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RESEARCH PAPER

User preferences and willingness to pay for in-vehicle assistance

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Abstract

As consumers' demand for interconnectivity and infotainment grows continuously, car manufacturers face the challenge of developing more sophisticated, user appealing and economically viable in-vehicle infotainment assistants while staying within the boundaries of their limited resources. Based on the results extracted from an empirical study with 278 participants from Germany, this contribution supports car manufacturers to tackle this challenge by providing concrete guidance on optimal feature design, pricing, as well as initial market segmentation. Regarding the optimal feature design, we note that delivering continuously available and flawless systems with a speech input interface should be the top priority when developing such vehicular assistance. Further, we suggest that the in-vehicle infotainment assistants should be either reactive (i.e., react only to driver's instruction) or independently proactive (i.e., exert full control without engaging the driver in decisions), but not semi-automatic (i.e., assistant issues recommendations and then follows the driver's instructions).

Keywords User preferences · WTP · In-vehicle intelligent personal assistant · Choice-based conjoint analysis

JEL classification D12 · M39

Introduction

The era of the Internet of Things (IoT) and advances in Artificial Intelligence (AI) create new possibilities for the automobile industry but also raise consumer's expectations in terms of safety performance and convenience (Williams et al. 2013). Considering the increasing amount of time people spend in their cars -not only driving but also sitting in traffic the comfort and infotainment features of smart cars developed to be an important selling point (Coppola and Morisio 2016).

In-vehicle infotainment assistance entails not only entertainment assistance such as music recommendations but also the ability of performing personal briefings (e.g., weather, news, appointments); reading out and sending e-mails, text, and voicemails; as well as issuing vehicle status warnings or recommendations for restaurants and points of interest (Large et al. 2017; Rhiu et al. 2015).

As the drivers' increased demand for infotainment features is also echoed in the expected growth of the global market for informative and entertainment assistance, the automotive industry sees itself "pressured with many challenges" (Macario et al. 2009)[1] to provide such assistance. Accordingly, some car manufacturers are currently investing substantially in the development of embedded in-vehicle digital assistants, while others intend to leverage existing smartphone installed intelligent assistants such as Apple's Siri to provide drivers with the infotainment features they wish for. Although both these strategies have advantages and disadvantages regarding their technical advancement flexibility and hardware costs (Coppola and Morisio 2016),

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[1] The global in-car entertainment market is expected to grow from \$14.4 billion in 2016 to \$33.8 billion by 2020 (Statistics 2017)

from an economic point of view, both approaches face the same design challenges. To be more specific, regardless of the technological implementation of in-vehicle assistants (i.e., embedded versus smartphone integrated), the economic perspective on the topic raises three essential questions: (1) What are the attributes or capabilities such in-vehicle assistants must have in order to ensure their adoption? (2) What are vehicle drivers willing to pay for such assistance? (3) What are the primary customer segments of the in-vehicle infotainment assistance?

Compared to other in-vehicle safety and adaptive assistance systems (Rhiu et al. 2015), in-vehicle infotainment assistance has received less attention from academia and commercial organizations. Even so, the current state of research documents very well that from a technical point of view in-vehicle infotainment assistants can present a broad set of features (e.g., social and contextual intelligence, natural language capabilities, the ability to manage appointments, e-mails and other messages (Large et al. 2017; Williams et al. 2013)). From a business and utilitarian perspective, however, car manufacturers face the challenge of developing user appealing and simultaneously economically viable in-vehicle assistance within the boundaries of their limited resources (i.e., time, budget and human resources restrictions). Especially if considering that some in-vehicle infotainment features will have mutual trade-offs (e.g., driver support quality and privacy stringency) or might be tied to high development costs but low user utility, car manufacturers' goal of developing successful in-vehicle infotainment assistance depends on their ability to find the right mix of assistance features and pricing models. Similarly, if taking into account that the market success of in-vehicle infotainment systems will – as in the case of any other new technology product – largely depend on the users' willingness to adopt the new product, it is imperative that when developing in-vehicle infotainment systems car manufacturers carefully consider the preferences of potential users for such vehicular assistance.

This study's primary goal is to support car manufacturers to tackle the challenges related to developing economically successful in-vehicle infotainment assistance by presenting concrete guidance about the optimal feature design and the price maximum drivers are ready to pay for in-vehicle infotainment assistance.

Formally, this contribution is structured as follows: after presenting the in-vehicle infotainment assistance features envisioned by the existing body of literature, this work presents an empirical study which identifies participants' valuation and willingness to pay for some of the assistant features discussed in prior literature. Then, after reporting the results of the empirical analysis, we discuss our findings, the study's limitations and possible future research paths.

Related work

Along with the growing demand for in-vehicle infotainment (Gaffar and Kouchak 2017; Williams et al. 2013) academics addressed various design aspects of such in-vehicle assistants (Parada-Loira et al. 2014). Accordingly, the existent body of literature presents several approaches and propositions to realize in-vehicle infotainment assistance (Eichhorn et al. 2010).

One approach, for instance, identifies the optimal design of in-vehicle assistance by pursuing a two-stage process. In the first stage, researchers formulate exploratory questions such as: what is the suitable entertainment content (e.g., video, games, e-mails, points of interest, general vehicle status), what is the appropriate form to present the content (e.g., video versus speech), what is the acceptance of in-vehicle assistance, and in which situations would driver use such assistance? Then, in the second stage, based on the answers from the first stage, researchers formulate the requirements for in-vehicle infotainment assistants.

Alt and colleagues (Alt et al. 2010) for example followed this approach and conducted an at first online survey to first grasp an understanding of the use of displays in cars, the forms and types of content drivers rate as useful. Then, based on the participants' answers in the online survey Alt and colleagues (Alt et al. 2010) envisioned that the in-vehicle assistant should be able to determine the vehicle status (e.g., if the car is currently driving or stands still) and traffic light zones (i.e., the areas in front of traffic lights) (Rosario et al. 2011); it should be able to adapt the entertainment content to be appropriate for the estimated time in which the car does not move; it should be able to let their users select the contents they wish to see or hear; it should also be functional without an Internet connection; and it should be able to inform the user about any change of vehicle status (e.g., that the car is about to move again in very short) (Rosario et al. 2011).

Another research approach for designing in-vehicle infotainment assistance is to address the topic from the Human-Computer Interaction (HCI) perspective. Most notably, this stream of literature highlights that designing vehicular support holds other requirements than the design of any other system or digital device (Hüger 2011). Meanwhile, typical digital systems or devices require a "screen-focused design" – i.e., a design which entices users to engage with the screen, in-vehicle infotainment assistance requires a "street-focused design" – i.e., a design which motivates users to keep focused on the road (Gaffar and Kouchak 2017).

Hence, from an HCI perspective, in-vehicle infotainment assistance have "a large number of special requirements" (Hüger 2011, p. 113). For one, vehicular infotainment assistance should avoid any driver distraction, should have a high quality with regard to stability of the system (Hüger 2011). Further, such assistant should have a high reusability in different other systems, a long life cycle, a certain ease of creating services, an offline availability as well as access to vehicle data (Hüger 2011, p. 113).

Because avoiding any diver distraction is the top requirement for such in-vehicle assistants (Hüger 2011) and at the same time there is a wide suspicion that in-vehicle assistance with certain kinds of features are actually distracting, confusing and cognitively overloading (Rhiu et al. 2015; Müller and Weinberg 2011; Cellario 2001), scientists conducted various field and laboratory experiments to better understand how the properties of assistance systems affect their user while driving.

Strayer and his colleagues (Strayer et al. 2017) for instance examined the impact of voice-based interaction between drivers and Siri, Cortana and Google Now. In two experiments with instrumented cars on suburban roads they found that, in general, talking to the intelligent assistants while driving is increasing the cognitive workload of the driver (Strayer et al. 2017). Further, Strayer and colleagues (Strayer et al. 2017) also found that the mental workload level of the driver varied between the three assistants and that this difference was associated with "the number of system errors, the time to complete an action, and the complexity and intuitiveness of the devices" (Strayer et al. 2017, p. 93).

