement of more senses leads to a more comprehensive experience of the product or service. Such a multi-sensory experience is more engaging and more memorable than other forms of education [87]. Muhammad and Artanti investigated whether an experience can have a positive effect on consumer satisfaction as well as on word of mouth [88]. In particular, approaches that target experiences are becoming more and more relevant due to the perceived exchangeability of brands [89].

Mooy and Robben distinguish between indirect and direct experience. The most indirect form is a product description, which is followed by word of mouth and a product photo that, for example,

can be displayed in a printed advertisement [90]. A product that can be seen in a shopping window is closer to direct experience, as is a product demonstration. Finally, the authors describe hands-on experience as pure, direct experience. Mooy and Robben (2002) agree that direct experience improves the ability to process information [90]. A product can be used as a communication tool that supports decision making during the purchasing process. Therefore, by applying a multi-sensory marketing perspective, companies can utilize sensorial strategies conveyed “through sensors, sensations and sensory expressions in relation to the five human senses in leaving imprints of a good or service” [81].

## 2.5. The Impact of Experience with BEV

Various authors have investigated the impact of experience on the perceived characteristics of BEVs. The main findings of their studies, with their time/length of experiment and number of participants, are displayed in Table 1.

**Table 1.** BEV experience and its influence.

Authors	Time or Length	Place/No. of Participants	Main Findings
Skippon, Garwood (2011) [91]	10 miles	UK 58	<ul style="list-style-type: none"> <li>• mixed results after the experience</li> <li>• 240 km are enough to consider a BEV as a primary car</li> </ul>
Burgess, King, Harris, Lewis (2013) [4]	6–12 months	UK 55	<ul style="list-style-type: none"> <li>• performance evaluated better after the test drive</li> <li>• change from negative to positive BEV stereotype is possible</li> </ul>
Jensen, Cherchi, Mabit (2013) [5]	3 months	Denmark 369	<ul style="list-style-type: none"> <li>• experience has a significant impact on preferences</li> <li>• importance of range increased after usage</li> <li>• the marginal utility of top speed increased</li> </ul>
Bühler, Cocron, Neumann, Franke, Krems (2014) [92]	3–6 months	Germany 79	<ul style="list-style-type: none"> <li>• improved overall perception</li> <li>• particular increase in perceptions of refueling costs and driving pleasure</li> <li>• no change in purchase intention</li> </ul>
Schneider, Dütschke and Peters (2014) [7]	Few weeks until six months	Germany 145	<ul style="list-style-type: none"> <li>• Positive change regarding driving pleasure, acceleration and reaction of others</li> <li>• Negative change regarding availability of public charging stations</li> </ul>
Rauh, Franke, Krems (2015) [93]	27.8 km	Germany 24	<ul style="list-style-type: none"> <li>• Range anxiety is reduced by BEV experience</li> </ul>
Skippon, Kinnear, Lloyd, Stannard (2016) [94]	36 h	UK 393	<ul style="list-style-type: none"> <li>• Product trial decreases willingness to purchase</li> </ul>
Schmalfuß, Mühl, Krems (2017) [95]	24 h	Germany 30	<ul style="list-style-type: none"> <li>• positive view of electric vehicles after short-term experience</li> <li>• no change in purchase intention</li> </ul>
Rauh, Franke, Krems (2017) [45]	94 km	Germany 74	<ul style="list-style-type: none"> <li>• Critical range experience in a protected environment reduces stress in future situations</li> </ul>

Source: elaboration based on sources included in the table.

Reviewing the obtained results, it can be noticed that the experience of using BEVs does impact the perception of their characteristics. For example, two performance factors, acceleration and driving experience, are perceived better. The observed range and the charging issues are similar after the test drive or perceived slightly more negatively. None of the studies we found showed an increase in willingness to purchase. In spite of some negative effects, most authors recommend direct experience to increase the acceptance of BEVs. It is also worth noting that the technology is developing rapidly: From today’s viewpoint, the technology in some of the cars used in past studies is outdated.



The methods of carrying out the experiments show that in most studies, the test drive period was extensive. Some results contain a low number of participants or were not conducted in the German market. Moreover, the results of the studies often do not describe the influence of experience on the perception of single characteristics of electric cars. After studying these results, a research gap was conceptualized as the central research question of our study: What is the influence of a short test drive experience on the perceived characteristics of battery electric vehicles in the German market? Due to high costs, there seems to be no sense in producers providing electric cars for extended test periods. That is why our research investigated the impact of a short driving experience (10 min). Based on our theoretical analysis, we proposed two hypotheses (H1 and H2) to be tested with the help of an experiment. One is connected to the overall perception of BEVs, and the other is linked to the intention to buy a BEV:

**Hypotheses 1 (H1).** *A short test drive experience with a BEV increases the positive attitude towards electric cars.*

**Hypotheses 1 (H2).** *A short test drive experience with a BEV increases the purchase intent towards electric cars.*

The first hypothesis can be specified when, after receiving an explanation of BEV performance factors, subjects are asked to evaluate them positively or negatively. The assumption is that the test drive experience increases the perception of every single factor. Regarding the second hypothesis, if BEV characteristics are evaluated better during the test drive, it can be assumed that the purchase intent also rises.

