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Smart Speaker Data Donations in Families: The Project Rosie Perspective

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ABSTRACT

Today, many families are finding themselves with the option to have their very own assistant at home in the form of a smart speaker. To meet the growing scientific need to better understand how families with young children use these devices at home, we showcase ongoing work that proposes a revised conceptualization of families' smart speaker use based on three important dimensions: how often the smart speaker is used (i.e., frequency), for what it is used (i.e., purpose), and by whom it is used (i.e., form) – so by the parent, the child, or by both together. For the assessment of families' smart speaker use, we combine self-reports of 400 Dutch parents with data donations of their smart speaker log-histories. With this, we not only test for the feasibility of this novel approach under the framework of the GDPR in the EU, but to also draw methodological conclusions about the alignment between self-reported and observed measures of smart speaker use. In addition, we offer an updated typology of different use-patterns across families that can further aid the study of predictors, conditions, and consequences of smart speaker use. Learning from first pilot data and the challenges we have faced, we offer preliminary conclusions and provide suggestions for future work.

CCS CONCEPTS

• **Security and privacy** → Human and societal aspects of security and privacy; Social aspects of security and privacy; • **Hardware** → Emerging technologies; Analysis and design of emerging devices and systems; Emerging tools and methodologies; • **Social and professional topics** → User characteristics.

KEYWORDS

smart speaker, data donations, ethics, children, families

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1 INTRODUCTION

In 1962, Hanna-Barbera Productions released an animated sitcom in the United States called 'The Jetsons', which followed a family relying on whimsical inventions to go about daily life [16]. A key character was Rosie: a robotic maid that did daily housework, child-rearing, and that provided the family various means for entertainment. She was, by all accounts, a member of the family. Now, about 60 years later, many families are finding themselves with the option to have their very own assistant – at least a basic one – in the form of a smart speaker. Smart speakers, such as the Google Home or Alexa Echo, are wireless devices with an integrated speaker and microphone that make use of Virtual Assistant (VA) technology. This technology relies on Artificial Intelligence (AI) to understand voice commands and carry out tasks for users [12], like playing music, reporting about the news, and controlling other smart appliances. Over the last years, the popularity of such devices has strongly risen, and interestingly, it seems that the presence of children in households has further accelerated their growth [21, 25].

Media use in families is known to impact children's further upbringing and development [1, 11, 22]. Thus, knowledge about concrete media-use-practices in families can aid empirical investigations on possible long-term effects – positive and negative. Therefore, parallel to the rising popularity of smart speakers, the need to scientifically understand how families use them at home increases. Existing research on this matter makes clear, that smart speaker use in families is a rather complex construct [9, 24], as it comprises three crucial dimensions: how often the smart speaker is used (i.e., frequency), for what it is used (i.e., purpose), and by whom it is used (i.e., form).

To measure these dimensions, existing scholarship on the one hand has previously relied on traditional self-report measures [13, 15, 24]. On the other hand, a handful of studies have started to make use of the unique advantage of smart speakers, namely using

them not only as the object of study, but also as a means for collecting data [10]. Since providers (e.g., Google, Amazon) are obligated to share with users what data are being stored about them, users can download these data and donate them to researchers, which can strengthen ecological validity of empirical findings [18]. Having said that, both methodological approaches still face several challenges: Survey studies lack specificity in the three use-dimensions and pose the risk for biases due to subjective reporting. Data donation studies depend on how the use-data are coded and where these data are being collected as different data protection regulations might apply (e.g., U.S. versus EU) [17, 26].

To address these challenges, we showcase ongoing work of a larger Dutch research project called 'Project Rosie' [23]. We propose a more comprehensive conceptualization and assessment of families' smart speaker use by combining self-reports with data donations in the EU-context. Learning from first pilot data of households with a smart speaker that uses Google Assistant, we offer preliminary conclusions about comparisons of the different use-assessments, and provide suggestions for future work also in terms of data-protection challenges.

2 LITERATURE REVIEW

The existing body of literature on the implementation of smart speakers in (family) households so far counts a handful of data donation studies that investigate concrete smart speaker use over time. Bentley et al. [4] analyzed donated data of 88 U.S. households with a Google Assistant and found four use-types, i.e., super users, explorers, medium users, and light users. Those use-types differed in how frequently users interact with their device and in the number of different purposes they use the device for. While this offers first insights into different use-patterns, the typology applies to households that not necessarily include children, it does not further specify between use-purposes, and has not been replicated on a sample outside the U.S.