On a similar note, Large and colleagues (Large et al. 2017) conducted a "Wizard of Oz" experiment to better understand the language and interaction style of drivers with a digital driving assistant. In this study, the authors view their digital driving assistant as a critical vehicle-driver interface which should proactively support their user with all sorts of personalized assistance in natural language (Large et al. 2017).

According to Large and colleagues' (Large et al. 2017) observations, drivers interact with the digital assistant socially and afford the in-vehicle assistant the same status as to humans. Additionally, Large et al. (2017) conclude that because drivers expect to be able to speak to the assistants as if it were a human being, such in-vehicle assistants must also be able to communicate like human interlocutors (Large et al. 2017).

In general, the in-vehicle assistants' capability to communicate with their user in natural language, is widely believed to be particularly suited for achieving a "street-focused" in-vehicle assistance Hence, the research community addressed this feature repeatedly. While some studies sustain the notion that speech interfaces are suitable for in-vehicle assistance and users expect to be able to talk to assistants in natural language (Large et al. 2017), other research efforts assert that speech interfaces have a bad reputation and that drivers are dissatisfied with the current state of this technology (Gaffar and Kouchak 2017). Cowan et al. (2017), Luger and Sellen (2016) and Wulf et al. (2014) for instance document that not only frequent but also infrequent users of intelligent personal assistants such as Siri or Google lament the current technology performance and issues with trust, data privacy, and transparency (Ram et al. 2018; Cowan et al. 2017).

Against the background of such findings, car manufacturers need to reassess if and to which extent the optimal design of vehicular assistance must rely on speech-recognition as the main interface for interaction. Similarly, car manufacturers have to assess the value of the other features that in-vehicle infotainment assistants can have.

On one hand prior literature present a wide range of features in-vehicle infotainment assistants can have (see Table 1). For instance, such assistants have to be social and able to express themselves in a way that feels natural to the driver (Large et al. 2017; Williams et al. 2013). They should be able to manage personal and contextual data to provide personalized (Moniri et al. 2012), proactive, seamless (Williams et al. 2013) and less disturbing hand-free and eye-free (Large et al. 2017). At the same time, existing studies also suggest that some of the proposed in-vehicle assistance capabilities might not be perceived well by potential users. Issues such as mental overload when interacting with in-vehicle assistance systems (Strayer et al. 2017, 2014), users' dissatisfaction with the state of the art speech recognition (error rates) (Cowan et al. 2017; Wulf et al. 2014) as well as user's concerns with data security

Table 1 Overview attributes/ features of in-vehicle infotainment systems derived from prior literature

Attributes /Features	Source
Manage content (appointments, e-mails, etc.)	Alt et al. 2010
Adapt content to the expected length of time that vehicle will not move	Alt et al. 2010
Personalize content	Strayer et al. 2017; Rhiu et al. 2015 Moniri et al. 2012
Ability to be proactive	Williams et al. 2013.
Context sensitivity	Rhiu et al. 2015; Moniri et al. 2012
Determine the current status of vehicle and traffic lights	Alt et al. 2010
Recognize and inform the user about vehicle status changes	Rosario et al. 2011; Alt et al. 2010
Continuous system availability (also without internet connection)	Hüger 2011; Alt et al. 2010
High system stability / low error rates	Strayer et al. 2017; Hüger 2011
Communicate with the user in natural language / have a Voice User Interface to provide eyes-free support	Large et al. 2017; Wulf et al. 2014
Communicate like human interlocutors	Large et al. 2017; Wulf et al. 2014
Minimally distracting menu structure design	Olaverri-Monreal et al. 2013

and privacy (Ram et al. 2018; Cowan et al. 2017) could be detrimental for acceptance of mass-adoption of such systems.

Following the conviction that positive user-experience and product satisfaction, and thus ultimately the mass-adoption and market success of in-vehicle infotainment assistants can be improved through a focus on user preferences (Olaverri-Monreal et al. 2013), this study uses the broad pool of features proposed by previous literature to identify the preferred and thus promising feature mix of vehicular assistants.

Empirical study

Study design

Our study is based on a range of established scientific approaches and data collection methods. It is based, in particular on the work of Chapman et al. (2008), which addresses design questions in the early development phase of new technology products (Chapman et al. 2008). Following Chapman et al. (2008) the core element of this study is an online survey with three sections (see Fig. 1).

The first, introductory section of the survey, presents the study participants a video, which shows the amenities an in-vehicle assistant could have. This step is essential to prepare the study participants for the second section of the study - a Choice Based Conjoint-Analysis (CBC).

Per se, CBC is "a popular market research method" (Gensler et al. 2012) used most commonly in marketing and business research (Green et al. 2001). Traditionally, CBC requires the participants to make repeatedly trade-offs between multi-attributed product versions (Green and Srinivasan 1990) in relation to a price (Chapman et al. 2008). This way participants are revealing their real preferences and utility perceptions about a product.

After the CBC section, our online survey features questions that capture the relevant information about the participants' personality and their attitude towards several facets of in-vehicle assistance. Please see Appendix 1 for the questionnaire of the study.

CBC set-up

The CBC was conducted with the Dynamic Intelligent Survey Engine (DISE) (Schlereth and Skiera 2012). The attributes and attributes levels prompted in the CBC have been selected by a panel of experts within a separate Delphi study which we conducted beforehand.

The experts on the panel represented not only car manufacturers and their affiliated partners but also other companies performing industry-related research. They had a wide array of backgrounds, including Project Management, Product Management, and academic and industrial subject experts from disciplines including Electrical Engineering, Mechanical Engineering, Machine Learning, Human Machine Interaction, Cloud Computing, Internet of Things, Marketing, and Information Systems. On the industrial research side, we involved companies from various relevant sectors, such as automotive suppliers, automotive OEM associations, and a software provider, covering both business and central functions, such as strategy and research.

Fig. 1 Online survey design – main sections

1. Introductory Video

2. Choice Based Conjoint Analysis (CBC)

- Explanation of all product attributes and their respective attributes levels
- 16 CBC choice sets with three product versions and a "No purchase option" each

	In-vehicle IPA 1	In-vehicle IPA 2	In-vehicle IPA 3	No purchase option
Personalization	Aggregated & Adaptive	Individualized	Static rules	I would not purchase any of these assistants
Proactivity	Independently Proactive	Semi-Automatic	Independently Proactive	
System error occurrence	10%	1%	5%	
System availability	Continuous	Limited	Continuous	
Price (Subscription)	20 €	5 €	10 €	
	○	●	○	○

3. Section with further questions

The Delphi study started with the initial set of in-vehicle assistant attributes proposed by existing literature (see Table 1). The initial list of attributes was then iteratively refined by consolidating feedback from the Delphi panel participants and providing new versions for further discussions.

The Delphi panel participants were mostly contacted via e-mail but were also contacted via phone whenever they did not respond within a reasonable timeframe. After several rounds of coordination (within two months) the experts agreed that related to in-vehicle infotainment assistance there are five attributes (or features) which are particularly relevant for potential users: personalization capability, proactivity, system errors occurrence, and system availability. Furthermore, they also agreed on the corresponding attribute levels each attribute can have (see Table 2).

In addition to the four attributes mentioned above, our goal to estimate the users' willingness to pay for vehicular assistance required that the price had to be included in the study as a fifth product attribute. Concerning the price, it is furthermore noteworthy that because the price ranges prompted in CBC studies are critical for estimating valid WTP values (Gensler et al. 2012), the price ranges in our CBC were also set by the panel experts, within multiple coordination phases.

