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REVIEW





Alexa, know your limits: developing a framework for the accepted and desired degree of product smartness for digital voice assistants

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Abstract

This research investigates the conditions for the acceptance of digital voice user interfaces focusing on the accepted and desired degree of product smartness. We argue that digital voice assistants (DVAs) are different from other smart products because DVAs are not self-contained products. Smart products also work without DVAs. Therefore, the decision to buy and use a DVA is different. DVAs are not designed to work in isolation. Of course, they can be used only to talk to, but that greatly restricts what the assistants are capable of. The existing literature lacks research on the critical characteristics and properties of DVAs, as well as a categorization of their smartness in the light of the advances in artificial intelligence. The qualitative research design is based on interviews with users and non-users of DVAs. Using a qualitative content analysis, a category system for the degree of product smartness (PS) of DVAs is developed. This paper contributes to the existing literature by exploring the attributes that influence the perception of DVAs and providing a graduated framework for organizing the accepted and desired degree of smartness for DVAs. The framework suggests four gradations each representing an advanced application of artificial intelligence. Red lines appear for some applications, indicating that they are technically feasible but, at least currently, rejected. Rejection relates to the device's autonomous decision-making and privacy control capabilities, as well as the style of interaction, when the DVA acts as though it was a friend. Future research should quantitatively investigate the relationships between user profiles and acceptance. For designers, the model provides guidance for offering user-customized settings for DVAs, according to user preferences.

Keywords Digital voice assistants · Product smartness · Autonomous products · Technological acceptance · Qualitative content analysis

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JEL Classification M31 marketing · M15 IT management · O33 technological change: choices and consequences · Diffusion processes

Introduction

Artificial intelligence (AI) forms the basis for the operation of many smart products nowadays (Mani and Chouk 2017). Digital assistants are such smart products that act like a personal assistant by collecting and evaluating data about its user, and then using it accordingly to support activities independently. Digital voice assistants (DVA) are digital assistants controlled by natural language. They have a voice user interface, to allow the user to control the system (Rijsdijk et al. 2007; Hellwig et al. 2018). "A voice assistant (VA) is an artificial intelligence software that simulates human intelligence through vocal dialogue" (Vernuccio et al. 2021). This product category, still quiet new, represents the research object of this paper.

The first DVA was Apple's Siri, announced in 2011 for the iPhone. Amazon followed with the DVA "Alexa" on the Echo, which has been on the market in Germany since 2016. In 2017, the DVAs Cortana (Microsoft), Bixby (Samsung), and Google's Assistant were introduced. DVAs are a new product category that offers more than previous smart products. New features include the product's ability to make decisions for the individual user and to communicate through speech in dialog form. The range of functions that they can perform can be expanded. As of January 2021, the sum of Amazon Alexa Skills in the United States was tallied at 80,111 and continues to grow (Statista 2021).

This study aims to explore the desired and accepted degree of product smartness (PS) in a DVA. PS is defined as "the ability to collect, process, and produce information and can describe it as "thinking" for themselves. As a result, [... they can] operate autonomously [...], respond to their environment [...], or communicate with other products" (Rijsdijk and Hultink 2009). Our research question is: How do consumers perceive the PS of DVAs? Which factors may influence acceptance and rejection? The research goals are twofold: first, we want to understand what influences the positive or negative (in terms of acceptance and rejection) perceptions of PS of DVAs, and second, we ask how these perceptions can be organized in a framework of application stages, each showing an advanced application of AI. The focus on PS is important; as products are becoming smarter, they will require more freedom in decision-making (Joshi et al. 2008) to be able to take over the tasks of their users. Thus, conclusions can be drawn regarding how DVAs can be designed to increase user acceptance. DVAs are not only a new and growing product segment, they are also changing the general usage behaviors of their users, e.g., automatically ordering products (Kumar 2018). The versatile relevance of smart products for companies regarding the product development of DVAs makes the study results important for science and practice. For instance, McLean and Osei-Frimpong (2019) suggest that future research could explore how the behavior of AI-enabled voice assistants influences their adoption and use, and to provide designers with practical guidelines. Here, we seek to make a contribution.

The paper is structured as follows: in the literature review, research on technology acceptance with special attention to the research on smart products and DVAs is presented. Next, methodology, sampling and data analysis are outlined. Finally, results are presented, discussed and implications as well as directions for future research are explained.

Theoretical foundation

Theories on technology acceptance

Studies on the acceptance of technical innovations have been carried out in different contexts and from different scientific perspectives. Acceptance of innovation is a very individual process influenced by many variables, which previous studies have examined (Warkentin et al. 2017). The reasons have been extensively studied in the research on the acceptance of innovations for several decades, and have established various scientific models. In this section, we explore this literature to identify reasons that might determine acceptance and rejection of technical products.

The influence of a consumer's personal traits on the acceptance of new products or services in general has been studied using the Theory of Reasoned Action (TRA) and showed that a person's beliefs and attitudes influence his or her intentions (Fishbein and Ajzen 1980). The TRA has been widely used due to its simplicity and its causal relationships are considered to be basically confirmed. Critiques argue that intention does not necessarily lead to behavior. The theory does not sufficiently consider covariates or the affective-cognitive views of individuals, which is why impulsive or emotional actions as well as unconscious or habitualized actions cannot be adequately explained.

The varying length of time it takes consumers to adopt innovations is the subject of other research. In the Diffusion of Innovations (DOI) model, Rogers (1983) distinguishes five groups: the first group adopts innovations the fastest, the last the slowest. In addition, the type of innovation is critical to its acceptance by potential users. Rogers identifies the relative advantage of an innovation based on the variables of "perceived compatibility," "complexity," "testability," and "observability" of the products. The determinants do not refer to a specific product category. Rather, they show in general what considerations a consumer makes before buying and using a novel product.

With the Technology Acceptance Model (TAM), Davis (1989) builds on the TRA and contains parallels to Rogers' model of the DOI. The TAM was developed specifically to provide a model for investigating the acceptance of computer technologies (Claudy et al. 2015; Conrad et al. 2012). At the core of TAM are the two determinants: "perceived usefulness" and "perceived simplicity of use". Usefulness and effort are weighed against each other in the decision-making process for consumer acceptance of an innovation, similar to a cost–benefit calculation. The TAM offers the possibility to evaluate not only the acceptance rate, as in Rogers (1983), but also to explore reasons for rejecting an innovation. Thus, obstacles to the acceptance of innovative technology can be specifically investigated and taken into account

in product design and communication (Davis 1989). Criticism of TAM is found in the subjective and hypothetical evaluation of the benefits and costs of an innovation. Particularly, in the case of very novel offerings, it can be difficult for potential users to realistically assess the two determinants (Al-Natour et al. 2011). However, these uncertainties characterize the decision-making processes in the run-up to the acceptance or rejection of technology, especially in the case of technical innovations (Conrad et al. 2012). For technical products, especially if they offer functions that were not previously possible, consumers must make hypothetical cost-benefit considerations. In another research, Venkatesh and Davis (1996) conducted experiments to understand what influences the perceived ease of use by testing computer selfefficacy and objective usability before and after hands-on experience. They found that self-efficacy is a constant influencing factor while usability is only relevant after direct experience.

A complement to the TAM is the Unified Theory of Acceptance and Use of Technology (UTAUT) originally developed for researching technology acceptance in companies (Venkatesh et al. 2003). The model aims to explain the intention to use a new IT technology, especially in a professional environment. Four factors are considered: performance expectancy, effort expectancy, the social influence and facilitating conditions. The first three factors influence the behavioral intent of a person. The behavioral intention and the existing facilitating conditions in turn influence the actual use of a new technology. Age, gender, experience, and the voluntary nature of the person's behavior are variables that act as moderators (Venkatesh et al. 2003). The UTAUT has been extended, to adapt it for research in the consumer market (Venkatesh et al. 2016). In a study on smart meters, trust and risk factors have been identified as key to the acceptance of this application, including the willingness to share private electricity data with an energy company (Warkentin et al. 2017). This shows that the novelty of many products in the market for end consumers, their diverse areas of application and the individuality of the decision-making process for the acceptance of innovations are influencing factors. This is reflected in the complex integration of additional variables into the research, e.g., on the basis of UTAUT (Venkatesh et al. 2016). The theoretical basis is provided in many cases by one or a combination of the technology acceptance models explained above.