Investigating more nuances regarding what smart speakers are used for and by whom, Garg and Sengupta [9] found in a data donation study of 18 U.S. family households with a Google Home that adults predominantly use the smart speaker for assistance (e.g., controlling connected household devices or setting timers) and entertainment purposes (e.g., playing music). Another donation study of ten U.S. families using Alexa Echo adds information seeking as a third popular category for adults [3]. While children's smart speaker-use mostly aligns with entertainment-driven and information-seeking usage, another popular use-purpose for them seems to be (emotional) small talk with the device [9] – something that adult users engage much less in. They, in turn, are more likely to use other communication features, like issuing a call, sending a message, or talking to other people at home through the intercom function (in case multiple devices exist in a household) [6]. Finally, Beneteau et al. [3] show that the number of times parents use the device tends to be overall higher than for children across different use-purposes (i.e., assistance, entertainment, information seeking). However, given that a smart speaker allows for interaction by multiple people individually as well as collectively, children and their caretakers have the possibility to also use the smart speaker together, for example to learn from each other or to enjoy moments of

joint entertainment [8, 19]. Previous cross-sectional survey results corroborate this prevalence of adult usage and the common form of co-usage in families [25].

Altogether, this means smart speaker use in families can be conceptualized along three dimensions, which can be defined as follows: Frequency of smart speaker use, which relates to how often the device is used for interactions and tasks. Purpose of smart speaker use, which refers to the type of interaction and task that the device is used for. Here, scholarship distinguishes between assistance, entertainment, information seeking, and communication as four main purposes. Lastly, form of use, which refers to the concrete user of each interaction, so in the case of families whether the parent or child individually used the device, or whether they used it together as a form of co-use. From a methodological standpoint, traditional empirical designs, such as quantitative measures in surveys or qualitative data gathered through interviews, have focused on measurements of use-frequency [13, 15] and use-form [24], as well as on more elaborate explanations of smart speaker use-purposes [6] separately. No study thus far has integrated all three dimensions of smart speaker use in one investigation. Furthermore, while a more comprehensive assessment of the three use-dimensions has found first application in existing data donation studies as outlined above, the body of literature using such designs is clearly dominated by U.S. samples. While this might be logical given that the majority of smart speaker products and services originates in the Anglo-American context, it leaves us with the question whether similar data donation designs are also feasible within the European Union where different and often stricter regulatory frameworks exist regarding the collection and processing of personal data (e.g., the General Data Protection Regulation (GDPR) (Zaem and Barber, 2021).

Hence, our first aim is to see whether all three use-dimensions can be assessed through self-reports and data donations from a non U.S. family sample. We take Dutch families as a case example here given recent adoption rates observed in the Netherlands that resemble numbers in the U.S. [25]. In addition, given the lack of evidence as to whether self-reported smart speaker use aligns with observed smart speaker use, we test for differences between survey-measures and data donations within families. Our final aim is to update the smart speaker-use types by Bentley et al. [4] with our Dutch sample by considering all three dimensions of smart speaker use for the typology. We ask:

RQ1: To what extent is it feasible to collect data on all three dimensions of families' smart speaker use (i.e., frequency, purpose, form) through self-reports and data donations in the Netherlands, and to what extent do these measures align within families?

RQ2: What different smart speaker use-types can be distinguished across Dutch families and to what extent do they differ from previously established types?

3 STUDY DESIGN

Self-reports of parents are collected through an online survey created in Qualtrics. For the data donations, we use a retrospective user-centric approach [18], asking parents to donate the past log-histories of their families' device use. To facilitate these donations, we use Port – an open-source infrastructure that enables a secure