Regarding the CBC design (i.e., the choice sets prompted), we acknowledge that given the high number of possible configurations (due to the multitude of attributes and associated attribute levels described in Table 2) we faced the challenge of reducing complexity and the length of the survey while still producing valid insights. Therefore, we created a suitable choice design by following the techniques described by Street and Burgess (2007), and constructed a D-optimal factorial design[2] with 14 choice sets for the estimation and two holdout choice sets to assess predictive validity.

Each choice set of the CBC presents different in-vehicle assistant variations and a "no purchase" option. The "no purchase" option allows us to capture the participants' choice behavior more realistically, as it can be used whenever the participant would not like to purchase any of the presented in-vehicle assistants (Gensler et al. 2012; Vermeulen et al. 2008).

Survey section with additional questions

The goal of this survey section is twofold: (1) first, it collects information that enables us to better understand the purchasing behavior of the participants and (2) second, it gathers knowledge which can help us identify potential customer types, as a basis for further market segmentation and pricing strategies. Therefore, in this section, we employ 7-point Likert scales, and insights from psychology, marketing, and computer sciences domains to capture the participants' psychographic and personal traits in a fairly accurate manner. Amongst others, we adopt the insights provided by Steenkamp and Gielens (2003) for computing the participants' attitude towards innovation, (Meuter et al. 2005) for measuring the participants' technology affinity and Jackson (1976) for capturing their willingness to take risks.

Moreover, following the study conducted by Alt and colleagues (Alt et al. 2010), we ask our participants to disclose their general attitude towards the in-vehicle assistant, if they prefer vehicle-related support (e.g., garage booking, door locking, car heater) over travel-related support (e.g., traffic management, tourist attractions, breakdown support) or personal-entertainment support (e.g., missed calls, music, shopping). Eventually, we also gather the participants' demographic information (i.e., age, gender, education), as well as their attitude towards potential in-vehicle assistant business models (i.e., freemium, free distribution financed via advertising spots, or free distribution funded by personal data intelligence).

Study participants

To conduct this study we hired a market research agency to provide a suitable sample of participants. From the individuals initially invited to participate in the study (390), a total of 308 persons attended our survey, but only 278 filled in the questionnaire correctly and provided us with valid answers to all our questions.

As Fig. 2 shows, our participant sample displays an almost equal gender split, with 49.6% of females and 50.4% males. Furthermore, it reveals that most of the participants (45%) are between 35 and 54 years old and hold a high school diploma (39%) or a University entry diploma (36%).

Moreover, the majority have a monthly net income of between €1000 and €2000 at their disposal. Only 5% of the participants have no income at all, and merely 6% earn a monthly net income higher than €4000.

All in all, the study sample, was meant to be representative for the German mass-market customers.

Evaluating the participants' WTP

The data gathered via the CBC enables us to determine the participants' preferred in-vehicle assistant capabilities and subsequently their WTP. In general, WTP represents the price maximum individuals accept to pay for a certain amount of a product or service (Gensler et al. 2012; Wertenbroch and Skiera 2002; Kalish and Nelson 1991). Thus, the participants' WTP can also be interpreted as the price threshold at which individuals are indifferent between purchasing and not purchasing a good (Gensler et al. 2012). Originally introduced for pricing public goods and services more than ten decades ago, the concept and

[2] A D-optimal design entails only appropriate attribute alternatives and groups them in choice sets (Vermeulen et al. 2008) in such a way that it minimizes the generalized variance of the estimated parameters (Street and Burgess 2007, p. 84).

Table 2 Overview prompted attributes and attributes levels in CBC

Attribute	Attribute description	Attribute levels	Attribute levels description
Personalization	The assistant's actions and recommendations should be based on the driver's preferences and thus congruent with the driver's support needs and expectations. Personalized assistance is likely to induce a higher user acceptance (Moniri et al. 2012) of such systems.	• Static Rules	The driver's preferences can be captured with a set of predefined "if <this>, then <that>" rules, which can change only via a system update.
		• Aggregated & Adaptive	The in-vehicle assistant has access to a pool of aggregated data with general knowledge about all drivers, and issues recommendations based on the most popular choices.
		• Individualized	The in-vehicle IPA uses the driver's implicit and explicit input, and personal information learn gradually about its driver's preferences and behavioral patterns and adapts its support accordingly.
Proactivity	In the context of vehicular assistance, proactivity entails that such agents do not only act in response to their environment but also start a conversation (Williams et al. 2013).	• Reactive	In this case, the in-vehicle IPA is passive and reacts only to the driver's instructions
		• Semi-Automatic	The in-vehicle IPA issues recommendations and then follows the driver's instructions – who can choose to either accept or discard the IPA's suggestions.
		• Independently Proactive	This in-vehicle IPA does not issue any recommendations but rather exerts full control over what happens next. The driver cannot interfere with the IPA's decisions.
System Error Occurrence and Input Comfort	The in-vehicle assistant interacts with its user through a Voice User Interface (VUI), which at its current development stage cannot ensure the complexity of language interaction between humans. Thus, it sometimes fails to recognize commands. There is a tradeoff between error rates and language complexity (Strayer et al. 2017).	• 1%	While interacting with the Assistant, 1 in 100 interactions results in an incorrect in-vehicle response. For this error rate, the VUI is limited to predefined commands, which the user needs to memorize and input in a predetermined order (input steps).
		• 5%	Voice commands are more flexible than in the 1% error case and do not require a specific input order. However, there is no full language flexibility possible, as the driver needs to mention specific "keywords" to activate certain functions.
		• 10%	In this case, the VUI displays full language flexibility, and the driver can speak commands using various words and without any predefined prompts.
System Availability	This attribute relates to the in-vehicle assistant availability concerning location, point in time, internet and wireless connection. (Hüger 2011; Alt et al. 2010)	• Continuous	Here, it is guaranteed that all functions can be controlled via voice commands at any location, at any point in time, even without any mobile phone or Internet connection.
		• Limited	In this case, voice operation is not possible without a mobile phone or Internet connection. The in-vehicle assistant might not work in remote areas, with a poor network connection.
Price (Subscription)	To reflect findings from commercial studies, which suggest limited user willingness to pay for connected car services (Viereckl et al. 2015), the in-vehicle assistant in our study can be purchased as a monthly subscription.	• Subscription Prices: €5, €10, €20, €30 or €50	To be able to depict a broad and realistic price range, the experts of the Delphi study agreed on five subscription prices. All subscriptions can be terminated at any time, with four weeks' notice.

methods of WTP have constantly been revisited and further developed. Consequently, there is a considerable amount of literature on WTP and its methods, including studies extrapolating individuals' WTP via conjoint analyses (e.g., Kohli and Mahajan 1991; Green and Srinivasan 1990).

In CBC the participant reveals her or his choice behavior while repeatedly choosing one version of an in-vehicle assistant from a range of variations alternating in attributes levels and prices. The basic assumption here is that the participants' most preferred and thus chosen in-vehicle assistant version is the one yielding them the highest utility. In formal terms, the probability that individual h chooses a certain in-vehicle assistant version i (in the following "product i", from a choice set a can be expressed by employing a logistic model (Gensler et al. 2012):

$$P_{h,i,a} = \frac{\exp(u_{h,i})}{\exp(u_{h,NP}) + \sum_{i' \in I_a} \exp(u_{h,i'})} \tag{1}$$

where:

$P_{h,i}$ *probability that consumer h chooses product i from choice set a*

$u_{h,i}$ *consumer's h utility level of product i*

$u_{h,NP}$ *consumer's h utility level of the no-purchase option*

$u_{h,i'}$ *consumer's h utility level of all presented products*

H *index set of consumers*

A *index set of choice sets*

I *index set of products*

I_a *index set of products in choice set a, excluding the no-purchase option*

The individual's h utility for product i is the sum of the partial utilities supplied by the product attributes minus the price:

$$u_{h,i} = \sum_{j \in J} \sum_{m \in M_j} \beta_{h,j,m} * x_{i',j,m} - \beta_{h,price} * p_i \tag{2}$$