None of the models considered here take into account that users can delegate actions and decisions to the product with different levels of autonomy, so that at the highest level, the device can decide not only when and how to perform the action, but also to initiate actions, without having received an order. It is the increasing degree of autonomy that is of interest in our research, which we explore in combination with further characteristics and properties of DVAs.

Research on smart products

The existing literature has already examined reasons for the rejection or acceptance of smart products. It has already been acknowledged that the complexity of a technical product has an influence on its acceptance (Rogers 1983). Perceived risk is another aspect that becomes evident from the research on smart products (Rijsdijk

and Hultink 2003, 2009). The more autonomous a smart product, the more complex and risky it is for the user. In a laboratory experiment with three smart products (vacuum cleaner, refrigerator, television), the general appreciation of the respective product is positively influenced by the perceived relative advantage and negatively influenced by the perceived risk of use (Rijsdijk and Hultink 2003). The authors suggest that smart products should be designed to provide feedback to the user about actions performed and to allow the user to intervene in or cancel actions. In a later experiment with smart products (refrigerator, digital camera, washing machine), Rijsdijk and Hultink (2009) find that effects of product smartness vary across the dimensions and categories. A higher level of product smartness always results in higher level of perceived risk. On the contrary, they find: product autonomy can reduce complexity.

The variable of perceived usefulness from the TAM as well as those of novelty, perceived cost, intrusiveness, self-efficacy, dependency, and privacy concerns was used as influencing factors for the rejection of smart products. The results show that the higher the benefits, novelty, and self-efficacy are rated by potential users, the lower the rejection of an innovation, such as with smartwatches. Privacy concerns influence the perceived intrusiveness of a product, which, especially when accessing private data, encourages the rejection of smart watches (Mani and Chouk 2017).

The extent to which the ability to intervene in autonomous processes, user disempowerment, and personal innovativeness influence the acceptance of autonomous products is the focus of three studies by Schweitzer and van den Hende (2016). The disempowerment factor is confirmed as a negative attribute. In addition, the respondents express concerns about technical dependency and external control by the device (Schweitzer and van den Hende 2016). The study results show that the possibility of intervening in the processes of an autonomous product increases the intention to use the product compared to products without this possibility. Again, the aspects of disempowerment or, in the opposite direction, the possibility of control are identified as important determinants. The negative evaluation of the restriction of self-determination and loss of control is also shown by Heiskanen et al. (2007). In addition, the possible loss of social contacts and the failure to understand radical product innovations prove to be reasons for their rejection, while the optimization of processes and the simplicity or convenience of use are rated positively by consumers.

Factors that characterize products as smart is another research area. Rijsdijk et al. (2007) identify six key factors that describe a product's smartness: autonomy, Learning, Responsiveness, Cooperation, Human-like Interaction, and Personality (Rijsdijk et al. 2007). Two years later, Rijsdijk and Hultink (2009) again surveyed consumers on various product categories and based the evaluation of product intelligence on five factors: autonomy, adaptability (previously the ability to learn), responsiveness, multifunctionality and cooperation. Across all categories, it was shown that higher product intelligence results in higher perceived risk. The perceived risk relates primarily to the functionality of the technology and the disclosure of personal data. Contrary to the authors' assumption, higher product intelligence results in increased observability from the customer's perspective (Rijsdijk and Hultink 2009). The results also showed that a higher autonomy of a product can lead to a reduced

perceived complexity. For example, consumers feel relieved when the smart product takes over tasks without the consumer having to actively intervene or think about the processes themselves (Rijsdijk and Hultink 2009). From the consumer's point of view, the factors that have emerged as risks are the functionality of the technology and the disclosure of personal data. In addition, it has been shown that the assessment of product smartness varies across different product categories. This indicates that a general categorization of smart products across all product categories in the consumer market has limitations. This paper examines product smartness for DVAs, more specifically a distinction of smartness at graduated levels.

While previous research divides aspects, such as risk, complexity and control, of smart products into reasons for acceptance or rejection, we assume that these aspects are a matter of degree, depending how and what for a DVA is used. The area of activity of a smart product like a robot vacuum cleaner is clearly limited. With a DVA, the user can significantly expand this field of activity. Thus, the perception of risk, control and complexity is expected to be graduated.

Research on DVAs

Research on DVAs is still limited and includes smartphones, online shopping assistants and similar innovations that act on behalf of users or real assistants within clearly delimited areas, for instance, to suggest clothing styles. Our interest lies on DVAs that are connected to other smart products and their scope of activity which is, at least theoretically, endless. We focus on literature from the household sector, thus literature on professional or public environments, such as stores is excluded because the decision to purchase and install smart products is not in this case carried out by private customers.

A key difference between DVAs and individual smart products, such as vacuum robots, is the direct versus indirect influence. This can be seen in the area of smart homes in the example of controlling lights via the Alexa DVA or smartphone, where the consumer does not directly operate a light equipped with a smart bulb, but instead speaks to a DVA, which in turn activates the light. On the assemblage theory, Hoffman and Novak (2018) developed a concept to capture the interaction of smart objects and their users. Using this structure, roles are analyzed in terms of enabling and forcing factors, and mutual influence is described, e.g., whether it is complete or partial. Such a consideration of objects and actors with their respective roles will continue to gain relevance as smart objects acquire more capabilities and become more ubiquitous. For example, the authors note that digital voice assistants, with their growing capabilities, are already outgrowing the boundaries of a home (Hoffman and Novak 2018).

The impact of privacy concerns and data use on adoption has been the subject of other studies of DVAs (Brill et al. 2019; Chung et al. 2017); . Moreover, studies show that consumers do not use voice control in public, although they prefer voice assistance in their private environments (Easwara Moorthy and Vu 2015; Ewers et al. 2020). In the context of e-commerce, Bandara et al. (2020) find that online shopping consumers are increasingly worried about their privacy, due to a lack of

responsibility on behalf of governments and private firms. This is another indication of the role of control, but for DVAs with regards to privacy and data security. Several authors focus on or include the role and influence of the (natural) voice. For example, spoken or oral conversations create a stronger sense of social presence than textual interactions (Gong and Nass, 2007). Finally, Chérif and Lemoine (2019) conduct experiments with anthropomorphic virtual assistants and find a strong effect of a human voice versus a synthetic voice on social presence, trust, and behavioral intentions. Based on the research findings discussed above that voice (human versus synthetic) and speech (whether the content of a conversation resembles that of a human) are the determinants that contribute to the perception of increased smartness of DVAs.

In the context of AI, which is the basis of DVAs, consumer experience with AI has been conceptualized. Four types of experience are described: data collection, classification, delegation, and social. The tension between potential benefits and apprehensions is demonstrated (Puntoni et al. 2021). In the context of DVAs, this tension can be seen as a basis for acceptance or rejection.

Theoretical considerations regarding the degree of PS

With DVAs, the user's decision-making and power to act are transferred to the system. DVAs are designed to act smart by making decisions within a given framework for their users and perform routine tasks (Nunamaker et al. 2011). DVAs are an interface for controlling numerous applications. They can remind users about an appointment, make appointments on their own, trigger orders and even detect the user's state of mind and react to it. These applications show an increasing autonomy of the DVA. However, there is no gradation of PS of DVAs, which differ from other smart products in that they need to be integrated into an ecosystem. Such a gradation will be investigated to support the future development of DVAs. In the studies presented above, various approaches for describing PS have been used and will serve as a basis for such a gradation. In cases of more advanced use, the ability of the system to go beyond the repetition of routine tasks to make decisions by acting proactively has been demonstrated. This refers to the distinction between prescriptive and delegated actions. If the action of a DVA is initiated by the user, Stephen (2017) speaks of prescriptive actions. On the other hand, if the system acts independently, without any explicit request from the user before each action, it can be described as a delegated action. Therefore, we conclude that the degree of the autonomy of a system, i.e., to what extent it can act independently of its user, can be used to explore distinctions with regard to PS of DVAs. In addition to autonomy, experts identified the ability to learn and to cooperate, as well as responsiveness, multifunctionality, personality and human-like interaction as further characteristics of smart products (Rijsdijk et al. 2007; Rijsdijk and Hultink 2009).