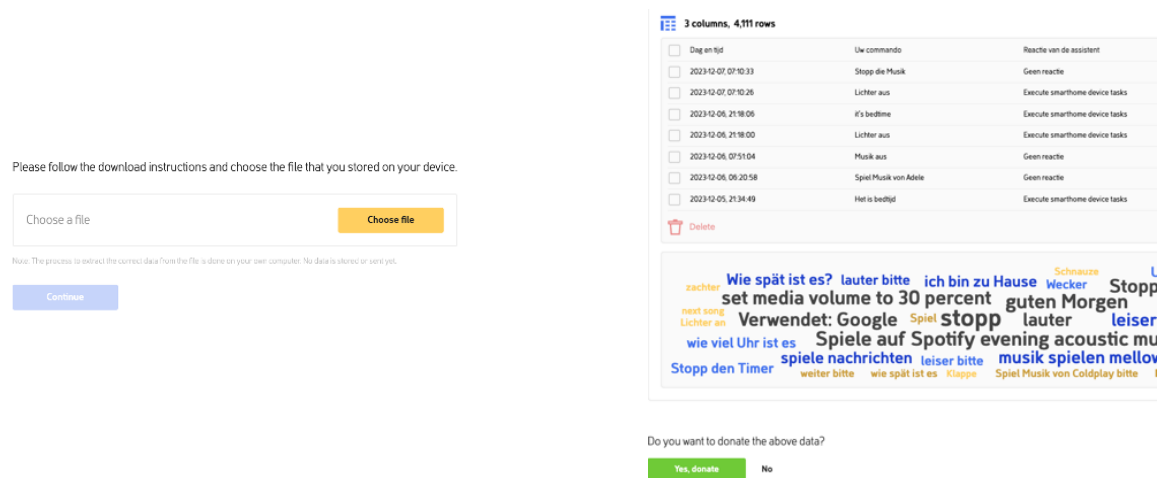


Figure 1: Screenshot of Port interface for uploading data to the data donation platform (left), and inspecting, editing, and donating the data (right) with pilot data

transport of sensitive donated data from participants to researchers in the EU (<https://datadonation.eu/>) [5]. Further information about our accompanying study materials can be found on OSF (https://osf.io/hy3mj/?view_only=ff31c8186c6d4fdc9d19ccd83fd03772).

3.1 Participants

Our sample is comprised of Dutch families with children between the ages of 3-8 years due to the noted influence of parents on young children’s interaction with technology [14, 24]. We recruit families that have possessed at least one Google Assistant-powered smart speaker for at least six months prior to our study so that we can draw more robust conclusions about their usage [2, 7, 8, 20]. Every participating family is represented by one parent/caretaker. Based on an a-priori power analysis for the comparison of means and the generation of a typology we aim to collect $N = 400$ self-reports in collaboration with a Dutch panel company (i.e., Motivaction). From this self-report sample, we expect about 10-20% ($N = 40-80$) to also participate in the data donation. This aligns with the data donation samples we have seen in previous studies (i.e., 10-88 households).

3.2 Procedure

First, parents are asked for their consent to the survey, which consists of a ten-minute questionnaire about characteristics of them and their household, and their subjective perception of their families’ smart speaker use. At the end of the survey, we explain the second part of the study – the data donation – and ask parents again for their consent (based on the legal basis of public interest following the GDPR). After receiving the link to the data donation portal, they are guided in how to obtain their data from Google, how to locally upload their data to the data donation platform, and how to inspect, edit, and then eventually donate their data (Figure 1). In case of (technical) issues or questions parents can consult a helpdesk. In the last step of the data donation, they can view their smart speaker data showing the *day and time* of every registered *command* as well as the *reaction of the device*. In addition, they see

a word cloud of their most frequently used commands, which is meant to help them understand better what they have been saying the most to their device. Finally, they are asked to decide whether to donate (parts of) their data. We hereby ask for the donation of at least the past six months; participants can choose to donate data from beyond that time-frame. Our study concludes with asking those who donated to what extent they recognized the data as belonging to their family for a validation check. Those who decided not to donate their data, we ask to explain their reasoning. These questions are optional.

3.3 Measures

In the survey, we ask parents to indicate how frequently in the past six months the parent, the child, and the parent and child together (co-usage) has/have used the device on average. Since we ask this question for each of the four use-purposes, we end up with twelve variables (1 frequency x 3 forms x 4 purposes; see Figure 2). From these variables, we can further calculate aggregates of (a) the total use-frequency per family, (b) the frequency per use-purpose per family, and (c) the frequency per use-form per family.

As an example, Table 1 shows all the styles available in this template, to be applied to the respective element of your text. From the data donations we derive use-frequency based on the time column and total number of donated interactions (i.e., rows) per family. We calculate respective averages per day, week, and month for each family and categorize their use-frequency along the 6-point scale used in the survey to align levels of both measurements. Use-purpose we infer from the command column by string matching the transcripts of commands with words most indicative of the four purpose categories [3, 4]. Commands that initially do not match any category are temporarily categorized as ‘other’ and later manually assigned. If a command is not conclusive, we use additional information, if available, from the reaction of the device. Upon full categorization, we obtain the average frequency per purpose per

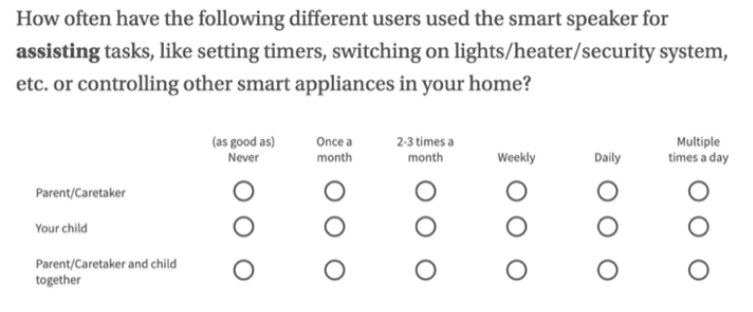


Figure 2: Example measure of families’ smart speaker use for assisting tasks; the same measure is used for each of the four use-purposes

family and again categorize those frequencies along the 6-point survey scale.