### 3. Research Methodology

#### 3.1. General Description and Questionnaires

To test the formulated hypotheses, a short test drive experiment was used to collect data from individuals using BEVs. Furthermore, the obtained results were processed with SPSS using statistical measures. Participants could rate factors influencing the perception of BEVs before and after the test drive. Moreover, this research indicates whether BEVs are able to compete with gasoline-powered cars. The test drive experiment was supported by Volkswagen AG, who provided four electric cars. The BEV's were available on six days (16–21 March 2018) for the execution of the experiment. They included one Volkswagen E-UP!, with a range of 160 km, and three Volkswagen E-Golfs, with a range of 300 km. A total of 20 instructors were involved. The field study was organized into four steps (Figure 2).



**Figure 2.** Steps of the field study. Source: Own study.

Before the experiment, the participants were informed that they would drive a BEV. The candidates completed the first questionnaire. They received no further facts about the vehicle or electromobility. The questionnaire was completed in the test car.

Questionnaire one was followed by the test drive phase. First, the signatures of the participants had to be obtained to ensure insurance coverage. After a short briefing by the instructor, the test drive could begin. Each test drive took about 10 min, without an exact route.

The third phase involved additional information. This approach was chosen to simulate a test drive situation, which could also be applied by companies. The information presented in the brochure contained facts about the vehicle itself (range in km, top speed, battery guarantee, acceleration, charging times, price comparison to cars with combustion engines, total cost of ownership, and CO<sub>2</sub> emissions) and about electromobility in general (sustainability, charging stations that are available in Germany).

After the test drive and perusal of the brochure, the participants completed questionnaire two, which mainly contained the same questions as in questionnaire one.

### 3.2. The Questionnaires

All questions asked the participants to evaluate a characteristic of electromobility or a particular BEV using a scale from 1 to 10. One is synonymous with very bad, whereas 10 is synonymous with very good. At this point, a conscious decision was made against using the usual Likert scale, which contains five steps [96]. A 10-stage evaluation system was selected because it allows identification of smaller changes (e.g., from 7 to 8).

Participants evaluated their general attitude towards BEVs and their performance factors before and after the test drive. Moreover, test drivers rated their purchase intention on a scale from 1 to 10, where they assessed how likely it is that they would consider an electric one when buying their next car.

One question investigated previous test drive experience with electric vehicles. Since the study aimed to evaluate the impact of first-time experience with this technology, candidates who already had experience with BEV or hybrid vehicles were excluded. The following descriptive and inductive evaluations were created with the statistical program package SPSS Statistics 25.0.

### 3.3. Profile of the Participants

It must be mentioned that all respondents taking part in the experiment were from the area around the city of Münster, in the North Rhine-Westphalia region. The results show that 131 persons completed the test drive and filled out the questionnaires. Nevertheless, 10 results were not taken into consideration due to prior experience with electric vehicles, and another 7 test drive results were disregarded because participants only answered the one questionnaire before the test drive. In total, 114 valid test drive experiments were successfully executed, and their profile characteristics are provided in Table 2.

**Table 2.** Profile characteristics of the participants.

Variable		Frequency	Percent	Valid Percent	Cumulative Percent
<b>Gender</b>					
Valid	male	62	54.4	54.4	54.4
	female	52	45.6	45.6	100.0
	Total	114	100.0	100.0	
<b>Age</b>					
Valid	18–29	46	40.4	40.4	40.4
	30–44	27	23.7	23.7	64.0
	45–60	25	21.9	21.9	86.0
	>60	16	14.0	14.0	100.0
	Total	114	100.0	100.0	
<b>Education Level</b>					
Valid	Primary School	9	7.9	7.9	7.9
	Secondary School	23	20.2	20.2	28.1
	High School	41	36.0	36.0	64.0
	Bachelor	20	17.5	17.5	81.6
	Master	18	15.8	15.8	97.4
	PhD	3	2.6	2.6	100.0
	Total	114	100.0	100.0	

Table 2. Cont.

Variable		Frequency	Percent	Valid Percent	Cumulative Percent
<b>Estimated Income</b>					
Valid	higher than average	41	36.0	42.7	42.7
	average	46	40.4	47.9	90.6
	lower than average	9	7.9	9.4	100.0
	Total	96	84.2	100.0	
Missing	4	18	15.8		
Total		114	100.0		
<b>Number of Cars within the Household</b>					
Valid	1	32	28.1	28.1	28.1
	2	65	57.0	57.0	85.1
	3	17	14.9	14.9	100.0
	Total	114	100.0	100.0	

Source: Own study (n = 114).

According to the survey, 54.4% of the participants were male and 45.6% were female. In addition, most of the respondents (40.4%) were young people between 18 and 30. The two second largest age groups were people aged 31 to 45 and 46 to 60, with 23.7% and 21.9%, respectively. In total, 14% of the participants were 61 or older. The group aged over 61 years was the smallest, with only 14.3%. Regarding education level, high school graduates were the biggest group, with 36%. Moreover, the majority of test drivers (57%) were employed. Income was regarded subjectively, with 47.9% respondents estimating their income as average while 42.7% declared that they earn more than average. Most respondents (57%) had two cars in their households.

#### 4. Results

The data included in Table 3 displays the changes in respondents' perceptions of various factors before and after the test drive.

Table 3. Evaluation factors before and after the test drive.