Responsiveness is defined as how a product reacts to certain stimuli with a predefined action (Rijsdijk et al. 2007). This allows processes to be automated according to different if-then functions. For example, the user determines that the DVA should remind him 30 min before an appointment listed on the calendar of his mobile phone. The ability to learn and draw their own conclusions, which DVAs are capable of as a result of machine learning, is a prerequisite for autonomy. Here, actions are no longer executed, as in the case of automation in accordance with the if-then logic specified by the user; rather, the system searches for its own logical rules and acts autonomously from the user (Schweitzer and van den Hende 2016). Referring to the example above, not only would the system play the reminder as indicated, but due to the appointment information without prior command from the user, e.g., start the auxiliary heating in the car, calculate the optimal route to the appointment, deposit it in the car navigation device and prompt the user in time to leave the house. Due to this differentiation, we consider automation in terms of responsiveness and autonomy in the sense of a learning ability.

Studies on the technology acceptance of smart products have shown that the factor of control or loss of control is crucial from the user's point of view for the evaluation of smart products and, consequently, for the decision to accept or reject them (Heiskanen et al. 2007; Schweitzer and van den Hende 2016), which reinforces that factor control is a differentiator. In addition to the control factor, the loss of social contact, reduced self-determination, increasing disempowerment, external control, dependency, obtrusiveness and privacy concerns have been identified as factors of smart products that are considered before acceptance or rejection (Heiskanen et al. 2007; Schweitzer and van den Hende 2016; Mani and Chouk 2017). In particular, the last two factors identified in a study on smart watches (Mani and Chouk 2017) may be relevant to DVAs due to their constant monitoring and analysis of their environment. However, there is no study that has specifically focused on evaluating the functions and features of DVAs on graduated levels. The present work will close this gap in the literary landscape. In our study, we explore the attributes of (external and loss of) control, disempowerment, reduced self-determination, technical dependency, functionality of the technology, loss of social contacts and the disclosure of personal data as features to explore the perceived degree of risk by users for the gradations of PS. Similarly, the optimization of processes, simplicity, convenience of use, adaptability, responsiveness, and cooperation are used as cues in the interviews to explore perceptions of graduated levels.

Methodology

This study aims to explore how consumers perceive the intelligence of DVAs and how this perceived intelligence might contribute to acceptance or rejection. The authors seek to gain new insights for explaining the motives of people for using or not using DVAs (Yin 2016, p. 10). We expose the study subjects to four use cases that have increasing levels of PS, and seek to understand how consumers perceive them and what aspects might lead to acceptance or rejection.

Using qualitative research, we aim to explore decisive attributes of DVAs and to uncover motives and influences on the acceptance or rejection for different levels of PS of DVAs (Yin 2016, p. 10; Mayring 2014, p. 3). Based on the broad range of possible aspects identified in the previous literature, we conduct an indepth study with users (Mayring 2014, p. 6). Since the research aims to compare

17-45 years, non-users		
M1	Male, 21 years	Student (economics), house with parents (rural)
M2	Male, 37 years	Employee (project management), house with wife and kids (rural)
W1	Female, 28 years	Employee (media and communications), flat with boyfriend (urban)
W4	Female, 45 years	Self-employed (medical and cosmetic treatments), house with husband (sub-urban)
17-45 years, users		
MN1	Male, 31 years	Employee (marketing), flat with wife (urban)
MN4	Male, 31 years	Employee (IT), flat (urban)
WN1	Female, 23 years	Employee (sales), flat with boyfriend (urban)
WN2	Female, 36 years	Employee (assistant to CEO), flat (urban)
Older than 46 years, non-users		
M3	Male, 70 years	Pensioner, flat (urban)
M4	Male, 49 years	Employee (executive level), house with wife (sub- urban)
W2	Female, 54 years	Employee (Marketing), house with husband and kids (rural)
W3	Female, 57 years	Employee (retail), flat with kids (urban)
Older than 46 years, users		
MN2	Male, 48 years	Employee (sales), flat with girlfriend (urban)
MN3	Male, 62 years	Employee (printing industry), house with wife (sub- urban)
WN3	Female, 67 years	Pensioner, house with husband (sub-urban)
WN4	Female, 53 years	Employee (finance), flat with kid (sub-urban)

Table 1	Sampling	participant	profile
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the generated data with existing theory and explore the transferability of previous theory to DVAs, the methods of grounded theory and qualitative content analysis were used (Glaser and Strauss 2017, p. 24). It enables theory building and testing based on the analysis of documents.

In our deductive approach, we use the aspects of acceptance or rejection found in the literature as prompts for the development of an interview guide (Appendix). Categories were developed inductively and built on the coding frame explained in "Analysis of the interviews". Four application scenarios of DVAs reveal the possible different levels of PS. Sixteen qualitative interviews were conducted. DVAs can be used and, because of their relatively low initial cost, can be purchased by all consumer groups that have unlimited legal capacity. This results in a wide range of users, potential users and convinced non-users. As indicated in Table 1, 16 subjects were recruited for the interviews. According to McQuarrie and McIntyre (2014), in a sample of 16, the probability of completely missing a viewpoint held by 20% of the customer population drops below 0.05. The interviewees belonged to different age groups, ranging from 21 to 70 years old. Eight users were under 45 and another eight were over 45 years of age. In contrast to Hwang and Nam (2017), we assume that the age groups above and below 70 are not appropriate for our research on DVAs. However, we consider age to be a potential factor influencing acceptance (Ertiö and Räsänen 2019). Furthermore, users as well as non-users of DVAs were interviewed, to avoid the possibility of a positively biased opinion of the pre-filtered group of active users (Slettemeås 2009).

The empirical setting for this study was Germany, which is relevant for consumer studies, as it is one of the biggest consumer markets in Europe (Canhoto et al. 2017). Regarding the boundary conditions, it should be noted that in May 2018, the General Data Protection Regulation (GDPR) came into force, a regulation of the EU law on data protection and privacy in the European Union (EU 2018). The introduction of the EU GDPR as well as the Cambridge Analytica scandal (Confessore 2018), which affected Facebook and not the providers of DVAs, but nevertheless drew the public's attention to the possibilities and dangers of using private data. As both researchers as well as the interviewees are native Germans, the interviews were conducted, transcribed and analyzed in the German language.

Due to the novelty of the DVA product category, it could not be assumed that all respondents knew the products and their features. Therefore, after some general questions, the conversation turned into a focused interview. We used videos that illustrated four different use cases (Table 2) of DVAs in real life situations.¹ This procedure also follows the recommendation of Conrad et al. (2012) to present innovative products in use cases to create a clear starting point for the conversation and allow users to be interviewed who were not currently using DVAs. The four use cases show an increasing adoption of decisions by the system. In the first case, Alexa routinely answers the user's questions or executes the user's commands. In the second case, appointments are made, and the system has access to the user's schedule and can react flexibly within this schedule. In the third use case, the system performs a series of tasks and acts independently but undesirably when it fails to recognize the user's voice to open the front door. In the latter case, the system interacts with the user in an empathetic and emotional way, giving advice as if it were a close friend. In addition to the open-ended questions about interviewees' observations and perceptions of the four use cases, we used the findings from previous studies as prompts, for review, and to keep the dialogue going.

The questions in the guideline were arranged to maintain suspense for the interviewee and pay tribute to answering the research questions based on the literature review. It is common for exploratory studies to be guided by theory for ensuring that the data collection offers a relevant basis for the data analysis (Shields and Rangarajan 2013). The demographic characteristics and information on the lifestyle of the respondent were discussed through open questions that stimulated narration (Rader et al. 2016). After a pre-test, one question was summarized and two questions were re-worded. In addition, it was decided to show all the application videos at the beginning and to conduct the interview afterwards to encourage optimal flow.

