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User Perspective on Anonymity in Voice Assistants – A comparison between Germany and Finland

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Abstract

This study investigates the growing importance of voice assistants, particularly focusing on their usage patterns and associated user characteristics, trust perceptions and concerns about data security. While previous research has identified correlations between the use of voice assistants and trust in these technologies, as well as data security concerns, little evidence exists regarding the relationship between individual user traits and perceived trust and security concerns. The study design involves surveying various user attributes, including technical proficiency, personality traits, and experience with digital technologies, alongside attitudes toward and usage of voice assistants. A comparison between Germany and Finland is conducted to explore potential cultural differences. The findings aim to inform strategies for enhancing voice assistant acceptance, including the implementation of anonymization methods.

Keywords: Voice Assistants, Trust, Privacy Concerns, Technology Commitment

1. Introduction

Voice assistants have become integral to our daily lives, particularly in commercial contexts, garnering a substantial user base (Kinsella, 2020; Kleinberg, 2018; Osborne, 2016). Their simplicity and natural communication style, without the need for additional peripherals, have contributed to their widespread adoption. However, as they infiltrate sensitive domains, socio-ethical considerations regarding their use are gaining prominence.

Despite their increasing popularity, concerns persist regarding the privacy of user input data, particularly speech data stored and processed on cloud platforms (Krüger and Siegert, 2020; Leschanowsky et al., 2023). This skepticism, stemming from fears of potential misuse for unauthorized purposes, is impeding the widespread adoption of voice assistants in public and healthcare interactions (Wienrich et al., 2021).

Despite the growing availability of speech-based technology, a significant portion of the population either uses these technologies minimally or not at all. The reasons behind this discrepancy remain unclear, leading many studies to simply categorize individuals as either users or non-users (Sinha et al., 2022). Moreover, a 2019 study revealed a rapid increase in the proportion of non-users of voice assistants in Germany over a two-year period, with privacy concerns identified as a major factor for non-usage (Splendid Research GmbH, Januar 2019).

To comprehensively understand the factors influencing both usage and non-usage, it is imperative to examine the perspectives of both users and non-users. While existing research often cites a lack of trust in voice assistants or the companies behind them, a deeper exploration into how users and non-users perceive and rationalize their mistrust, their views on speaker anonymization, and the factors influencing their attitudes and behaviors remains largely unexplored.

Several studies have linked the non-usage of voice assistants to issues of trust and privacy/data security concerns (Olson and Kemery, 2019; Brill et al., 2019; Dhagarra et al., 2020; Vimalkumar et al., 2021). A more recent survey by Bitkom in Germany highlighted data security as the primary concern among participants, with 59% expressing worry over their data, 53% fearing eavesdropping by third parties, and 35% being reluctant to transmit background speech over the internet (Bitkom, 2022). Despite these apprehensions, the survey also revealed a general willingness to utilize voice assistants, with only 22% of participants expressing reluctance to control devices via voice commands.

However, a nuanced understanding of why some individuals harbour data security concerns while others do not remain elusive. Nonetheless, existing research underscores the positive impact of perceived usefulness and competence on trust and attitudes toward voice assistants (Pitardi and Marriott, 2021). Hereby, most studies do not differentiate between mobile and stationary systems. But, distinguishing between stationary and mobile Voice User Interfaces (VUIs) is essential due to the differing contexts and usage patterns associated with each platform. Stationary VUIs, such as smart speakers, are typically used in fixed locations within homes or workplaces, providing hands-free access to in-

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formation and services. In contrast, mobile VUIs, integrated into smartphones or wearable devices, offer on-the-go access to voice-activated features, enabling seamless interaction while moving. Consequently, the current study intentionally makes this differentiation.

As part of this discussion, a study conducted in early 2023 specifically investigated individual reasons for the use and non-use of voice-assisted technologies in Germany by surveying both users and non-users. The study also examined whether anonymizing user information and speech input helps reduce barriers towards voice assistants (Haase et al., 2023). The current paper aims to explore whether and how there are differences in response behaviour among two selected European countries. For comparison, Finland was chosen as it shares the same legal framework (data protection, AI regulation) as an EU country but has a significantly higher level of digitization than Germany. According to the Digital Economy and Society Index (DESI), which tracks the progress of EU member states in four key areas including human capital, connectivity, integration of digital technology, and digital public services, Finland has a digitization index of 69.6 (1st place), whereas Germany, ranked 13th, has an index of only 52.88 (European Commission, 2022).