Group Statistics					
Variable	Time	N	Mean	Std. Deviation	Std. Error Mean
General attitude toward electric cars	before test drive	114	6.86	2.073	0.194
	after test drive	114	7.62	1.767	0.165
knowledge about electric cars	before test drive	114	4.18	2.066	0.194
	after test drive	114	5.89	1.918	0.180
willingness to purchase an electric car	before test drive	114	3.79	2.302	0.216
	after test drive	114	5.35	2.417	0.226
estimation of price	before test drive	114	3.55	1.624	0.152
	after test drive	114	5.48	1.830	0.171
estimation of running cost	before test drive	114	5.37	2.130	0.199
	after test drive	114	6.19	1.932	0.181
safety	before test drive	114	7.31	1.815	0.170
	after test drive	114	7.70	1.667	0.156
range in km	before test drive	114	3.73	1.806	0.169
	after test drive	114	4.25	2.068	0.194
reliability of the electric car and battery	before test drive	114	5.22	1.779	0.167
	after test drive	114	6.01	1.948	0.182

Table 3. Cont.

Group Statistics					
Variable	Time	N	Mean	Std. Deviation	Std. Error Mean
charging times	before test drive	114	4.18	1.934	0.181
	after test drive	114	4.26	2.166	0.203
comfort of charging procedure	before test drive	114	6.82	2.268	0.212
	after test drive	114	6.86	2.319	0.217
public charging	before test drive	114	4.32	2.290	0.214
	after test drive	114	4.59	2.241	0.210
charging at home	before test drive	114	6.04	2.569	0.241
	after test drive	114	6.59	2.478	0.232
acceleration and driving pleasure	before test drive	114	6.82	2.024	0.190
	after test drive	114	8.61	1.392	0.130
driving comfort	before test drive	114	8.03	1.727	0.162
	after test drive	114	8.95	1.128	0.106
maximum speed in km/h	before test drive	114	6.13	1.976	0.185
	after test drive	114	6.76	2.117	0.198
eco friendliness of electric cars	before test drive	114	7.38	2.451	0.230
	after test drive	114	7.54	1.992	0.187

Source: Own study (n = 114).

In total, 16 categories presented in Table 3 show a change in the average value before and after the test drive. It can be observed that no value developed negatively; rather, an increase in factor perception was observed. The table below shows the increase of the mean of the evaluation factors in % from the highest to the lowest one (Table 4). The highest increase is noticed in the “estimation of price” (by 54%), followed by “willingness to purchase an electric car” and “knowledge about electric cars” (both by 41%), as well as “acceleration and driving pleasure” (by 26%); the lowest factors, with almost no increase, are “eco friendliness” and “charging times” (both by 2%), and “comfort of charging procedure”, by 1% only.

Table 4. Increase of evaluation factors in %. Source: Own study (n = 114).

Factors	Increase
estimation of price	54
willingness to purchase an electric car	41
knowledge about electric cars	41
acceleration and driving pleasure	26
estimation of running cost	15
reliability of the electric car and battery	15
range in km	14
driving comfort	11
general attitude toward electric cars	11
maximum speed in km/h	10
charging at home	9
public charging	6
safety	5
eco friendliness of electric cars	2
charging times	2
comfort of charging procedure	1

We now examined whether all questions from the first hypothesis can be combined into scores. If possible, the hypothesis was also evaluated on the basis of the summarized data. For this purpose, the Cronbach's Alpha was calculated (Table 5).

**Table 5.** Cronbach's Alpha I.

Reliability Statistics				
Cronbach's Alpha	N of Items			
0.805	15			
Item-Total Statistics				
(before test drive)	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
general attitude toward electric cars	79.04	217.741	0.523	0.786
knowledge about electric cars	81.73	242.023	0.121	0.815
estimation of price before test drive	82.35	237.079	0.287	0.802
estimation of running cost	80.54	228.092	0.333	0.800
safety	78.60	230.119	0.375	0.797
range in km	82.18	224.482	0.486	0.789
reliability of the electric car and battery	80.68	225.138	0.483	0.790
charging times	81.73	221.633	0.498	0.788
comfort of charging procedure	79.09	210.594	0.582	0.780
public charging	81.59	213.802	0.523	0.785
charging at home	79.87	211.938	0.475	0.789
acceleration and driving pleasure	79.09	220.824	0.484	0.789
driving comfort	77.88	228.870	0.425	0.794
maximum speed in km/h	79.77	223.505	0.451	0.791
eco friendliness of electric cars	78.53	230.252	0.239	0.810

Source: Own study (n = 114).

Cronbach's Alpha indicates how a summary of the individual questions makes sense statistically. The maximum value is 1.0. The larger the value, the more suitable the summary. A value from 0.6 to 0.7 can be interpreted as a useful summary [97]. Due to low selectivity, three values (knowledge about electric cars, estimation of price before test drive, and eco-friendliness of electric cars) were selected. The result of the Cronbach's Alpha II is provided in Table 6.