¹ Video 1: https://youtu.be/y7SRMLsAdww; video 2: https://youtu.be/yv_8dx7g-WA; video 3: https:// youtu.be/sgJLpuprQp8; video 4: https://youtu.be/z3jqIGT-kmg.

Table 2 Use cases show	n to the interviewees	
	DVA	Use case
Video 1	Alexa (Amazon)	Upon request by the users, Alexa answers questions about the next day's schedule, the weather, plays requested music according to a playlist, adds items to a shopping list, tells a joke, switches off light
Video 2	Google Duplex	With the help of Google Assistant, Duplex speaks for the user, e.g., by calling the hairdresser and making an appointment, and calling a restaurant for a reservation
Video 3	Smart home application (no name)	By voice command, the user turns on the music, has a smoothie prepared, checks his appointments and is reminded of a dentist appointment. When he returns from the dentist, the system does not under- stand his commands due to problems with pronunciation after dental treatment. This is a demonstra- tion of a technical malfunction
Video 4	Xiaoice (Microsoff)	The social chat bot for the Chinese market that makes a full-duplex (two-way) phone call to a human on the other end of the line. It can converse with someone similar to Google Duplex by predicting what the person is going to say and then responding quickly. Like a human, it can make interjections to draw attention to important events. During the demo, the user thanks Xiaoice for an empathetic com- ment. Then Xiaoice interrupts the speaker mid-sentence to warn him of strong winds in the area and remind him to close the windows

Twelve interviews were conducted in January 2019 and another 4 in October 2020. The participants gave their consent to record the interviews. Although the recording of a conversation with a tape recorder leads to a less natural environment, the possibility of being able to capture detailed answers with great accuracy was seen as more important (Gläser and Laudel 2006).

Analysis of the interviews

The transformation of spoken words into text requires rules (Mayring 2014, p. 45). To produce the transcripts, the rules of Dresing and Pehl (2012, p. 26–29) were used. After a first screening of the interviews, a coding guide was developed in accordance with the aim of the study. Mayring (2014, p. 51) distinguishes three types of units for the analysis. The coding unit was content-bearing sentences or sentence parts. The context units were the entire interview of an interviewee. The evaluation unit was all 16 interviews which were evaluated one after the other. The categories were defined and refined after analyzing a portion of the material until the category system no longer needed adjustment. After revision, the entire material was worked through and individual passages were placed in the appropriate categories (Mayring 2014, p. 66).

A coding frame was developed (O'Connor and Joffe 2020), following the defining and refining process described by Mayring (2014, p. 66). The source text is summarized and abstracted step-by-step following the rules by Mayring (2014, p. 79-81). The categories were developed inductively: for example, in interview W2, the phrase "Yes, these are all the issues; there is a possibility that it will be hacked, my privacy will come out, and they will all play with it." paraphrases "the danger of hacking the system and disclosure of private data". By clustering with other, identical or similar paraphrases, the category of "Concerns regarding security/vulnerability" could be identified. It was ensured that all relevant passages were included into the category system. According to this scheme (summary, paraphrasing, clustering, reduction), all interview texts were edited. This process "of iteration, not as a repetitive mechanical task but as a deeply reflexive process, is key to sparking insight and developing meaning. Reflexive iteration is at the heart of visiting and revisiting the data and connecting them with emerging insights, progressively leading to refined focus and understandings." (Srivastava and Hopwood 2009). As soon as the category system no longer needed any adaptation, the coding scheme was used by an independent encoder to verify the reproducibility. Categories that led to larger deviations were subsequently revised again. To make the coding of the transcripts transparent and comprehensible, a general definition was formulated for each subcategory that was meant to cover all occurrences of this category. An anchor example per category and written coding rules supported a consistent categorization of the text (Mayring 2014, p. 97–98). Finally, the transcripts were analyzed based on the coding scheme, leading to the findings to be illustrated by quotes in the next chapter. The initial categories (level 1) for the attributes were subsequently analyzed and grouped into a higher order (level 2-main categories) to relate to broader conceptual issues (Yin 2015, p.196). The categories for the gradations were developed

based on the use cases and here the goal to find which level of the attributes were accepted or rejected could be reached.

The quality criterion of validity, among other things, includes the validity of the chosen sample. For this research, a quota procedure was chosen to obtain a heterogeneous mix in terms of age and status of use to reduce the risk of a systematic distortion of the sample (Mayring 2014, p. 56). The second quality criterion for qualitative empirical work is the consideration of reliability, which can be ensured above all by demonstrating the reproducibility. For this, Mayring (2014, p. 111) recommends the inclusion of an independent analyst who applies the developed categories to the texts to be examined. The category scheme is considered to be reproducible if the independent analysis comes to the same result as the evaluation of the first coder. The coding scheme was developed by a first coder and used by an independent encoder to verify the reproducibility. Categories that led to larger deviations were subsequently revised again.

The four use cases show four possible gradations between the automated execution of routine tasks and the proactive execution of tasks by the system without a concrete order by the user. The first level between automation and autonomy of actions was perceived and commented accordingly by the interviewees. The development of the further levels is based on the literature-based guiding questions and the corresponding comments of the interviewees.

Results

The perceived degree of PS of DVAs

At the beginning, the respondents were asked to name innovative products of the last few years and their characteristics. In the course of the interview, respondents talked about their understanding of intelligent products. The smartphone was named and described by factors such as independence in the completion of defined tasks, individual adaptation to the respective user, and simple and mobile operability. The support and facilitation in everyday life, acceleration of processes, as well as time savings for the user were considered to be advantages of products. Occasionally, their entertainment value, access to the Internet and the combination of many functions and applications in one product were also mentioned as added value.

Since both users and non-users of digital voice assistants participated in the survey, all participants were subsequently shown videos showing four different use cases of digital voice assistants. The first video shows the use of the voice assistant Alexa with functions such as appointment reminder or weather query. The next application provides a glimpse into a smart home, where various household appliances are networked and respond to voice input. In the third application, a dialog between the Google Assistant voice assistant and a hair salon is reproduced. The voice assistant calls a hairdresser according to its user's specifications to make an appointment. The last application again shows a dialog, but this time between the user and his voice assistant Xiaoice. The scene illustrates an instance when the voice assistant proactively calls its user to inquire about the user's well-being. By showing

the video, all participants have a common basis on which the subsequent interview questions could be based.

After the videos, the subjects talk about attributes of DVAs that they call smart. These can be grouped into three categories. Table 3 shows the categories and anchor examples. Self-directed action, learning ability, and actions based on data analysis are mentioned. The similarity to humans is another characteristic that lends itself as a category.

We group "independent, adaptive action" and "action based on data analysis" in the main category (Level 2) "automatization/autonomy". We define the category "similarity to humans" as the main category, which is divided into two subcategories: "human language" and "human behavior/interaction". Figure 1 shows our framework in which automatization/autonomy is depicted on the top row. The further main categories and their graduated levels are explained in the remainder of this section.

The degree of autonomy of DVAs

The question of the autonomy of DVAs was discussed. The subjects noted the increasing smartness in the four use cases. Consistent with the general perception of smart products, the respondents noted that the smartness of DVAs is based on the ability to act independently and individually. In addition, it was mentioned that the nature and cleverness of the data analysis, that drives the actions of a voice assistant, are critical to smartness. At many points, the interviewees provided responses regarding the independent capacity of DVAs (Table 4).

The subjects recognize an increasing degree of autonomy of the DVA and describe the differences with words such as simple or banal for Use Case 1, in which the system only executes actions on the user's instructions. In the second case, an increase in the scope of actions is observed, and in the other two cases, actions that require fewer and fewer commands from the user. Notably, in Use Cases 3 and 4, the increasing humanization of the DVA is perceived. In particular, the human language as well as the personal, empathetic interaction is mentioned by the test persons. In the interviews, the increasing smartness of the four DVAs is described by the diminishing to completely absent control by the user. Speech and personal interaction were also mentioned as signs of increasing smartness.

There are, however, quotes that suggest the rejection of a certain degree of autonomy of the DVA. This leads to the categorical rejection of autonomous applications in the text passages of other users, especially with regard to Use Case 4 (Table 5).