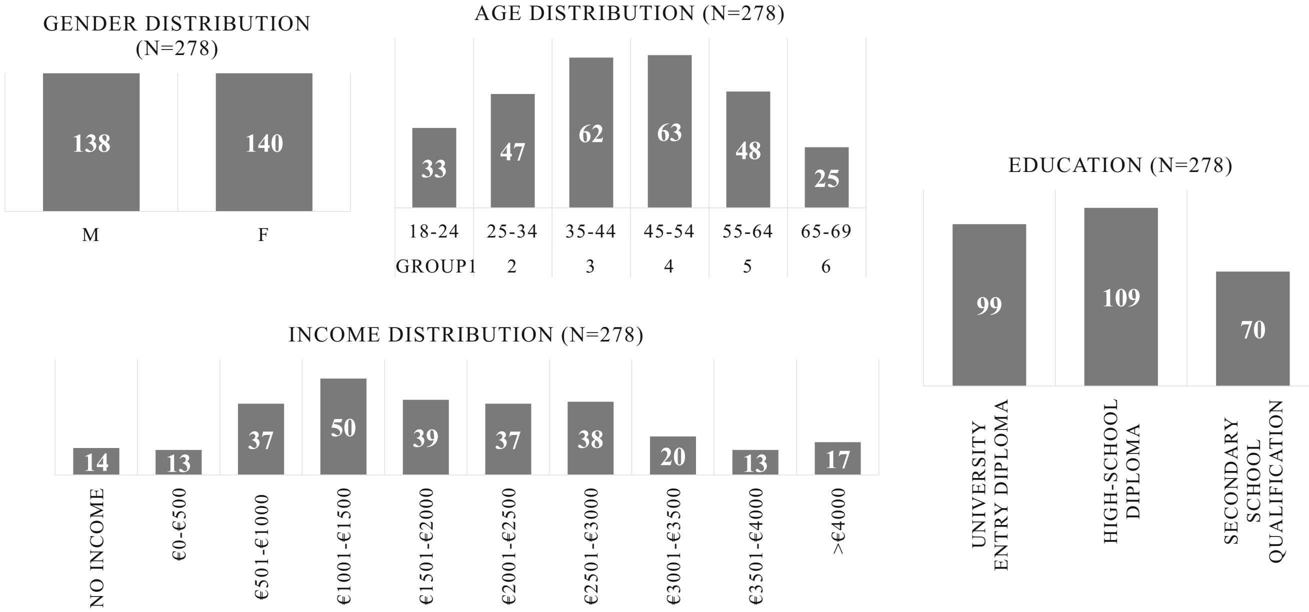

Fig. 2 Study participants

with:

$u_{h,i}$	consumer's h utility level of product i
J	index set of product attributes excluding price
M_j	index set of alternatives for the attribute j
$\beta_{h,j,m}$	consumer's h parameter for the alternative m of the attribute j
$x_{i,j,m}$	binary variable indicating if product i features the level m of the attribute j
$\beta_{h,price}$	consumer's h price parameter
p_i	price for product i

Defining WTP as the price point at, which an individual is indifferent towards purchasing or not purchasing an in-vehicle assistant version (3), WTP can be rewritten as eq. (4):

$$\sum_{j\in J}\sum_{m\in M_j}\beta_{h,j,m}*x_{i',j,m}-\beta_{h,price}*WTP_{h,i}=\beta_{h,NP} \quad (3)$$

$$WTP_{h,i}=\frac{1}{\beta_{h,price}}\left(\sum_{j\in J}\sum_{m\in M_j}\beta_{h,j,m}*x_{i,j,m}-\beta_{h,NP}\right) \quad (4)$$

where.

$\beta_{h,NP}$ is the consumer's h utility from choosing the no-purchase option

Based on the CBC output and (1) and (2) we first estimated the individual parameters for each product attribute, the price and the no-purchase option (i.e., $\beta_{h,j,m}$, $\beta_{h,price}$, $\beta_{h,NP}$). Then, we computed the overall WTP (4) for each of the presented in-vehicle IPA versions.

Findings

The data collected reveals that 50% of the participants (139 out of 278 participants) - display a "sometimes buy" behavior and decide for each choice set anew to purchase or not to purchase any in-vehicle assistant versions presented. Moreover, 21% of the participants display an "always buy" behavior and chose one of the three in-vehicle assistant versions presented in the 16 various choice sets. In contrast, 29% did not find any of the prompted in-vehicle assistant versions appealing and opted for the "no purchase" option in all choice sets.

To gain a deeper understanding about the main factors driving the participants' who always choose to purchase some version of the assistant, we estimated a logistic model explaining the purchase behavior of always purchasers. We found a statistically significant ($p < .01$) negative effect of age and a statistically significant ($p < .05$) positive impact of the participant's technology anxiety level (technophobia) on the participants purchase decision.

As the results of our estimation show (see Appendix 2), a higher level of technophobia is, in our case, related to an increase in the probability to purchase vehicular assistance.[3] Although counterintuitive at first, this finding is in line with Large et al. (2017) insight that drivers regard voice controlled in-vehicle assistants more as human dialogue partners, rather than technological systems. Further, it also supports the notion that regarding

[3] To ensure valid results, we performed Spearman correlation tests to check for potential multicollinearity between the independent variables of the model, but specifically between the participants' age and technophobia levels. The results of the Spearman correlation test reveals no statistically significant correlation between technophobia and age, supporting the validity of the finding mentioned above.

usability, anthropomorphic information systems (i.e., personified information systems) are perceived to be easy to use (Pfeuffer et al. 2018), especially by those who usually might be nervous operating such systems (Howe 2009).

In a next step, we turned our attention to the group of "sometimes purchasers" and performed a cluster analysis according to which sometimes purchasers can be split into three relevant customer segments (see Table 3).[4]

Our segmentation effort allows us to identify participant groups where participants display homogenous in-vehicle assistance preferences within their group but have diverging in-vehicle assistance preferences across groups. By identifying these customer groups, practitioners can develop suitable product positioning strategies along with the optimal product feature design. Given that positioning strategies determine which and how the product attributes and their benefits are communicated to the public, they can significantly influence the customers' purchase behavior positively.

After performing the cluster analysis we turned our attention to carefully evaluate the participants' preferences for various in-vehicle assistant feature and their willingness to pay for these.

Participants' preferences for in-vehicle IPA features

The evaluation of the CBC part of the study reveals that sometimes purchasers show a strong preference for continuously available, proactive in-vehicle assistants that provide personalized support, and preferably low subscription fee (see Appendix 3). This finding is not very surprising, especially when considering that individuals naturally tend to purchase products they consider to be the best value for money. What is indeed unexpected is the participant's preferences for proactivity, as well as their preferences for low system error rates instead of language flexibility when interacting with the vehicle assistant.

Preferences for proactivity

In this study, the in-vehicle assistant presented to the participants could feature three levels of proactivity. More specifically, the in-vehicle assistant could be either reactive (i.e., the assistant reacts only to the driver's instructions); semi-automatic (i.e., the assistant issues recommendations but then follows the drivers' decisions); or independently proactive (i.e., the assistant does not issue any recommendations but rather exerts full control over what happens next).

Based on Spiekermann's concept of technology paternalism, which refers to a persons' fear to get overruled by a system and lose the control over the current situation (Spiekermann and Pallas 2007; Spiekermann and Ziekow 2006), we expected that the independently proactive in-vehicle IPA would be the participants least preferred option. On the contrary, we expected that the semi-automatic in-vehicle IPA would be the participants most preferred option. Surprisingly, the data reveals precisely the opposite – i.e., sometimes purchasers prefer independently proactive in-vehicle IPAs the most, and semi-automatic versions the least.