The aim of this study is to increase the understanding of individual reasons for the use and non-use of voice-assisted technologies by surveying users and non-users and whether anonymization of user's information and speech input helps to reduce restraints towards voice assistants. Hereby, the use and non-use of VUIs in a stationary and mobile scenario will be analyzed between the participants from Germany and Finland.

2. Methods

The study employs a data collection method similar to that of (Haase et al., 2023) for the initial step. It investigates the relationships between attitudes toward voice assistants (distinguishing mobile and stationary systems), technology commitment (including acceptance, competence, and control beliefs), individual personality traits, and actual usage or non-usage. To achieve this, data is gathered through an online survey questionnaire.

Utilizing quantitative methods, the research design focuses on analyzing correlations between different user variables and the adoption or rejection of voice assistants.

Recruitment: Both surveys aimed to gather a diverse sample in terms of age (spanning from 18 to 81) and gender. Additionally, they collected information on participants' education level, technology usage, and familiarity with modern information and communication technologies.

The recruitment for the German survey was carried out by students from the Human-Technology Interaction and Rehabilitation Psychology programs at the University of Applied Sciences Magdeburg-Stendal, as well as through various mailing lists managed by the researchers. Utilizing the snowball method, the students encouraged others, peers, friends, and family members, to participate in the survey. The first part of data collection took place from January 16 to January 29, 2023. For the Finnish survey, recruitment was conducted by the first and second authors through mailing lists, social media post by the city of Espoo and LinkedIn posts. The second part of data collection started on October 10, 2023, and was terminated on March 10, 2024.

Survey and evaluation methods: The survey was conducted using the SoSci survey platform hosted at Otto von Guericke University, Magdeburg (Leiner, 2019). This platform ensures end-to-end SSL encryption and secure data storage. Servers are located in a certified and secured data center in Germany, adhering to the General Data Protection Regulation (GDPR). The Ethics Committee of the Department of Applied Human Sciences at Magdeburg University of Applied Sciences approved the Germon version of the study. The Finnish counterpart survey was approved by the research ethics committee at Aalto University. Participants provided informed consent, acknowledging the study's objectives, voluntary participation, right to withdraw, and their rights under the GDPR.

Survey content: Both surveys covered sociodemographic variables, Big-Five personality dimensions (BFI-L) (Rammstedt and John, 2005), current technology usage, and perceived hedonic and utilitarian benefits, trust in voice assistants and general privacy concerns were included. Table 1 gives an overview of both survey contents. For most items, the same (English) questionnaires as those used in the German study were employed. However, in the sociodemographic variables, the question regarding educational attainment was adapted to the Finnish system. Since there is no translated and validated version or anything comparable for the construct of technology readiness, we have opted to use the Affinity for Technology Interaction (ATI) Scale for the Finnish questionnaire instead of the Technology Commitment (Neyer et al., 2012). Consequently, the areas of experiencing technology competence and technology control experience are unfortunately omitted. For all other scales, we refer the reader to the paper on the German study (Haase et al., 2023). In total, the

Table 1: Overview of the different instruments of the survey, differences to the German questionnaire apart from language are highlighted. Details can be found in the text. The last row denotes whether the instrument is used for the (G)erman and/or (F)innish questionnaire.

Section	# Items	Content	Reference	
Sociodemographic Variables	5	age, gender, education degree, current employment, place of residence	–	G,F
Big-Five Personality	21	Short version of the Big-Five Inventory (BFI-K)	(Rammstedt and John, 2005)	G,F
Technology Commitment	12	Brief Measure of Technology Commitment Commitment	(Neyer et al., 2012)	G
Affinity for Technology Interaction	9	Just measures the technological affinity	(Franke et al., 2019)	F
Technology Usage	6	computer/smartphone usage per week, use of voice assistants, frequency of use	–	G,F
Hedonic and Utilitarian Benefits	5	Hedonic (enjoyment, entertainment value, fun in accomplishing tasks) Utilitarian (convenience in organizing time, facilitation of tasks)	(McLean and Osei-Frimpong, 2019)	G,F
Trust	3	truthfulness of statements, trustworthiness, trust in developing companies	(Pitardi and Marriott, 2021; Olson and Kemery, 2019)	G,F
Privacy concerns	5	confidentiality doubts, hesitations about conducting transactions via voice assistants, worries about personal data storage, and reluctance to share personal information	(Pitardi and Marriott, 2021; Olson and Kemery, 2019)	G,F

German questionnaire comprises 57 items and the Finnish survey covered 54 items, due to the different questionnaires regarding technology experience, Technology Commitment vs. Affinity for Technology Interaction.