These results show that consumers actually feel an increase in perceived PS. Gradations arise in the transition from automation to autonomy. To clarify this perceived increase, the subjects used terms such as steps, levels, or categories. While all subjects accept the actions of the DVA in Use Case 1, reservations increase with the degree of autonomy. Use Case 4 is rejected without exception. Figure 1 summarizes the gradation from automation to autonomy, as explained above. In the following section, further attributes are discussed.

Table 3 Attributes of digital voice as	sistants	
Level 1-category	Definition	Anchor example
Acts independently, capable to learn	The device acts independently, is capable of learning, takes on own tasks	MN1: [] the less I have to coordinate through an external app, the more self-sufficient, the smarter the voice assistant W1: That the assistants really learn to interact and react to differ- ent situations individually as well
Actions based on data analysis	The device analyzes data and performs actions in accordance with this data basis	MN1: But if it now uses technology, data, and my search queries on the Internet to detect that I am not feeling well and calls me on the basis of that, then I think it is very smart
Similarity to humans	The device resembles a human being, e.g., in speech or activities	MN2: This dialog, it sounds a lot like a human being WN2: [] the more similar it is to a human being and how a human being thinks, then yeah that's smart. So that it can respond to the inputs quasi-individually

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Fig. 1 Framework of graduated levels of PS of DVAs

 Table 4
 Perceived level of autonomy

Category	Anchor example
Use case 1—acts according to simple if-then functions	WN2: Well, the first one is relatively simple, you know that, it feels like nothing new. W1: I would say that with the first, it's mainly about assistance in the sense of really supporting, providing infor- mation, being a watch list, all these things
Use case 2—controls other things according to simple in-then functions	WN2: The second one goes one step further, that I can really control my home with it and not just start banal queries
Use case 3—acts freely within a defined frame	WN2: The third one is already a significant step further, because the computer really reacts to the language and then speaks like a human being, 'mhm', 'uh', in other words so relaxed
Use case 4—acts proactively without a concrete task	W1: Now with the latter, it is also mainly about replacing, supporting human interactionW4: But this example, where the Chinese woman is called just because the computer felt like it, that is another step

Perceived risk and the demand for control

When asked about the perceived risk associated with digital voice assistants, the respondents commented on risks that they associate with DVAs. This main category includes a variety of concerns with the use of DVAs, which are shown in Table 6. The risks cited by consumers were often associated with a desire for control and the ability to customize the degree of freedom of the DVA. Therefore, the main category, "risk," was included in our framework, as, from the consumer's perspective, risk increases as control decreases.

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Category	Anchor example
Use case 1—acts according to simple in-then functions	 W3: The smartness of the first category was for me rather the one I would agree with or could live with. The other one is more something I would have to realize with fright () so for me it is still better to make an appointment with a living person than with a machine MN2: That doesn't mean to me that Alexa doesn't get to decide when she sends out the robot vacuum cleaner. But THAT she does it on the day, that is my decision
Use case 2—controls other things according to simple in-then functions	 WN1: But not at the moment, because I don't want anyone to make appointments for me. This thought is somehow still a bit strange for me M3: But giving things out of hand at the first moment, and that's just the way it is with these things, would be a bit too dangerous for me. And also too risky. So I would leave what I do to someone else and completely and I don't want that []; No, it's not supposed to act completely autonomously. Neither is a car
Use case 3—acts freely within a defined frame	 WN3:but I practically give my house and the functions partly into a foreign hand and must rely on the fact that everything functions. () I don't want that. No I absolutely don't want that, that it is autonomous MN1: I practically just want to set a framework and not intervene in every single function
Use case 4—acts proactively without a concrete task	 MN3: And with the last video, yes () I am a human being and have a brain, I'll say that now. So I don't want to give away everything that can be done. ()That's a bit creepy, if you spin that on W2:is no longer involved in the [decisions and actions] of the last assistant (), () the control is partly or completely gone from [her] MN3: slightly exceeded his competence

Concerns include that data are collected and can be used for marketing purposes, to manipulate users, or that privacy is not protected. The risk of malfunctions, i.e., that the voice assistant misunderstands signals or performs unwanted actions, was also named. Other respondents, saw a risk in the fact that criminals can gain access to the system. The subject sees a clear difference in the risk assessment between collecting data, which is essential for him to use a voice assistant, and passing on data to third parties, which would not be acceptable. Closely related to this statement is the subcategory ambiguity in handling data. Here, text passages can be found in which users address their lack of knowledge about the use of their data. The uncertainty "[w]ho (...) gets hold of my data and what (...) they [do] with it" is reflected in many respondents' fear that data will be evaluated unintentionally. Accordingly,

Table 6 Perceived risł	c and the demand for control	
Level 1-category	Definition	Anchor example
Data collection	The ongoing collection of data by the device was mentioned as a concern	WN2: this transparent citizen thing. That will go so far at some point, I say, it's already like that now, that I'll get the advertising tailored to me, but maybe I'll get the prices tailored to me at some point, because the supply is based on individual demand. The machine then knows that [] likes this and that chocolate and therefore it costs 50 cents more
Data use	Lack of clarity as to what the data will be used for causes discomfort	MN1: But what must not happen, and we have to distinguish between collecting data and passing on data, is that this data is then made available to unauthorized third parties who have no right to it, to whom we have not given our consent, or companies can take possession of it
Criminal activities	Interviewees fear that criminal activities (theft, burglary) will be enabled	WN3: Well. I still think that, as with any electronic system, there is the possibility that someone could log in and do something stupid with it W1: Or even conversations can be recorded and it can be turned into a listening device W2: Yes, these are all the issues, is there a possibility that it will be hacked, that my privacy will be leaked, they all play into it
Manipulation	The fear of external control or manipulation is named as a perceived risk of digital voice assistants	M2: [] product suggestions on Amazon. But you can still see through that. But at some point there will certainly come a point where you no longer see through it, or you only see through it with the necessary background knowledge and are otherwise actively manipulated. And that is/ I don't know, also discussions with political opinions, there one gets perhaps also only the news or messages before-set, which fit one straight into the collar. That's how you build your own world, or rather, your own world is built and you are actively manipulated W3: [] but Siri simply makes an appointment, because he knows that I have nothing planned officially at that time. So I would then already feal extransity controlled []

Table 6 (continued)		
Level 1-category	Definition	Anchor example
Privacy invasion	The fear of interference in the user's privacy is named as a perceived risk of digital voice assistants,	WN1: [] you have to be aware that the assistants also interfere with your privacy. I mean, as she also said in the last example in the video, she also said 'please close the window', although he first said 'Bye now'. So I had the feeling that he had had enough, that maybe it didn't suit him either, that the voice assistant just switched on like that and absolutely asked [] WN3: No, because I still control my use as such and know what I'm doing, or I should know what I'm doing, what I want, I don't have the feeling that my privacy is being invaded by an external party
Control/loss of control	That the user is in control of the device, dominates it and gives orders to it are named as prerequisites to using digital voice assistants	M3: the device [should not] determine, but one [should] [] Well, I think right now the things or the tasks that we give Alexa are not that important yet, so you would not have to control that M1: If you think about it, you now have a robot that makes your hair appointment for you. Now let the one across the street also be a com- puter, then a computer communicates with a computer. Both think they are human beings, both pretend to be human beings. This raises some questions as to whether this is okay in the future
Possibility to intervene	The respondents express the wish to be able to intervene in operations and processes	M1: If I could intervene there, delete logs before they are transmitted, it would be great MN2: I don't know if you really use it at the end of the day. But that I CAN intervene, that is the important thing, yes WN2: something breaks down and () there is nowhere [a] light switch [to] press W3: Now, as soon as more, as in the case of the family or the hairdress- ing salon are involved, you have to look very carefully and need rules

respondents state that they believe digital voice assistants invade their privacy. However, the fact that this is not a universal attitude is shown by the fact that three respondents do not see any encroachment by digital voice assistants on their privacy. Others, on the other hand, would feel externally controlled by the automated arrangement of appointments. In addition, if digital voice assistants become widespread, two respondents see a danger in the fact that politicians could use the devices to try to influence their users, e.g., by filtering news. Direct effects on the user or people in his or her environment are seen as a risk by five of the interviewees. For some, it is conceivable that users will unlearn activities and lose independence the more they rely on the digital voice assistant. The fear that interpersonal communication will suffer from the use of digital voice assistants is mentioned as a further risk. The subcategories show that the perceived risk with regard to digital voice assistants extends beyond the technical functionality of a DVA.