Regarding the content that should be presented proactively by vehicular assistants, we found that in line with commercial studies' results "consumers rate driving-related information as more important than driving-unrelated ones" (Wee et al. 2015). Accordingly, entertainment related information (e.g., music choice) is less important than the vehicle- or travel-related information and recommendations (e.g., fuel recommendations, garage booking).

Preferences for system error rates versus input comfort

Prior research highlights the importance of voice input interfaces for the operation and control of vehicular assistance. It also mentions a broad user dissatisfaction with the current state of voice-input interfaces. Accordingly, we asked the study participants to reveal if they prefer a voice-interacting in-vehicle assistant or one which issues recommendations on a display.

As the results of the study show, 80% of the participants favor the voice-interacting in-vehicle assistant. When facing a tradeoff between system error occurrences and the option to control and interact with the in-vehicle assistant in natural language, the majority of participants decides that convenience of input commands is less important than a low system error rate.

Preferences for other in-vehicle assistant characteristics

As mentioned briefly at the beginning of this contribution, there are technically two divergent approaches to develop in-vehicle infotainment assistance: One method is to implement vehicular assistance embedded in the vehicle's head unit. Another approach is to develop infotainment assistants that run on an external device such as a smartphone.

From a technical perspective both methods present advantages, disadvantages, and challenges (Coppola and Morisio 2016). Yet, from the users' perspective, we note that participants favor the embedded method over the integrated one. 82% of the participants would use an embedded in-vehicle assistant, but only 61% would like to use it if it were run from a smartphone.

A potential explanation therefore is that participants greatly appreciate a consistent control logic when interacting with such in-vehicle assistants (Olaverri-Monreal et al. 2013). When asked about the importance of consistency in the control logic of in-vehicle systems, 82% of the participants confirmed that for them such consistency is important, if not essential.

[4] During our segmentation and further analyses, we focus on the group of sometimes purchasers following Gensler et al.' (2012) insight that including extreme response behavior (i.e., always purchasers or never purchasers) in CBC studies harms the validity of WTP estimates.

Table 3 Overview of customer segments in the group of sometimes purchasers

Description	Segment 1 Baby Boomers & Millennials	Segment 2 Generation X & Seniors & Digital Natives	Segment 3 Generation X
Age composition	55–64 (55%) 25–34 (45%)	45–54 (53%) 65–69 (21%) 18–24 (26%)	35–44 (89%) 45–54 (8%) 65–69 (2%)
Gender split (m/f)	55% / 45%	53% / 47%	45% / 55%
Education			
Secondary school diploma (SD)	HD: 43%	HD: 44%	UD: 45%
High school diploma (HD)	UD: 37%	UD: 32%	HD: 29%
University entry diploma (UD)	SD: 20%	SD: 24%	SD: 26%
Net Income split (income in €)			
No income	0%	5%	0%
0–500	2%	4%	3%
501–1000	15%	20%	10%
1001–1500	23%	15%	21%
1501–2000	15%	16%	13%
2001–2500	13%	18%	13%
2501–3000	13%	13%	8%
3001–3500	8%	2%	10%
3501–4000	8%	2%	10%
> 4000	4%	5%	13%
Kids (number of kids on average)	1	1.105	0.97
Segment size (∑ = 139)	44	57	38

Participant's WTP for in-vehicle assistance features

Based on the data collected via the CBC we computed the sometimes purchasers' WTP for various in-vehicle support features and then the participants' overall WTP for several versions of the in-vehicle assistant.

Because the in-vehicle assistant is an additional service which can be purchased as a monthly subscription and can be terminated with a four weeks' notice, the WTP values presented in Table 4 depict the price maximum a participant is willing to pay, for using the in-vehicle assistant for a month (4 weeks).

On the aggregated level (Column (1)), the participants value the system availability feature of the in-vehicle assistant the most. On average, sometimes purchasers are prepared to pay €8.19 per month for a continuously available assistant, €6.7 per month for a low system error rate, and a €5.08 per month if the assistants' recommendations are individualized based on the driver's data. On the contrary, the participants value the proactivity capability of the in-vehicle assistant the least, as participants are willing to pay only a maximum of €3.07 per month for this attribute.

The lowest WTP values relate to the personalization via static rules, a limited system availability, and a system error occurrence of 10%.

When looking at the three different customer segments, however, it is visible that meanwhile participants in the first segment value the continuous availability of the in-vehicle assistant the most (i.e., €12.03) and a 1% system

Table 4 WTP estimates for in-vehicle IPA attributes levels

Attribute	Attribute levels	(1) WTP in € Aggregated	(2) WTP in € / Segment		
			Segment 1	Segment 2	Segment 3
Personalization	• Static Rules	0.45	0.19	0.65	0.46
	• Aggregated & Adaptive	4.74	5.94	3.53	5.15
	• Individualized	5.08	6.40	2.75	7.04
Proactivity	• Reactive	3.07	3.47	3.24	2.34
	• Semi-Automatic	1.18	1.45	1.14	0.93
	• Independently Proactive	2.94	3.64	1.93	3.65
System error occurrence and input comfort	• 1%	6.70	8.11	6.04	6.05
	• 5%	1.41	1.19	1.99	0.81
	• 10%	0.94	1.05	0.62	1.31
System Availability	• Continuous	8.19	12.03	6.30	6.57
	• Limited	0.54	0.41	0.22	1.15

error rate as second most (i.e., €8.11), the participants in segment two and three would be willing to pay significantly less for these attributes.

Further, it is notable that altogether the participants in the first segment value the in-vehicle assistant as a complete product the most and is ready to pay a total of €30.19 per month for an individualized, independently proactive, 1% error rate, and continuously available in-vehicle assistant. In contrast, the participants in segment three and segment two are willing to pay for the same in-vehicle assistant only €23.32 and €17.03 per month, respectively (see Table 5). A possible explanation therefore is that participants' spending budget in segment two is lower than the spending budget of participants in the first or third segment.

As Table 3 shows, participants in segment two have on average less net income but on average more kids than the participants in the first or third customer segment.

Discussion

This study examines the question of optimal design of in-vehicle assistance from an economic perspective. This perspective uses design insights from existing literature to further identify in the users' opinion the most promising combination(s) of in-vehicle assistance features. In doing so, our study enables car manufacturers to develop and implement next-generation user-appealing and economically successful in-vehicle assistants without having to resort to lengthy and complex "design-test-redesign" iterations. Further, by presenting a user preference focused design, it also improves the acceptance and eventually mass-adoption of such assistant systems.

From a scholarly point of view, this study contributes to the existing literature on the design of in-vehicle infotainment systems by presenting the users' view on the support features such infotainment systems should have. Prior research has traditionally focused on ways to design appealing and less distracting in-vehicle assistance capabilities from a technical or human-computer interaction perspective. Our study adds the economic perspective to this existing body of knowledge about designing vehicular infotainment. Because in theory in-vehicle assistants can have a broad set of capabilities, which if combined into a system could be too expensive to implement or bring no only little value for their user, our study identifies the optimal feature design of in-vehicle infotainment assistance based on the users' preferences and willingness to pay for such assistance.

Moreover, this study contributes to the existing literature on intelligent assistant systems and the role of anthropomorphic cues in user-acceptance of such systems. As our results reveal, anthropomorphic interfaces such as the speech interface can help technophobic people to overcome their fear of technology by leading them to perceive complex information systems as easy to use. Hence, we conclude that to increase the likelihood that a broad mass of users will accept in-vehicle assistants in the future, such assistants should have interfaces that personify them.

Another contribution to the current state of the literature relates to the vehicular assistants' proactivity capabilities. Prior studies conclude that drivers expect that in-vehicle assistants act as if they were human interlocutors (Large et al. 2017). However, our results suggest otherwise. In particular, we find that participants prefer a reactive in-vehicle assistant over an independently proactive one, but an independently proactive in-vehicle assistant over a semi-automatic one.