**Table 6.** Cronbach's Alpha II.

Reliability Statistics				
Cronbach's Alpha	N of Items			
0.819	12			
Item-Total Statistics				
(before test drive)	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
general attitude toward electric cars	63.94	167.987	0.546	0.799
estimation of running cost	65.43	182.035	0.262	0.824
safety	63.49	178.394	0.411	0.810
range in km	67.07	174.862	0.492	0.804
reliability of the electric car and battery	65.58	174.494	0.510	0.803
charging times	66.62	173.635	0.476	0.805
comfort of charging procedure	63.98	164.690	0.546	0.799
public charging	66.48	167.119	0.494	0.804
charging at home	64.76	163.191	0.485	0.806
acceleration and driving pleasure	63.98	169.628	0.529	0.801
driving comfort	62.77	177.735	0.454	0.807
maximum speed in km/h	64.67	172.631	0.483	0.805

Source: Our own study (n = 114).



The value for “estimated running cost” before the test drive displayed a low selectivity. Therefore, the value was eliminated. The next Cronbach’s Alpha was estimated (Table 7).

**Table 7.** Cronbach’s Alpha III.

Reliability Statistics				
Cronbach's Alpha	N of Items			
0.824	11			
Item-Total Statistics				
(before test drive)	Scale Mean if Item Deleted	Scale Variance if Item Deleted	Corrected Item-Total Correlation	Cronbach's Alpha if Item Deleted
general attitude toward electric cars before test drive	58.57	149.291	0.561	0.803
safety	58.12	159.737	0.414	0.816
range in km	61.70	156.406	0.495	0.809
reliability of the electric car and battery	60.21	157.141	0.487	0.810
charging times	61.25	154.775	0.489	0.810
comfort of charging procedure	58.61	146.823	0.547	0.804
public charging	61.11	148.863	0.500	0.809
charging at home	59.39	146.153	0.471	0.814
acceleration and driving pleasure	58.61	151.938	0.521	0.807
driving comfort	57.40	159.163	0.457	0.813
maximum speed in km/h	59.30	153.751	0.498	0.809

Source: Own study (n = 114).

The total selectivity was bigger than 4. Also, Cronbach’s Alpha, with a value of 0.824, displayed a good value for the 11 items. A summary of these values as a score can be justified (Table 8).

**Table 8.** Score before and after the test drive.

Statistics			
Variable		Score Before Test Drive	Score after Test Drive
N	Valid	114	114
	Missing	0	0
	Mean	5.9482	6.5638
	Median	5.8636	6.5455
	Std. Deviation	1.22655	1.24866
	Minimum	2.45	3.45
	Maximum	8.64	9.82

Source: Own study (n = 114).

Our next step was testing whether an underlying population was normally distributed. The Kolmogorov–Smirnov and the Shapiro–Wilk tests were applied (Table 9). A significant *p*-value stands for a violation of the normal distribution. In this case, both tests were not significant [98]. With this observation, it can be concluded that the data is normally distributed. This can also be noticed within the Q.Q plots [99], represented below, before and after the test drive (Figure 3).

Table 9. Test of normal distribution.

Variable	Tests of Normality					
	Kolmogorov–Smirnov <sup>a</sup>			Shapiro–Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Score before test drive	0.065	114	0.200 *	0.989	114	0.512
Score after test drive	0.051	114	0.200 *	0.992	114	0.740

\* This is a lower bound of the true significance. <sup>a</sup> Lilliefors Significance Correction. Source: Own study (n = 114).