In the risk assessment, the respondents made a clear distinction between the collection of data, which is essential for the use of a voice assistant and the data transfer to third parties, which would not be acceptable to him. The insecurity regarding data use is reflected by many respondents in the fear that their data are shared unintentionally. Accordingly, subjects indicate that DVAs invade their privacy. Apart from a risk of data security is a possible manipulation or remote control by the device. If, for example, product proposals are so well matched to the user, that one is no longer able to identify them as adapted advertising, this is perceived as active manipulation. Others would feel externally controlled by the automated arrangement of appointments, such as the hairdresser appointment in Use Case 3. In addition, the widespread use of DVAs were perceived as dangerous, as politicians could try to influence the users, e.g., by filtering the news. The unknown impacts on the users or people in their environment were considered to be a risk of DVAs. For some, it is conceivable that users will forget about their activities and lose their independence the more they rely on the DVA. The fear that interpersonal communication will suffer from the use of DVAs is also pronounced as a further risk. The statements show that the perceived risk of DVAs extends beyond the product and its technical functionality, while demonstrating strong concerns related to data privacy and security.

The risk of malfunction, e.g., that the voice assistant misunderstands signals or carries out unwanted actions, was barely mentioned in our study. If so, respondents saw a risk in allowing criminals to gain access to the system. Other risks mentioned were related to the data of the users and the potential for external manipulation. The subjects expressed concerns that the data recorded by the DVA would be used for marketing purposes, e.g., targeted advertising campaigns and prices. The technical risk becomes important when dependency exists and the consequences of technical failures become critical. This is the case, for example, when a former existing solution is completely replaced by the functionalities of a DVA.

The most pronounced subcategory from the interviews is the need for control or the user's dominance over a DVA. The fourth application where the voice assistant makes recommendations to the user, e.g., to go to bed now, especially causes discomfort. The desire for control seems to be based on the functions and design of the DVA. Presently, the area of the application of the language assistant Alexa is limited to simple functionalities, such as providing information or controlling other smart devices, e.g., light bulbs. As the skills of the DVA grow, its scope extends beyond the communication with its own user to external persons, e.g., in Use Case 3. In this case, respondents call for specific rules to clarify such situations.

The importance of control is confirmed in statements in which respondents demand a "possibility to intervene". While some would like to establish an individualized framework within which the voice assistant can act freely, others would like to be able to intervene in any action as needed. This is seen as an important factor concerning DVAs, as the ability to intervene gives the user a sense of security. This possibility of personally configuring the functions of a voice assistant is considered very positive and is compared to the process of familiarizing a secretary who has to adapt to a new boss. This configuration of the device represents a limitation of autonomy.

Anthropomorphic attributes of DVAs

Similarity to humans has emerged as a new attribute compared to responses to generic smart products. This concerns anthropomorphic attributes, such as speech on the one hand, and the display of empathy and emotions on the other. The subjects find that the dialogs of applications three and four sound very human (Table 7).

This is the voice, which is becoming less and less distinguishable from that of a real human being. Concerning the third application, i.e., the actual dialogic speech, is perceived as an increase of the DVA's smartness.

When DVAs perform human-like interactions, such as asking about feelings and showing solicitude, as is the case in Use Case 4, some of the subjects perceive this as a further increase in smartness and highlight it positively. However, some statements show that the interviewees have reservations about human-like interactions with devices. After considering the four use cases, respondents also commented on the perceived differences between the applications in terms of language and empathy. Alexa is described as the simplest application, as only predefined commands and responses are included in the feature set.

Another aspect is the discomfort that some subjects experience when talking to a machine. Subjects said they prefer to communicate with a human. While some value the personal exchange with their hairdressers and would not want to miss it, others state a lack of added value from these applications or think it is "... simply a too narrow gauge ..." (M2).

According to the text passages from a total of interviews, the subcategory "personal level undesired" is one of the largest subcategories The text passages, for the most part, refer explicitly to Use Case 4, where the voice assistant proactively calls the user and asks how he is feeling. It turns out that all interviewees reject the personal and emotional level of the DVA because they simply do not want to talk about their personal feelings with an electronic device, as this offers no added value. They recognize as well that the last case shows emotional involvement, although this causes rejection. There seems to be a sense of unease here that uninvolved third parties cannot judge whether they are talking to a human being or a computer. Therefore, it is a clear requirement for them that all stakeholders of DVAs, especially

Level 1-category Definition Anchor example Language/Voice Human-like quality of the language is identified WN2: the more similar it is to a person and how a person thinks, that's s [] speaks like a human being W1: gives more individual answers W1: dv the others, with the human voice, that is somehow another la anguage and then also speaks like a human being, so 'mhm', 'uh', so rela wout finguishing feature for increased smartness WN4: And the others, with the human voice, that is somehow another la absolute increase for me is simply an assistant who lix appointment for you. And then the absolute enhancement for me is simply are admost like a human being, like a personal assistant who lix appointment for you. And then the absolute enhancement for me is simply are admost like a human being [] dv evices the ing more and more toward resembling a human being [] dv evices the ing more and more toward resembling a human being [] dv evices the ing more and more toward resembling a human being [] dv evices the ing more and more toward resembling a human being [] dv evices the ing more and more toward resembling a human being [] dv evices the ing more and more toward resembling a	Table 7 Anthropomorph	ic attributes of DVAs	
Language/Voice Human-like quality of the language is identified WN2: the more similar it is to a person and how a person thinks, that's s Language/Voice Human-like quality of the language is identified WN2: the more similar it is to a person and how a person thinks, that's s Empathy/emotion The emotional, empathic tone is cited as a distinguishing feature for increased smartness inguishing feature for increased smartness tinguishe and the others, with the human voice, that is somehow another le absolute increased smartnes who is already a clear step further, because the computer language and then also speaks like a human being, so 'mhm', 'uh', so relating a language and then also speaks like a human being, so 'mhm', 'uh', so relating anyour feelings a upointment for you. And the others, with the human voice, that is somehow another le absolute enhancement for me is simply an assistant who live appointment for you. And then the absolute enhancement for me is simply an assistant who live appointment for you. And then the absolute enhancement for me is simply an each more toward resembling a human being its negotes the resonal level to be the DVA is the feel, especially with a robot or a computer. I honestly find it strange to its mean	Level 1-category	Definition	Anchor example
Empathy/emotion The emotional, empathic tone is cited as a distribution of the third one is already a clear step further, because the computer inguishing feature for increased smartness WN2: The third one is already a clear step further, because the computer language and then also speaks like a human being, so 'mhm', 'uh', so relaw with the human voice, that is somehow another leaves under leaves the computer increase for me is simply an assistant who already has feelings a your feelings [] WN4: And the others, with the human voice, that is somehow another leaves used smartness WN4: And the others, with the human voice, that is somehow another leaves used smartness WN4: And the others, with the human voice, that is somehow another leaves used smartness WN4: And the others, with the human voice, that is somehow another leaves use in the absolute enhancement for me is simply an assistant who ling a numan being, like a personal assistant who ling more and more toward resembling a human being Personal level undesired Emotional, empathic tone of the DVA is reacted and is identified as an obstacle to how I feel, especially with a robot or a computer. I honestly find it strange its use	Language/Voice	Human-like quality of the language is identified	WN2: the more similar it is to a person and how a person thinks, that's smart [] speaks like a human being W1: gives more individual answers
Personal level undesired Emotional, empathic tone of the DVA is WN2: And the last video I honestly found a bit suspicious. To talk about rejected and is identified as an obstacle to how I feel, especially with a robot or a computer, I honestly find it strange its use	Empathy/emotion	The emotional, empathic tone is cited as a dis- tinguishing feature for increased smartness	WN2: The third one is already a clear step further, because the computer really reacts to the language and then also speaks like a human being, so 'mhm', 'uh', so relaxed somehow WN4: And the others, with the human voice, that is somehow another level. And then the absolute increase for me is simply an assistant who already has feelings and notices or feels your feelings [] WN1:who is almost like a human being, like a personal assistant who lives and makes an appointment for you. And then the absolute enhancement for me is simply an assistant that already has feelings and notices or feels your feelings [] devices that are simply moving more and more toward resembling a human being.
Common and and and and and and and and and an	Personal level undesired	Emotional, empathic tone of the DVA is rejected and is identified as an obstacle to its use	WN2: And the last video I honestly found a bit suspicious. To talk about my emotions and how I feel, especially with a robot or a computer, I honestly find it strange and would be out of the question for me personally

active users, passive users, non-users and manufacturers, abide by a common set of specific rules.