Recalling that the reactive in-vehicle assistant reacts only to the driver's instructions but never initiates an interaction, and the independently proactive assistant does not issue any recommendations but rather exerts full control over what happens next, our findings reveal that although participants value in-vehicle assistance and interaction, they do not necessarily wish to engage in complex dialogues with such assistants. Hence, our findings suggest that the widespread notion that designing in-vehicle assistants requires a balance between designing an "engaging" and "effective" dialogue (Large et al. 2017) needs to be verified into more detail.

In addition to its contribution to the existing body of knowledge, our research presents findings that benefit practitioners in many ways:

Firstly, our results reveal a high economic potential of vehicular infotainment assistance. As 70% of the participants would purchase some vehicular infotainment assistance and would be willing to pay up to €23.04 per month for these services, practitioners can better estimate the expected revenues such assistants can create.

Second, based on our concrete feature design indications that car manufacturers should try to implement embedded speech interacting in-vehicle assistants that have the same (coherent) control logic like the remaining services on board of the vehicle; and focus first on delivering continuously available and faultless assistance, and only then on bringing to their user personalized assistance in an either reactive, or independently proactive way; companies can also calculate their development costs more realistically.

Third, our insights enable car manufacturers to make better informed strategic decisions. Based on the information about the support features vehicle infotainment systems should entail, and juxtaposing the cost and revenue estimates for in-vehicle infotainment assistance, car manufacturers can answer, for instance, the question whether

Table 5 Top 10 WTP values for various in-vehicle assistant designs

#	IPA Version	Personalization			Proactivity			Error Rate			Availability		WTP			
		1	2	3	1	2	3	1	2	3	1	2	Aggregated	WTP/ Segment		
		Static Rules	Aggregated adaptive	Individua-lized	Reactive	Semi-automatic	Inde-pendent	1%	5%	10%	Continuous	Limited		Segment 1	Segment 2	Segment 3
1	3111			X	X			X			X		23.04	30.02	18.34	22.01
2	3311			X			X	X			X		22.91	30.19	17.03	23.32
3	2111		X		X			X			X		22.70	29.55	19.12	20.12
4	2311		X				X	X			X		22.57	29.72	17.81	21.43
5	3211			X		X		X			X		21.15	27.99	16.24	20.60
6	2211		X			X		X			X		20.81	27.53	17.02	18.71
7	1111	X			X			X			X		18.41	23.81	16.24	15.42
8	1311	X					X	X			X		18.29	23.98	14.93	16.74
9	3121			X	X				X		X		17.75	23.09	14.29	16.76
10	3321			X			X		X		X		17.63	23.26	12.98	18.07
...	...															

to develop vehicular assistants alone or as a common effort, with other companies.

Furthermore, our initial market segmentation efforts enable car manufacturers to maximize their sales volume by developing competitive business models, and positioning and pricing strategies. More specifically, our results reveal that to attract customers from all customer segments, the in-vehicle infotainment assistant should offer different types of proactivity features and support an appropriate price discrimination scheme.

If a price discrimination scheme is not possible, or not desirable, the in-vehicle assistant should be offered as a service free of charge. This particular pricing strategy would have a positive impact on the mass-adoption of such systems by increasing brand loyalty of current customers and attracting those who are not willing to pay for in-vehicle assistance at all. Half of the non-purchaser group ($n = 80$) for instance, decided not to purchase any version of the in-vehicle assistant frequently based on their explicit rejection to pay for such a service. When asked if participants would use the in-vehicle infotainment system if it were for free, 51% of the non-purchasers (41 out of the 80 non-purchasers) answered in the affirmative.

Moreover, 30% of the non-purchasers would even bear advertising, and 15% would trade their personal data for a free version of the in-vehicle assistant. Similarly, to be able to use the in-vehicle IPA for free, 74% of the sometimes buyers (i.e., 103 participants) would accept advertising, while only 33% would agree to the usage of their personal data. These results suggest that in Germany, car manufactures or other companies providing in-vehicle infotainment services should refrain from the monetization of personal data and focus on advertising based revenues instead.

Finally, our findings also suggest that another suitable strategy to skim off profits which would otherwise not be possible to realize would be to offer the in-vehicle assistant in a standard version which user can extend by booking various extra-charge add-on assistance capabilities (i.e., independent proactivity).

Limitations and further research paths

To conclude, we remark that although the design of the study and the employed methodologies strive to ensure fairly realistic and unbiased results regarding the users' preferences and WTP values (e.g., by showing the participants a video showing the amenities an infotainment assistant could have), in the end, we rely on self-reported data. This could be problematic, especially when investigating new technologies where participants have only limited or no experience at all using such technologies (Large et al. 2017). Along these lines, we reckon that the participants' preference of an embedded in-vehicle assistant over a smartphone integrated one might be biased due to participants' bad experiences when using Siri, Google Now, Cortana or Alexa. Experiments employing for instance the "Wizard of Oz" methodology or experiments with prototypes of in-vehicle assistance could help remedy the issues. Yet, on the downside, such experiments are not always feasible or realistic.

Further notable limitations of our study are the sample size and the attribute levels presented in the CBC section.

Regarding our sample size it is noteworthy that although 278 participants completed the survey, the WTP analyses have been conducted on a sample of 139 participants – i.e., only those who did not display an extreme purchase behavior of always or never buying one version of the prompted IPAs. The rationale to perform the WTP analyses on a restrained sample follows the lead of academic research advocating that including participants with extreme purchase behaviors biases the WTP analyses. Yet, we acknowledge that the rather small sample size of the sometimes buyers could raise concerns related to the representativeness of the used sample and thus of the analyses results themselves (Kelley and Maxwell 2003).

Concerning the attribute values prompted in the CBC section, we recognize that these strongly reflect the engineering perspective rather than the customer's view of the construction of in-vehicle infotainment assistance. Therefore, some of the requested attributes (e.g., 1% error rate) may be too technical to allow participants to fully understand the actual meaning and differences between the different attribute levels.

Finally, we must also mention that the study remains a snapshot of the current in-vehicle infotainment assistance market. Given the high pace at which technology evolves, and the fact that people's attitude towards in-vehicle assistance changes over time, it is recommendable to repeat this study in a few years, after a new generation of in-vehicle infotainment assistants has been launched.

Additionally, we also encourage fellow researchers to repeat our study in an international setting. As our study participants are all from Germany, and the remaining sample size of sometimes buyers is rather small, the transferability of results to other markets and thus cultural backgrounds is ensured only by conducting similar studies with an internationally recruited participant pool.

Hereby, it would be recommendable to reproduce the study not only in "traditional" automobile markets such as Germany, U.K., U.S., Japan but also in countries from the "emerging" automobile markets (e.g., Brazil, South Africa, China, India). Due to potential differences in the customers' expectations and preferences in the two previous automobile market types, it is conceivable that vehicular assistance in emerging automobile markets may have different designs and requirements than vehicular assistance in traditional automobile markets.

Appendix 1

Survey questionnaire (translated from German)

Additional questions related to participants' preference for in-vehicle assistance.

1. Please rate following statements:

I would use the in-vehicle assistant if it were for free	Yes / No
I would use the service if it was free but financed by advertising	Yes / No
I would use the service if it were free and funded by insight into my data	Yes / No

2. The assistance system can act proactively on its initiative to assist you while driving. A distinction is made between vehicle-related proactivity (e.g., tank recommendation, garage service with booking), travel-related proactivity (e.g., traffic guidance, recommendation for breaks), and personal proactivity (e.g., music selection, missed call indication). Please rank the areas of proactivity according to your preferences. First click on the function you most like, then on the second, third and so on. You can renew the entry by pressing the reset button at the top right.