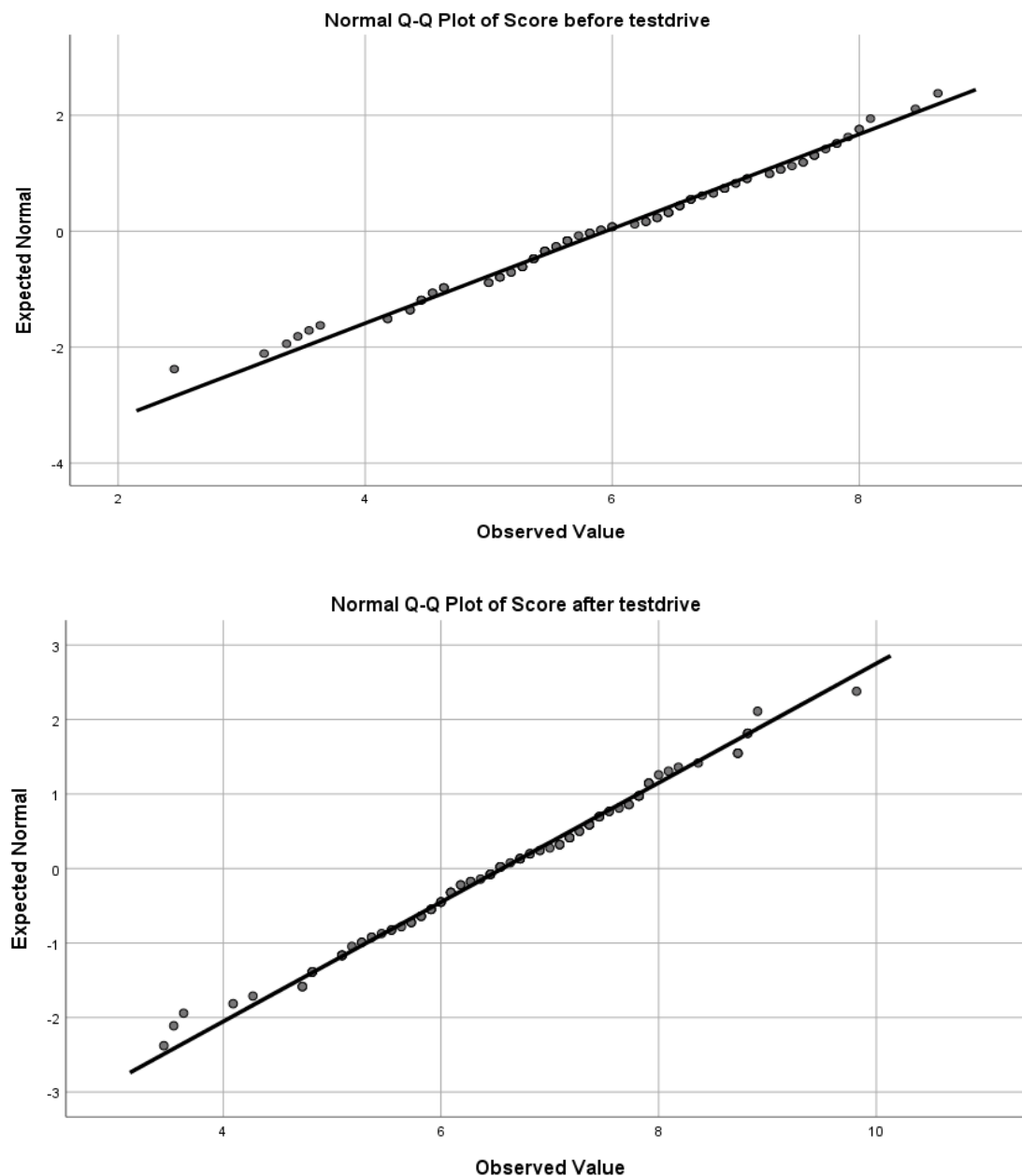


Figure 3. Q-Q plots before and after the test drive. Source: Own study (n = 114).

Hypothesis 1 stated that a short test drive experience with a BEV increases the positive attitude towards electric cars. To check if there was a difference between the values before and after the test drive, the Wilcoxon test was used (Table 10).

Table 10. Wilcoxon test H1 I.

Ranks				
Variable		N	Mean Rank	Sum of Ranks
general attitude toward electric cars after test drive – general attitude toward electric cars before test drive	Negative Ranks	24 <sup>a</sup>	39.56	949.50
	Positive Ranks	62 <sup>b</sup>	45.02	2791.50
	Ties	28 <sup>c</sup>		
	Total	114		
knowledge about electric cars after test drive – knowledge about electric cars before test drive	Negative Ranks	8 <sup>d</sup>	23.63	189.00
	Positive Ranks	76 <sup>e</sup>	44.49	3381.00
	Ties	30 <sup>f</sup>		
	Total	114		
estimation of price after test drive – estimation of price before test drive	Negative Ranks	9 <sup>g</sup>	40.89	368.00
	Positive Ranks	82 <sup>h</sup>	46.56	3818.00
	Ties	23 <sup>i</sup>		
	Total	114		
estimation of running cost after test drive – estimation of running cost before test drive	Negative Ranks	26 <sup>j</sup>	33.44	869.50
	Positive Ranks	53 <sup>k</sup>	43.22	2290.50
	Ties	35 <sup>l</sup>		
	Total	114		
safety after test drive after test drive – safety before test drive	Negative Ranks	30 <sup>m</sup>	31.47	944.00
	Positive Ranks	42 <sup>n</sup>	40.10	1684.00
	Ties	42 <sup>o</sup>		
	Total	114		
range in km after test drive – range in km before test drive	Negative Ranks	29 <sup>p</sup>	42.38	1229.00
	Positive Ranks	55 <sup>q</sup>	42.56	2341.00
	Ties	30 <sup>r</sup>		
	Total	114		
reliability of the electric car and batter after test drive – reliability of the electric car and batter before test drive	Negative Ranks	26 <sup>s</sup>	36.21	941.50
	Positive Ranks	59 <sup>t</sup>	45.99	2713.50
	Ties	29 <sup>u</sup>		
	Total	114		
charging times after test drive – charging times before test drive	Negative Ranks	42 <sup>v</sup>	42.07	1767.00
	Positive Ranks	43 <sup>w</sup>	43.91	1888.00
	Ties	29 <sup>x</sup>		
	Total	114		
comfort of charging procedure after test drive – comfort of charging procedure before test drive	Negative Ranks	44 <sup>y</sup>	38.57	1697.00
	Positive Ranks	39 <sup>z</sup>	45.87	1789.00
	Ties	31 <sup>aa</sup>		
	Total	114		
public charging after test drive – public charging before test drive	Negative Ranks	34 <sup>ab</sup>	34.44	1171.00
	Positive Ranks	40 <sup>ac</sup>	40.10	1604.00
	Ties	40 <sup>ad</sup>		
	Total	114		
charging at home after test drive – charging at home before test drive	Negative Ranks	30 <sup>ae</sup>	41.95	1258.50
	Positive Ranks	54 <sup>af</sup>	42.81	2311.50
	Ties	30 <sup>ag</sup>		
	Total	114		
acceleration and driving pleasure after test drive – acceleration and driving pleasure before test drive	Negative Ranks	16 <sup>ah</sup>	32.75	524.00
	Positive Ranks	79 <sup>ai</sup>	51.09	4036.00
	Ties	19 <sup>aj</sup>		
	Total	114		
driving comfort after test drive – driving comfort before test drive	Negative Ranks	21 <sup>ak</sup>	28.83	605.50
	Positive Ranks	56 <sup>al</sup>	42.81	2397.50
	Ties	37 <sup>am</sup>		
	Total	114		
maximum speed in km/h after test drive – maximum speed in km/h before test drive	Negative Ranks	32 <sup>an</sup>	38.75	1240.00
	Positive Ranks	55 <sup>ao</sup>	47.05	2588.00
	Ties	27 <sup>ap</sup>		
	Total	114		

Table 10. Cont.