3.4 Analyses and preliminary conclusions

Our first research question asked to what extent it is feasible to collect data on all three dimensions of families’ smart speaker use (i.e., frequency, purpose, form) through self-reports and data donations in the Netherlands, and to what extent these measures align within families. Based on a first pilot with donations of three households with as smart speaker using Google Assistant, we see that we are unable to robustly infer the third dimension, *use-form*, since neither the details about time, nor those of the command, or the reaction of the device provide reliable information as to who used the smart speaker. In previous studies, this was either obtained from additional donated details such as specific user- and or device-name, or from original audio recordings (e.g., 3). However, due to privacy regulations in the EU, collection of these data was not permitted by our university’s ethics committee. See Table 1 for an overview of the dimensions, their definitions, and assessments.

In order to investigate whether self-reported and observed smart-speaker use align, we compare smart speaker use-frequency and -purpose that we obtain through the data donations with the respective self-reports from the survey using paired t-tests with Bonferroni correction.

Our second research question asked what different smart speaker use-types can be distinguished across Dutch families and to what extent they differ from previously established types. To answer this question, we obtain descriptives for all our twelve use-variables from the survey (i.e., means, standard deviations) as well as averages of the aggregated use-frequency per family, frequency per use-purpose per family, and frequency per use-form per family. We proceed with updating Bentley et al. [4]’s typology using Latent Class Analysis (LCA) on all twelve use-variables captured in the self-reports. LCA allows us to detect similar use-patterns across families and differentiate between different sub-groups. These analyses will be finalized once data collection is completed, which is expected for the end of May 2024.

4 FUTURE WORK

This study is the first in the EU-context that uses a combined approach of survey measures and data donations for the investigation

of smart speaker use in families. Preliminary insights from our ongoing work suggest hereby that data donation designs, especially when including data from minors, can be limited by privacy regulations and ethical guidelines of institutions. In our case, it meant that we could not collect robust information about who specifically used the smart speaker. This information is therefore only available through our survey data, which has consequences for our methodological comparison. Further, we want to note that data donation approaches require additional technical skills (i.e., Python skills and application testing) and legal resources (i.e., setting up privacy agreements) compared to traditional survey methods. Hereby, researchers should particularly account for heightened sensitivity of stakeholders, such as ethical review boards, legal support, or panel companies, that might meet this research design with an extra cautious attitude. Eventually, it is about finding a balance between researching novel technologies with cutting-edge research methods and safeguarding the protection of participants and researchers’ scientific integrity.

Once completed, our work can further aid scholarship on families’ smart speaker practices, as it builds ground for follow-up investigations looking into predictors of smart speaker use (e.g., digital literacy, privacy concerns), as well as conditional factors (e.g., parental media-mediation) and consequences of it (e.g., family dynamics, children’s relationship formation with the assistant). These empirical insights will become meaningful for further shaping technological development and for empowering families so that smart speakers remain at the service for them. Next to this, cross-cultural investigations can be a fruitful addition to determine the extent to which observed patterns of smart speaker use are specific to the Dutch context or rather represent broader trends. Whatever the focus may be, we hereby encourage researchers to make use of Open Science principles along the way to learn from experiences of others and share – where possible – insights, materials, and further recommendations with the community.

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Table 1: Conceptualization and assessment of the three smart speaker use-dimensions in the survey and data donation

Smart speaker use-dimension	Definition	Assessment in survey	Assessment in data donation
Frequency	How often the device is used for interactions and tasks	six-point scale (see Figure 2)	Obtained via the total number of registered commands and respective averages calculated per month, week, day
Purpose	The type of interaction and task that the device is used for:	six-point scale per each of the four purposes (see Figure 2)	Obtained by categorizing each transcribed command along the four purposes of assistance, entertainment, information, and communication via automated string matching and manual categorization
<i>Assistance</i>	e.g., controlling lights, setting timer, etc.		
<i>Entertainment</i>	e.g., playing music, telling jokes, stories, etc.		
<i>Information</i>	e.g., asking for the time, news, weather, etc.		
<i>Communication</i>	e.g., calling, sending message, small-talk, intercom, etc.		
Form	The concrete user of each interaction	six-point scale with three items reflecting the three use-forms (see Figure 2)	Not obtainable due to ethical regulations
<i>Parent use</i>	by the parent individually		
<i>Child use</i>	by the child individually		
<i>Co-use</i>	By the parent and child together		

data donation portal and guiding us through the legal and ethical process.

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