Vehicle-related proactivity	Travel-related proactivity	Personal or entertainment proactivity
☐	☐	☐

3. Please rank the functions related to **vehicle-related proactivity** according to your preferences. First click on the function you most like, then on the second, third and so on. You can renew the entry by pressing the reset button at the top right.

Fuel recommendation	Garage booking	Door locking	Seat heater
☐	☐	☐	☐

Please rank the functions related to **travel-related proactivity** according to your preferences. First click on the function you most like, then on the second, third and so on. You can renew the entry by pressing the reset button at the top right.

Traffic management	Restaurants	Break recommendation	Tourist attraction
☐	☐	☐	☐

Please rank the functions related to **personal or entertainment-related proactivity** according to your preferences. First click on the function you most like, then on the second, third and so on. You can renew the entry by pressing the reset button at the top right.

Missed Calls	Music choice	Shopping places	Visit nearby friends
☐	☐	☐	☐

4. The assistance system messages can either be communicated verbally by voice or visually over the vehicle dashboard. In the second case, they would be made aware of the messages on screen by a noise. Which alternative do you prefer?

Voice interface	Visual interface
○	○

5. Voice commands could be either spoken freely or with a fixed number of predetermined commands. However, in comparison to fixed voice commands, commands spoken freely induce a higher number of recognition errors. What percentage of erroneous interpretations would you be willing to accept, if you can use the assistant with a variety of freely spoken voice commands, instead of fixed commands?

1% more errors	5% more errors	10% more errors
O	O	O

6. The operation of smartphone installed applications (for example navigation, music player, telephone) which are mirrored and operated from the vehicles head unit might present different operating logic or menu guidance across applications. Applications which are embedded in the vehicle's head unit have a coherent operating logic or menu guidance.

Would you like to use an embedded in-vehicle assistant?	Yes / No
Would you like to use an in-vehicle assistant integrated into a smartphone?	Yes / No

7. Please indicate how important a coherent operating logic in the entire assistance system is for you.

Not important at all	Not important	Partly important	Important	Very important
O	O	O	O	O

7-point Likert-type statements for the participants' psychographic properties (Bruner, 2009).

8. Privacy awareness (Kumaraguru and Cranor 2005)

- Consumers have lost control over how companies gather and process their private data.
- Most companies handle the personal information they collect about consumers in a reasonable and confidential manner.
- The existing laws and organizational procedures provide adequate protection for the privacy of consumers.

9. Technophobia (Meuter et al. 2005)

- I feel frightened when I use technology.
- Technical terms sound like confusing technical language.
- I avoided technology because I am unfamiliar with it.
- I hesitate to use most forms of technology out of fear to make mistakes that I cannot correct.

10. Change seeking behavior (Steenkamp and Baumgartner 1995)

- I like to continue doing the same old things rather than trying new and different things.
- I like to experience novelty and change in my daily routine.
- I like a job that offers change, variety, and travel, even if it involves some danger.
- I am continually seeking new ideas and experiences.
- I like continually changing activities.
- When things get boring, I like to find some new and unfamiliar experience.
- I prefer a routine way of life to an unpredictable one full of change.

11. Innovativeness (Product trial) (Steenkamp and Gielens 2003)

- When I see a new product on the shelf, I am reluctant to try it out.
- Generally, I am among the first to buy the new products when they come on the market.
- When I like a brand, I rarely switch to an application to try something new.
- I am very cautious to try new and different products.
- I am usually among the first to try the new brands.
- I rarely buy brands of which I am unsure how they are going to perform.
- I like to take my chances by buying new products.
- I do not like to buy a new product before others do it.

12. Risk appetite (Jackson 1976)

- I enjoy being daring.
- I take risks.
- I am looking for the danger.
- I know how to handle the rules.
- I am ready to try everything.
- I am looking for adventure.

13. Participant's attitude towards the in-vehicle assistant.
14. Participant's perceived usefulness of the in-vehicle assistant .

Further information.

15. Gender.
16. Age.
17. Education.
18. Monthly net income.

Appendix 2

Table 6 Main drivers of purchase behavior of always purchasers

Variables	Logistic model (Coeffs) DV: Always purchaser (Yes = 1 / No = 0)
Gender (Male = 1; Female = 0)	0.103 (0.331)
Age group	−0.329*** (0.126)
Education	0.0684 (0.241)
Privacy awareness	−0.108 (0.167)
Technophobia	0.313** (0.132)
Change seeking	0.225 (0.264)
Innovativeness	0.0139 (0.280)
Risk appetite	0.0894 (0.180)
Attitude towards assistant	0.140 (0.235)
Usefulness	0.0220 (0.228)
Income group	−0.0125 (0.0712)
Constant	−3.113 (1.933)
Observations	278

Standard errors in parentheses

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Appendix 3

Table 7 Utility values for in-vehicle assistant's attribute levels

Attribute	Attribute levels	Aggregated (Std. Dev.)	Segmented		
			Segment 1 (Std. Dev.)	Segment 2 (Std. Dev.)	Segment 3 (Std. Dev.)
Personalization	• Static rules	−0.33 (0.560)	−0.33 (0.537)	−0.27 (0.554)	−0.44 (0.577)
	• Aggregated & Adaptive	0.04 (0.427)	0.02 (0.468)	0.05 (0.415)	0.06 (0.390)
	• Individualized	0.29 (0.508)	0.31 (0.561)	0.22 (0.505)	0.39 (0.416)
Proactivity	• Reactive	0.06 (0.453)	0.08 (0.521)	0.08 (0.393)	−0.01 (0.445)
	• Semi-automatic	−0.07 (0.429)	−0.15 (0.409)	−0.06 (0.459)	0.00 (0.387)
	• Independently proactive	0.02 (0.412)	0.07 (0.424)	−0.02 (0.422)	0.01 (0.377)
System error occurrence and input comfort	• 1%	0.55 (0.662)	0.55 (0.562)	0.62 (0.684)	0.46 (0.731)
	• 5%	0.03 (0.283)	0.03 (0.272)	0.01 (0.270)	0.05 (0.312)
	• 10%	−0.58 (0.635)	−0.58 (0.572)	−0.63 (0.633)	−0.52 (0.699)
System availability	• Continuous	0.67 (0.596)	0.70 (0.596)	0.64 (0.540)	0.68 (0.671)
	• Limited	−0.67 (0.596)	−0.70 (0.596)	−0.64 (0.540)	−0.68 (0.671)

References

Alt, F., Kern, D., Schulte, F., Pfleging, B., Shirazi, A.S., & Schmidt, A. (2010). Enabling micro-entertainment in vehicles based on context information. In Proceedings of the 2nd international conference on automotive user interfaces and interactive vehicular applications. *ACM*, 117–124.

Bruner, G. C. (2009). *Marketing Scales Handbook: A compilation of multi-item measures for consumer behavior & advertising research*. (Vol. 5). GCBII Productions.

Cellario, M. (2001). Human-centered intelligent vehicles: Toward multimodal interface integration. *IEEE Intelligent Systems, 16*, 78–81.

Chapman, C. N., Love, E., & Alford, J. L. (2008). Quantitative early-phase user research methods: Hard data for initial product design. In Hawaii international conference on system sciences. *Proceedings of the 41st Annual. IEEE*, 37–37.

Coppola, R., & Morisio, M. (2016). Connected car: Technologies, issues, future trends. *ACM Comput. Surv. CSUR, 49*, 46.

Cowan, B.R., Pantidi, N., Coyle, D., Morrissey, K., Clarke, P., Al-Shehri, S., Earley, D., & Bandeira, N. (2017). What can i help you with?: Infrequent users' experiences of intelligent personal assistants. In Proceedings of the 19th international conference on human-computer interaction with Mobile devices and services. *ACM*, 43.

Eichhorn, M., Pfannenstein, M., Muhra, D., & Steinbach, E. (2010). A SOA-based middleware concept for in-vehicle service discovery and device integration. In Intelligent vehicles symposium (IV). *2010 IEEE. IEEE*, 663–669.