Ranks				
Variable		N	Mean Rank	Sum of Ranks
eco friendliness of electric cars after test drive – eco friendliness of electric cars before test drive	Negative Ranks	38 <sup>aq</sup>	36.86	1400.50
	Positive Ranks	40 <sup>ar</sup>	42.01	1680.50
	Ties	36 <sup>as</sup>		
	Total	114		

<sup>a</sup> General attitude toward electric cars after test drive < General attitude toward electric cars before test drive.

<sup>b</sup> General attitude toward electric cars after test drive > General attitude toward electric cars before test drive.

<sup>c</sup> General attitude toward electric cars after test drive = General attitude toward electric cars before test drive.

<sup>d</sup> knowledge about electric cars after test drive < knowledge about electric cars before test drive. <sup>e</sup> knowledge about electric cars after test drive > knowledge about electric cars before test drive. <sup>f</sup> knowledge about electric cars after test drive = knowledge about electric cars before test drive. <sup>g</sup> estimation of price after test drive < estimation of price before test drive. <sup>h</sup> estimation of price after test drive > estimation of price before test drive. <sup>i</sup> estimation of price after test drive = estimation of price before test drive. <sup>j</sup> estimation of running cost after test drive < estimation of running cost before test drive. <sup>k</sup> estimation of running cost after test drive > estimation of running cost before test drive. <sup>l</sup> estimation of running cost after test drive = estimation of running cost before test drive. <sup>m</sup> safety after test drive after test drive < safety before test drive. <sup>n</sup> safety after test drive after test drive > safety before test drive. <sup>o</sup> safety after test drive after test drive = safety before test drive. <sup>p</sup> range in km after test drive < range in km before test drive. <sup>q</sup> range in km after test drive > range in km before test drive. <sup>r</sup> range in km after test drive = range in km before test drive. <sup>s</sup> reliability of the electric car and batter after test drive < reliability of the electric car and batter before test drive. <sup>t</sup> reliability of the electric car and batter after test drive > reliability of the electric car and batter before test drive. <sup>u</sup> reliability of the electric car and batter after test drive = reliability of the electric car and batter before test drive. <sup>v</sup> charging times after test drive < charging times before test drive. <sup>w</sup> charging times after test drive > charging times before test drive. <sup>x</sup> charging times after test drive = charging times before test drive. <sup>y</sup> comfort of charging procedure after test drive < comfort of charging procedure before test drive. <sup>z</sup> comfort of charging procedure after test drive > comfort of charging procedure before test drive. <sup>aa</sup> comfort of charging procedure after test drive = comfort of charging procedure before test drive. <sup>ab</sup> public charging after test drive < public charging before test drive. <sup>ac</sup> public charging after test drive > public charging before test drive. <sup>ad</sup> public charging after test drive = public charging before test drive. <sup>ae</sup> charging at home after test drive < charging at home before test drive. <sup>af</sup> charging at home after test drive > charging at home before test drive. <sup>ag</sup> charging at home after test drive = charging at home before test drive. <sup>ah</sup> acceleration and driving pleasure after test drive < acceleration and driving pleasure before test drive. <sup>ai</sup> acceleration and driving pleasure after test drive > acceleration and driving pleasure before test drive. <sup>aj</sup> acceleration and driving pleasure after test drive = acceleration and driving pleasure before test drive. <sup>ak</sup> driving comfort after test drive < driving comfort before test drive. <sup>al</sup> driving comfort after test drive > driving comfort before test drive. <sup>am</sup> driving comfort after test drive = driving comfort before test drive. <sup>an</sup> maximum speed in kmh after test drive < maximum speed in kmh before test drive. <sup>ao</sup> maximum speed in kmh after test drive > maximum speed in kmh before test drive. <sup>ap</sup> maximum speed in kmh after test drive = maximum speed in kmh before test drive. <sup>aq</sup> eco friendliness of electric cars after test drive < eco-friendliness of electric cars before test drive. <sup>ar</sup> eco-friendliness of electric cars after test drive > eco-friendliness of electric cars before test drive. <sup>as</sup> eco-friendliness of electric cars after test drive = eco-friendliness of electric cars before test drive.

The majority of values showed a significant change while differences in the categories of “charging times”, “comfort of charging procedure”, “public charging”, and “eco-friendliness” were not significant (Table 11). On the basis of these analyses, the statement can be made that H1 was confirmed only when the abovementioned four areas were not included.

Table 11. Wilcoxon test H1 II.