User characteristics and their influence on gradations of PS for DVAs

All interviewees knew already-if only fundamentally-about DVAs as shown in Video 1. None of them knew of a DVA corresponding to Video 4, who calls his user as though he were a friend. The perception of an increasing product smartness from Video 1 to Video 4 is uniform for all interviewees, independent of the person's characteristics. But the personal evaluation of the use cases with respect to the attitude towards the products varied. According to literature, young people are generally more willing to embrace innovation (Yi et al. 2006; Hwang and Nam 2017). In our study, the younger group of non-users has shown a rather negative attitude regarding DVAs: three out of four interviewees stated, that they would not use any of the DVAs shown in the videos. Whereas three out of four interviewees of the older non-user group can imagine using at least the DVA of the first video. A younger age of the consumers does not seem to be a user-characteristic that clearly influences the rating of DVAs. But considering the characteristic user or non-user, users seem to generally be more open to innovative DVAs than non-users. All the user groups would like to have a DVA according to the use cases shown in Videos 1 and 2. Half of them would even like to use the DVAs of Videos 3 or 4. That confirms the findings, that the experience of a user with technology influences the technology usage in the future (Kim and Malhotra 2005; Ma et al. 2014). As Rogers identified, it is also crucial how easily an innovation can be integrated into existing routines or environments (Rogers 2003). Hence, the evaluation of innovative products is an individual, user-specific process. This is also evident from the concerns regarding the "permanent recording of data", which many interviewees describe as the feeling of being under surveillance. Therefore, it can be attributed to the determinant of obtrusiveness identified by Mani and Chouk (2017). One subject, on the other hand, emphasizes that the data recording is absolutely fundamental to the functions of a DVA and is, therefore, acceptable. While the benefits are still defined quite uniformly, the concerns are very individual. In summary, it can be said, that the data recording, the communication with a DVA, especially on an individual level, as well as limited functionalities from a user's point of view, negatively influence the weighing of the advantages and disadvantages. However, no pattern could be identified, linking the views concerning DVAs with specific user characteristics.

Discussion

Summary of the findings

The purpose of the study was to explore the attributes that influence the perception of DVAs and to provide a model for organizing the desired and accepted degree of product smartness (PS) in a DVA. Rather than continuing to search for reasons for acceptance and rejection of technical products, which have been extensively explored in the literature on technical and smart products, our focus is on uncovering the key features that distinguish DVAs from other technical products from the users' perspective and to what extent these contribute to acceptance and rejection. First, there is the increasing degree of autonomy that DVAs enable. This is accompanied by an increase in risks for the user and thus the desire for control over the device. Second, this is the human-like character that appears through the type of language, but also through the content of the speech and the interaction. In other words, the human-like quality is shown through voice (how it is spoken) and interaction (what is said). Overall, we find that the acceptance or rejection of these attributes varies with the degree of smartness of the DVA as illustrated in our framework (Fig. 1).

Table 8 provides a summarized explanation of our model, including an overview of the definitions established, illustrations, and future research approaches. Overall, our conceptualization can serve as a useful foundation for productive further development of DVAs, smart products, and human computer interaction.

We used the findings of previous research on technical and smart products as well as DVAs to approach the question of the attributes that promote or hinder the use of DVAs. In the process of building categories, we identified four main categories under which the attributes can be grouped. In these four categories, gradations of acceptance and rejection can be recognized. The results show that consumers perceive gradations in terms of PS. These are related not only to the degree of automation and the possibility for control by the user, but above all, to the resemblance to human speech and behavior. This perception coincides with the definition from the research, which suggests the attribute autonomy for a goal-oriented action of a device without the user's intervention (Rijsdijk and Hultink 2009). Automation, on the other hand, we defined as actions taken by systems within a predefined framework or input by the user. The added value of autonomy is recognized by the subjects interviewed. Many refer to the support of DVAs concerning smaller, everyday tasks. In their study in smart products, Rijsdijk and Hultink (2003) delimit three different levels of autonomy. Our use cases show that the range of autonomy is larger when a DVA steers multiple other devices. The inclusion of the attribute control is important in the context of autonomy. The proactivity of a DVA distinguishes itself as the highest expression of autonomy. In a study in the B2B area by Wünderlich et al. (2013), the rejection of autonomous processes is attributed to the lack of observability of the processes taking place and, thus, to the feeling of a lack of control. Among others, the fear of technical malfunctioning increases with autonomy (Rijsdijk and Hultink 2003). While the degree of autonomy is more clearly limited in the industrial context (Gronau 2016), it is less clear in private use, at least from the consumer's perspective. An ideal degree of autonomy that supports the users in the best possible way without overburdening them technically still needs to be defined. Our model describes four levels that result from the presented use cases. It may be possible to identify finer gradations in further developed applications. Finally, our research addresses the application of DVAs in a domestic or household context. Further applications are conceivable, e.g., in augmented and virtual realities up to a future meta-world in which DVAs appear as and act on behalf of their users.

Table 8 Summary of main categories	(Level 2), definitions, illustration and potent	tial research questions	
Level 2 category	Definition	Illustration	Potential research questions
Automatization/autonomy of activity	Automatization: recurring processes taken over by the system are based on predefined tasks and firmly defined rules and regulations or input of users; autonomy: extent to which a product is able to operate in an independent and goal-directed way without interference of the user	Level 1: assisted, supportive decision- making Level 2: partial, verified decision Level 3: delegated decision Level 4: autonomous decision	What will be an optimum degree of autonomy? Will technical developments allow finer gradations? How will technical developments extend the framework e.g. the degree of smart- ness and attributes? How do users respond in use scenarios
User control/system control	Degree to which either the user or the system can control risks that are associ- ated with DVAs (malfunction, hacking, disempowerment) and privacy (data collection, use and transfer)	Level 1: decisions made and data used based on inputs from user Level 2: limited flexibility according to user preferences Level 3: system collects data and acts within defined limits Level 4: system collects data and acts freely	outside of their homes? Will possibilities to control lead to greater trust and confidence? Will increased control perhaps lead to an overload of choices, thus causing less control or avoidance due to rising complexity? How to avoid an overload of decisions users have to make? Should users be informed when they are being monitored and data are being col- lected?
Similarity to humans	Anthropomorphism: tendency to attribute l	numan characteristics to inanimate objects	

Table 8 (continued)			
Level 2 category	Definition	Illustration	Potential research questions
Language/voice	Artificial, synthetic voice without ability	Level 1: synthetic voice, limited sentences	How will different voices appeal to users?
	to express emotion (text-to speech) or modulation in contrast to human voice that has multiple options to adapt	Level 2: synthetic voice, making sugges- tions on limited sentences, variance possible	Should there be a choice, e.g., female or male voice?
		Level 3: human voice, free dialogue	Should voice adapt to the user's mood?
		Level 4: human voice, free, mood adjusted dialogue, dialect, slang or col- loquial speech	To what extent should the DVA understand dialects?
Interaction	Degree of intuitiveness and respon- siveness in the dialogue; degree of adaptation to emotions (e.g., fear, anger,	Level 1: rational, fact-based answers to questions and commands	How to conceptualize and measure personal/emotional interaction between humans and DVAs?
	sadness, happiness)	Level 2: suggestions within a limited framework	When should DVAs try to address users' emotions and when should they be strictly task-specific?
		Level 3: performs actions and responds in a friendly manner	Which emotions are accepted in human- DVA interaction?
		Level 4: shows compassion and empathy	What emotions shown by the DVA cause strong rejection?
			How can the DVAs speech rate, pitch- average,—range and—changes, intensity, and/or voice quality be used to express which type of emotions?