Gaffar, A., & Kouchak, S. M. (2017). Minimalist design: An optimized solution for intelligent interactive infotainment systems. In Intelligent systems conference (IntelliSys). 2017.*IEEE*, 553–557.

Gensler, S., Hinz, O., Skiera, B., & Theysohn, S. (2012). Willingness-to-pay estimation with choice-based conjoint analysis: Addressing extreme response behavior with individually adapted designs. *European Journal of Operational Research, 219*, 368–378.

Green, P. E., Krieger, A. M., & Wind, Y. (2001). Thirty years of conjoint analysis: Reflections and prospects. *Interfaces, 31*, 56–73.

Green, P. E., & Srinivasan, V. (1990). Conjoint analysis in marketing: New developments with implications for research and practice. *Journal of Marketing*, 3–19.

Howe, K. (2009). Anthropomorphic systems: An approach for categorization. In *International conference on internationalization, design and global development* 173–179.

Hüger, F. (2011). User interface transfer for driver information systems: A survey and an improved approach. In Proceedings of the 3rd international conference on automotive user interfaces and interactive vehicular applications. *ACM*, 113–120.

Jackson, D. N. (1976). *Jackson personality inventory JPI: Manual*. Research Psychologists Press.

Kalish, S., & Nelson, P. (1991). A comparison of ranking, rating and reservation price measurement in conjoint analysis. *Marketing Letters, 2*, 327–335.

Kelley, K., & Maxwell, S. E. (2003). Sample size for multiple regression: Obtaining regression coefficients that are accurate, not simply significant. *Psychological Methods, 8*, 305–321.

Kohli, R., & Mahajan, V. (1991). A reservation-price model for optimal pricing of multiattribute products in conjoint analysis. *Journal of Marketing Research, 28*, 347–354.

Kumaraguru, P., & Cranor, L. F. (2005). Privacy indexes: a survey of Westin's studies. http://repository.cmu.edu/isr/856/. Accessed 12 July 2018

Large, D. R., Clark, L., Quandt, A., Burnett, G., & Skrypchuk, L. (2017). Steering the conversation: A linguistic exploration of natural language interactions with a digital assistant during simulated driving. *Applied Ergonomics, 63*, 53–61.

Luger, E., & Sellen, A. (2016). Like having a really bad PA: the gulf between user expectation and experience of conversational agents. In Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems. *ACM*, 5286–5297.

Macario, G., Torchiano, M., & Violante, M. (2009). An in-vehicle infotainment software architecture based on google android. In Industrial embedded systems, 2009. SIES'09. IEEE international symposium on. *IEEE*, 257–260.

Meuter, M. L., Bitner, M. J., Ostrom, A. L., & Brown, S. W. (2005). Choosing among alternative service delivery modes: An investigation of customer trial of self-service technologies. *Journal of Marketing, 69*, 61–83.

Moniri, M. M., Feld, M., & Müller, C. (2012). Personalized in-vehicle information systems: Building an application infrastructure for smart cars in smart spaces. In Intelligent environments (IE). *2012 8th International Conference On. IEEE*, 379–382.

Müller, C., & Weinberg, G. (2011). Multimodal input in the car, today and tomorrow. *IEEE Multimed., 18*, 98–103.

Olaverri-Monreal, C., Lehsing, C., Trübswetter, N., Schepp, C. A., & Bengler, K. (2013). In-vehicle displays: Driving information prioritization and visualization. In Intelligent vehicles symposium (IV). *2013 IEEE. IEEE*, 660–665.

Parada-Loira, F., González-Agulla, E., & Alba-Castro, J. L. (2014). Hand gestures to control infotainment equipment in cars. In Intelligent vehicles symposium proceedings. *2014 IEEE. IEEE*, 1–6.

Pfeuffer, N., Benlian, A., Gimpel, H., & Hinz, O. (2018). Catchword "anthropomorphic information systems." bus. Inf. *Systems Engineering* forthcoming.

Ram, P., Markkula, J., Friman, V., & Raz, A. (2018). Security and privacy concerns in connected cars: A systematic mapping study. In 2018 44th Euromicro conference on software engineering and advanced applications (SEAA). *IEEE*, 124–131.

Rhiu, I., Kwon, S., Bahn, S., Yun, M. H., & Yu, W. (2015). Research issues in smart vehicles and elderly drivers: A literature review. *Int. J. Hum.-Comput. Interact., 31*, 635–666.

Rosario, B., Lyons, K., & Healey, J. (2011). A dynamic content summarization system for opportunistic driver infotainment. In Proceedings of the 3rd international conference on automotive user interfaces and interactive vehicular applications. *ACM*, 95–98.

Schlereth, C., & Skiera, B. (2012). DISE: Dynamic intelligent survey engine. In *Quantitative marketing and marketing management*. Springer, 225–243.

Spiekermann, S., & Pallas, F. (2007). Technologiepaternalismus—Soziale Auswirkungen des Ubiquitous Computing jenseits von Privatsphäre. In *Die Informatisierung Des Alltags*. Springer, 311–325.

Spiekermann, S., & Ziekow, H. (2006). RFID: A systematic analysis of privacy threats and a 7-point plan to adress them. *J. Inf. Syst. Secur., 1*, 2–17.

Steenkamp, J. E., & Baumgartner , H. (1995). Development and Cross-Cultural Validation of a Short form of CSI as a Measure of Optimum Stimulation Level. *International Journal of Research in Marketing*, 97–104.

Steenkamp, J.-B. E., & Gielens, K. (2003). Consumer and market drivers of the trial probability of new consumer packaged goods. *Journal of Consumer Research, 30*, 368–384.

Stratistics MRC (2017). In-Car Entertainment - Global Market Outlook (2016–2022) [WWW Document]. URL https://www.strategymrc.com/report/in-car-entertainment-market. Accessed 6 Dec 2018.

Strayer, D. L., Cooper, J. M., Turrill, J., Coleman, J. R., & Hopman, R. J. (2017). The smartphone and the driver's cognitive workload: A comparison of apple, Google, and Microsoft's intelligent personal assistants. *Can. J. Exp. Psychol. Can. Psychol. Expérimentale, 71*, 93–110.

Strayer, D. L., Turrill, J., Coleman, J. R., Ortiz, E. V., & Cooper, J. M. (2014). Measuring cognitive distraction in the automobile II: Assessing in-vehicle voice-based. *Accident; Analysis and Prevention, 372*, 379.

Street, D. J., & Burgess, L. (2007). *The construction of optimal stated choice experiments: Theory and methods*. John Wiley & Sons.

Vermeulen, B., Goos, P., & Vandebroek, M. (2008). Models and optimal designs for conjoint choice experiments including a no-choice option. *International Journal of Research in Marketing, 25*, 94–103.

Viereckl, R., Ahlemann, D., Koster, A., & Jusch, S. (2015). Connected Car study 2015: Racing ahead with autonomous cars and digital innovation. *Strategy&pwc.*

Wee, D., Kässer, M., Bertoncello, M., Heineke, K., Eckhard, G., Hölz, J., Saupe, F., & Müller, T. (2015). *Competing for the connected customer—Perspectives on the opportunities created by car connectivity and automation*. McKinsey Co..

Wertenbroch, K., & Skiera, B. (2002). Measuring consumers' willingness to pay at the point of purchase. *Journal of Marketing Research, 39*, 228–241.

Williams, K.J., Peters, J.C., & Breazeal, C.L. (2013). Towards leveraging the driver's mobile device for an intelligent, sociable in-car robotic assistant. In Intelligent vehicles symposium (IV), 2013 IEEE. *IEEE*, 369–376.

Wulf, L., Garschall, M., Himmelsbach, J., & Tscheligi, M. (2014). Hands free-care free: elderly people taking advantage of speech-only interaction. In Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational. *ACM*, 203–206.