Test Statistics <sup>a</sup>		
Variable	Z	Asymp. Sig. (2-Tailed)
General attitude toward electric cars after test drive – General attitude toward electric cars before test drive	−4.019 <sup>b</sup>	0.000
knowledge about electric cars after test drive – knowledge about electric cars before test drive	−7.168 <sup>b</sup>	0.000
estimation of price after test drive – estimation of price before test drive	−6.862 <sup>b</sup>	0.000
estimation of running cost after test drive – estimation of running cost before test drive	−3.497 <sup>b</sup>	0.000

Table 11. Cont.

Test Statistics <sup>a</sup>		
Variable	Z	Asymp. Sig. (2-Tailed)
safety after test drive after test drive – safety before test drive	−2.097 <sup>b</sup>	0.036
range in km after test drive – range in km before test drive	−2.516 <sup>b</sup>	0.012
reliability of the electric car and batter after test drive – reliability of the electric car and batter before test drive	−3.923 <sup>b</sup>	0.000
charging times after test drive – charging times before test drive	−0.268 <sup>b</sup>	0.788
comfort of charging procedure after test drive – comfort of charging procedure before test drive	−0.211 <sup>b</sup>	0.833
public charging after test drive – public charging before test drive	−1.188 <sup>b</sup>	0.235
charging at home after test drive – charging at home before test drive	−2.368 <sup>b</sup>	0.018
acceleration and driving pleasure after test drive – acceleration and driving pleasure before test drive	−6.556 <sup>b</sup>	0.000
driving comfort after test drive – driving comfort before test drive	−4.625 <sup>b</sup>	0.000
maximum speed in kmh after test drive – maximum speed in kmh before test drive	−2.889 <sup>b</sup>	0.004
eco friendliness of electric cars after test drive – eco friendliness of electric cars before test drive	−0.708 <sup>b</sup>	0.479

<sup>a</sup> Wilcoxon Signed Ranks Test; <sup>b</sup> Based on negative ranks. Source: Own study (n = 114).

Hypothesis 2 stated that a short test drive experience with a BEV increases the purchase intent towards electric vehicles. In the following, the Wilcoxon test was used to clarify whether there was an overall change (Table 12).

Table 12. Wilcoxon test H2 I.

Ranks				
Variable		N	Mean Rank	Sum of Ranks
willingness to purchase an electric car after test drive – willingness to purchase an electric car before test drive	Negative Ranks	13 <sup>a</sup>	26.31	342.00
	Positive Ranks	72 <sup>b</sup>	46.01	3313.00
	Ties	29 <sup>c</sup>		
	Total	114		

<sup>a</sup> willingness to purchase an electric car after test drive < willingness to purchase an electric car before test drive.

<sup>b</sup> willingness to purchase an electric car after test drive > willingness to purchase an electric car before test drive.

<sup>c</sup> willingness to purchase an electric car after test drive = willingness to purchase an electric car before test drive.

Source: Own study (n = 114).

If one compares the mean values mentioned in Table 3, it is possible to observe that this parameter increased by 41%, from 3.79 to 5.35. The abovementioned test shows the significance of these values (Table 13) and therefore H2 can be confirmed.



**Table 13.** Wilcoxon test H2 II.

Test Statistics <sup>a</sup>	
	willingness to purchase an electric car after test drive – willingness to purchase an electric car before test drive
Z	−6.555 <sup>b</sup>
Asymp. Sig. (2-tailed)	0.000

<sup>a</sup> Wilcoxon Signed Ranks Test. <sup>b</sup> Based on negative ranks. Source: Own study (n = 114).

In the following, various univariate analyses were performed to determine whether any variables significantly influenced the result. The Mann–Whitney U test was used to analyze the effect of gender (Table 14). In addition, other factors, such as age, education level, and the number of cars in the household, were examined in the context of correlations.

**Table 14.** Mann–Whitney U test H2 I.

Ranks				
Variable	Gender	N	Mean Rank	Sum of Ranks
willingness to purchase an electric car before test drive	male	62	54.65	3388.00
	female	52	60.90	3167.00
	Total	114		
willingness to purchase an electric car after test drive	male	62	55.69	3452.50
	female	52	59.66	3102.50
	Total	114		

Source: Own study (n = 114).

Both *p*-values were not significant (Table 15); therefore, a connection between gender and test results could not be proven. No significant correlations with age, education level, number of cars in the household, or estimated income could be identified (Table 16).

**Table 15.** Mann–Whitney U test H2 II.

Test Statistics <sup>a</sup>		
	Willingness to Purchase an Electric Car before Test Drive	Willingness to Purchase an Electric Car after Test Drive
Mann-Whitney U	1435.000	1499.500
Wilcoxon W	3388.000	3452.500
Z	−1.019	−0.644
Asymp. Sig. (2-tailed)	0.308	0.519

<sup>a</sup> Grouping Variable: Gender. Source: Own study (n = 114).

**Table 16.** Spearman's rho correlation H2.

Correlations						
Variable	Spearman's Rho					
	Willingness to Purchase an Electric Car before Test Drive			Willingness to Purchase an Electric Car after Test Drive		
	Correlation Coefficient	Sig. (2-Tailed)	N	Correlation Coefficient	Sig. (2-Tailed)	N
Age	0.061	0.520	114	0.198 *	0.034	114
Education level	0.037	0.698	114	−0.044	0.641	114
Number of cars within the household	−0.069	0.467	114	−0.079	0.404	114
Estimated income	−0.077	0.453	96	−0.051	0.620	96

\* Correlation is significant at the 0.05 level (2-tailed). Source: Own study (n = 114).