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The second main category that appeared was control. Users do seek control over a number of aspects that have been identified in previous research. Heiskanen et al. (2007) identified external control as a risk factor from the user's point of view in a study on personalized diets controlled by a smart device. Missing control of data collection and data use was an important aspect that strengthened the rejection of smart watches in the study by Mani and Chouk (2017). Respondents feared a type of Big Brother effect, which was caused by the recording and possible evaluation, especially with regard to personal data (Mani and Chouk 2017). The interviewees in our research perceive a number of risks in using DVAs. These range from malfunction, to misuse, criminal offenses, disempowerment, and often to data collection and transfer. Technical developments and future research should address how to enable this control to increase trust in DVAs without overwhelming the user with a plethora of choices and settings.

For many subjects, the similarity of a DVA to a human being is indicative of their smartness, which is why this factor must be included in the differentiation of individual gradations. This attribute was already identified by Rijsdijk et al. (2007) but not studied in its various forms. Some subjects find differences in the human similarity of DVAs. The similarity to humans is referred to as anthropomorphism, which is the tendency to attribute human characteristics to inanimate objects. A distinction is made between the speech or voice of the DVA and the content of the speech that leads to the interaction. In its simplest form, the voice of the DVA is artificial and synthetic and cannot express emotion. In a more advanced form, it is indistinguishable from a human voice because of its modulation and multiple adaptations. Interaction refers to the degree of intuitiveness and responsiveness in dialogue and the degree of adaptation to emotions such as fear, anger, sadness, or joy. The first use case with Alexa is seen as more technical, as the DVA offers simple, supportive activities. The increase of PS is shown through personal assistance functions, as in Use Case 3, and, to a personal emotional level, as in Use Case 4, where the user is supported by referrals with a clear focus on a friendship-like interaction. The emotional level is perceived as more human-like than the technical level. As a result, it can be concluded that a DVA showing emotion and solicitude is perceived to be smarter. In previous expert interviews, human-like interaction was seen as a moderately important variable for the intelligence of a product (Rijsdijk et al. 2007). The authors conclude that the human-like interactions of smart products meet the needs of users, in as much as they match existing values and behaviors (Rijsdijk et al. 2007). Although the empathy of a product, e.g., acting similar to a human being was perceived to have been only moderately decisive in the previous research (Rijsdijk et al. 2007), this attribute has been rated in our in-depth interviews as indicative of the smartness of DVAs. It might be interesting for developers to test whether different voices (e.g., male, female) appeal to different users and whether users should be given a choice. There is also the question of whether and to what extent different moods or states of mind should be taken into account. Finally, further attributes are conceivable, e.g., by the DVA taking on a human figure (augmented reality) expressing facial expressions and gestures, among other things. Emotions in human-computer interaction especially in voice-based interaction will a growing area of interest for science and practice (Klie 2021).

Arrows in Fig. 1 indicate the likely evolution of the framework in the future, e.g., in terms of autonomy and other attributes, as DVAs are increasingly used outside the home environment. A further attribute would be conceivable if the DVA, for instance, took on a human form, e.g., as an avatar or robot. Anthropomorphic virtual shopping assistants have already been proposed to enhance the in-store shopping experience for customers (Corvello et al. 2011). The extent to which highly human-like robots elicit positive responses has not been fully researched. Some studies suggest that a higher degree of similarity to a real human figure does not necessarily lead to higher user acceptance (Mori 1970; Groom et al. 2009).

Consumer experience with AI was presented in a concept paper by Puntoni et al. (2021). They show four types of consumer experiences and the resulting psychological tensions that arise for consumers. The tensions they describe became apparent in many of our interviews. Further fields of experience (unchartered experience) are expected, which cannot yet be described in concrete terms due to ongoing developments. A fundamental assumption of our work is that AI and its applications will continue to evolve. We fundamentally believe that this technology has the potential to improve people's lives. It is up to us, developers, researchers and regulators, to shape this development. In summary, the attributes of the autonomy of actions, control over decisions, human-like voice and speech, as well as empathetic, emotional behavior emerge as attributes for the gradations of smartness of DVAs. The individual attributes can exist in different forms. From the interview results presented above, we assume a polarity behind the respective attributes. Thus, the attributes can be contrasted, and based on our use cases, result in four gradations of the PS of a DVA. We contribute to the existing literature with a graduated framework, organizing the accepted and desired degree of smartness for DVAs. Our framework of gradations of DVAs shows an advanced application of AI from left to right at each stage. The subjects respond differently to the stages of development of DVAs, however, resulting in the appearance of red lines for applications that are technically feasible but-at least currently-rejected. Rejection relates to the device's autonomous decision making, privacy control capabilities, and a friendlike interaction with the DVA. Future research should quantitatively investigate the relationships between user profiles and acceptance. For designers, the model provides guidance for offering users customized settings for DVAs according to their preferences.

While the fourth application example with the voice assistant Xiaoice has been met with rejection by the people interviewed in this study, this voice assistant is already actively used by more than 40 million consumers in the Asian market (Dawar and Bendele 2018). In times of social distancing, as in the current corona pandemic, such applications can help people to overcome feelings of loneliness, at least temporarily, and contribute to relieving the capacity of telephone counseling services. Finally, clear communication regarding the handling and storage of the data collected by the digital assistant can reduce the barriers and perceived risks for potential users.

Limitations and implications for future research

Our study is not without limitations. The study sample is based on users and nonusers in Germany. Technology use is a context-dependent phenomenon; how individuals define smartness and how they respond to it may vary depending on the context. Therefore, future researchers should investigate the extent to which the study's findings can be generalized to other contexts, i.e., other countries. Another limitation relates to the qualitative nature of the study, which is based on interviews with users and non-users. Designers, based on their technical expertise, may develop a finer gradation of DVAs than the one based on the use cases discussed here with users/non-users. Therefore, a further step would be to extend the model to include the viewpoint of designers. However, the extent and consistency of the results cannot be verified due to the qualitative approach of this study. This is a limitation of our random sample. Quantitative studies that verify these thresholds with statistical representativeness are recommended. In addition, the personal characteristics of respondents should be examined in relation to PS traits, as this may reveal patterns of acceptance and rejection of personality traits. This would allow DVA manufacturers to discuss what level of smartness is acceptable to their target audience. Further studies should focus on the psychological barriers and the values of users for identifying characteristics that influence the gradation of PS of DVAs. Finally, longitudinal studies could show how demonstrated rejection changes over time.

Implications for practice

It is important for companies to understand the changing living environments of their consumers (Rijsdijk et al. 2007). AI systems will increasingly be able to take over the everyday tasks of humans and, therefore, change user behaviors. Manufacturers of DVAs need to understand the expectations and reservations of users to be able to develop products according to users' needs and wants (Stephen 2017). As a perceived risk with DVAs, the subjects mentioned topics relating to the handling of their data. The interviews showed that the handling of user data, e.g., the recording, storage and general security, by DVAs is an important factor, and the need for control and transparency becomes evident. It is important for companies to acknowledge this in their development and marketing of DVAs. Brill et al. (2019) showed that meeting the expectations of consumers has a positive and important impact on customer satisfaction with digital assistants. They suggest that "firms must help customers properly define what to expect from the firm's interactive experience". Our work will support companies in doing so with a graduated framework according to the desired and accepted degree of smartness of DVAs. With regard to the expression of the individual differences, there is certainly a connection with the refusal of a DVA. However, this is not a uniform pattern among all respondents. While some respondents argue against an elevated degree of autonomy, others see the proactivity of a DVA as its main advantage. The personal emotional level leads to rejection among many of the subjects. This implies that the degree of expression within the

four categories of PS for DVAs allows conclusions to be drawn as to when a DVA will be accepted or rejected by certain consumer groups. This degree is marked as red strokes within the framework, as the product characteristics on the right side of the respective marker lead to the rejection of the DVA.

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