## 5. Discussion and Conclusions

When observing the German vehicle market, it can be noticed that car manufacturers have not yet managed to establish a strong market position with BEVs. The reasons for this could be that the disadvantages (negative BEV performance factors) outweigh the advantages (positive BEV performance factors). Especially, range in km, charging times, and infrastructure are major hindrance factors. TCO, environmental-friendliness, and driving characteristics can be evaluated positively, considering the current state of technology. Another explanation for the lack of market success could be the lack of experience of potential consumers.

The automotive industry is faced with the challenge of finding an optimal approach to BEV marketing. The innovation of electric cars needs to reach critical masses to be successful. Currently, innovators comprise the group targeted as the primary users of BEVs. Due to the novelty of the product, not many people have driven such a vehicle. In our assessment, an experience-based marketing strategy can tackle this problem. Our findings confirm the positive effects of utilizing multi-sensory marketing methods [81] to increase experiences with electric cars. This provides some valuable theoretical and practical contributions to the implementation of this marketing concept.

The effect of the test drives is noticeable, especially in some specific areas. Consumers can be convinced that the acquisition cost is lower than expected. Moreover, driving an electric car creates an opportunity to feel the driving characteristics that are marked by fast acceleration, increased driving pleasure, and higher comfort through the lower noise and absent gear changes. These tangible attributes are difficult to convey through a classical marketing approach that does not take advantage of direct experience. Furthermore, it is demonstrated that test drives increase the perception of range and confidence in engine/battery liability. These positive effects can be created by car manufacturers by offering direct experience in the form of test drives. In this way, they can increase potential customers' general attitudes and knowledge about BEVs.

Driving the vehicle enables experience-based learning. The knowledge gain is measurable. BEV manufacturers have the chance to explain innovations by making use of this direct contact with the product. The influence can be seen in the increased purchase intentions.

Similar to the results of previous studies [91,93–95] the outcomes of our field study suggest that a short test drive can raise the perception of electric vehicles in general. The analysis of the individual characteristics of electric cars reveals positive developments regarding the perception of acquisition costs (+54%) and acceleration /driving pleasure (+26%). Other increasing values are maintenance and energy cost (+15%), engine/battery reliability and durability (+15%), range in km (14%), driving comfort (+11%), top speed (+10%), and charging at home (+9%). It is worth noting the increased knowledge gained through the test drives. Our results show that utilizing sensory marketing concepts [13–15,81,82] to increase general BEV value perception and raise customer purchase intent does not require long-term experiments, and that short test drives may appropriately serve this objective. Our results show that people changed their perception of BEVs by executing a short test drive. Moreover, Audi has already used this method to promote BEVs [100].

In addition to gains in perception and knowledge, the probability of considering a BEV within the next car purchase rises with a first-time experience. The willingness to purchase an electric vehicle increased by 41%, which brings new insights after previous studies did not observe this effect [95].

The Norwegian government has succeeded in establishing this technology, with all its advantages and disadvantages. The price of artificial influence is a large subsidy expenditure. Our research reveals that other possible ways to support the acceptance of electric cars exist. In addition, an increasing development of battery technology can be observed, forecasting an increase in range. Moreover, prices for lithium should continue to fall.

The present study has several limitations, as it was conducted under certain restrictions that were related to limited financial resources and other factors. First of all, as noted above, the electric cars used for the experiment were provided by Volkswagen. It could be the case that the brand or product-specific characteristics influenced the results. The state of the charge of the battery could also

have changed the results of the study. People who performed the test drive in the morning enjoyed a vehicle with a full range. The opposite was the case for people who drove at a later time in the day. Consequently, range anxiety could have had a negative influence on the results. Another limitation is the distance driven. Since there was no predefined route, the test subjects drove on different roads. Also, the exact driving times varied. A further variable in the experiment was the 20 instructors that executed the test drive. They were advised to represent a neutral viewpoint. However, this could not be proven. Lastly, all participants came from the North Rhine-Westphalia region, which is close to the city of Münster. In this respect, the sample may not be representative of the whole population of Germany.

We see at least three areas where research based on short BEV test-driving experiments could be enhanced to yield more insightful results. The first one would be to embrace richer conceptual frameworks combining sensual marketing and innovation management for BEV analysis. The second one is related to improving the research methodology, where the research separates the effect of the information that was given in the brochure from the effect of experience. The question is, for example, does an approach that only provides information without a test drive have a similar positive effect? Finally, our study should be extended to other regions of Germany and expanded to compare other BEV brands to identify differences and similarities, probably modifying the research methodology. Additionally, the goal of this study was to measure the change in value perception after a short 10-min test drive. Participants rated the BEV directly after driving. To get improved results, a third questionnaire should investigate the long-term effects. Moreover, the study should be periodically repeated due to constantly improving technology. In two years, the findings could be different from the results obtained today. Finally, new product releases from various BEV manufacturers are expected in 2020. Consumers have used and gotten used to petrol engines for more than 100 years. Changing such ingrained consumer attitudes takes time. Based on our results, it can be stated that the use of a short test drive could accelerate this process.

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