Hypotheses and Analysis: Both questionnaires are analyzed based on the following hypotheses, with each device type tested independently:

Trust & Concerns Regarding Privacy

H1 Individuals with lower trust in VUIs use them to a lesser extent than those with higher trust.

H2 Individuals with stronger privacy concerns use VUIs to a lesser extent.

Hedonic & Utilitarian Benefits

H3 Individuals who perceive lower utilitarian benefits from VUIs also use them to a lesser extent.

H4 Individuals who experience lower hedonic pleasure in using VUIs also use them to a lesser extent.

Relationship between Trust, Provacy & Hedonic, Utilitarian Benefits

H5 There is a relationship between perceived hedonic and utilitarian benefits and trust in VUIs.

H6 There is a relationship between perceived hedonic and utilitarian benefits and concerns regarding privacy with respect to VUIs.

Technology Readiness & Technological Experience

H7 Individuals who report overall lower technology readiness use VUIs to a lesser extent.

Personality

H8 Statistical correlations can be found between the Big Five dimensions of Neuroticism, Conscientiousness, Openness, and VUI usage.

For data analysis, SPSS 29 was utilized. Hypotheses 1 to 4 were tested using a point-biserial correlation, given that usage vs. non-usage represents a dichotomous variable. Hypotheses 5 to 8 were examined using a Spearman correlation, as the variables under consideration are each regarded as interval-scaled.

3. Sample Description

A total of 581 people finished the German survey and 46 people finished the Finish survey.

Not surprising, the average age of the participants is relatively young (German: M=34.5 years, Finland M=35.4 years), see Table 2 for the age-group distribution. In terms of gender distribution, in the German survey the majority is female (female: 55.6%, male: 43.5%9, diverse 0.7%) while in the Finnish survey a gender equality was achieved (female 47.8%, male: 50.0%, diverse: 2.2%). Thus, the participant samples are comparable, except a slight shift between the age-groups of Gen Z (18-25) and Millennials (26-35).

Table 2: Age distribution of survey participants

	German [%]	Finland [%]
18 to 25	46.5	17.4
26 to 35	16.9	41.3
36 to 45	11.9	26.1
46 to 55	11.4	10.9
56 to 65	7.4	4.3
66 to 75	5.0	0.0
Unknown	1.4	0.0

4. Results

Hypothesis 1 was confirmed for the German sample for both stationary ($r_{pb} = .174$, $p < 0.001$) and mobile usage ($r_{pb} = .256$, $p < 0.001$), that individuals with lower trust in VUIs use them to a lesser extent. In the Finnish sample, this holds true only for the use of stationary devices ($r_{pb} = .296$, $p = 0.023$); for mobile VUIs, the analysis is not significant ($r_{pb} = .213$, $p = 0.077$), but only marginally outside significance.

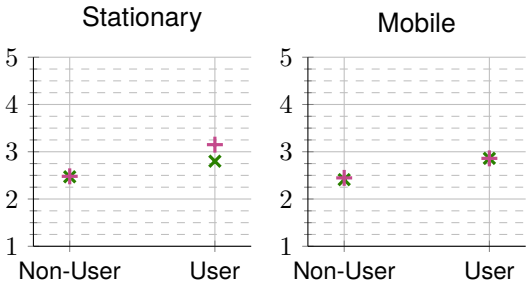

Figure 1: Mean Difference between trust and usage of stationary and mobile VUIs for German (×) and Finnish (+) participants (H1).

Hypothesis 2 was also confirmed for the German participants, both for stationary ($r_{pb} = -.245$, $p < 0.001$) and mobile ($r_{pb} = -.273$, $p < 0.001$) usage. For the Finnish questionnaire, interesting differences emerge between stationary and mobile usage. While there is no correlation between privacy concerns and the use of VUIs for stationary usage ($r_{pb} = .021$, $p = 0.444$), this is highly pronounced for mobile devices ($r_{pb} = -.374$, $p = 0.005$).

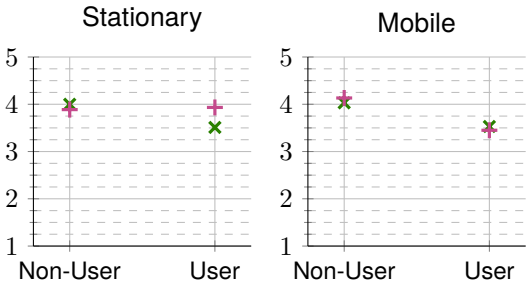

Figure 2: Mean Difference between privacy concerns and usage of stationary and mobile VUIs for German (×) and Finnish (+) participants (H2).

Regarding the perceived hedonic and utilitarian benefits (H3 & H4), quite contrary observations were made between German and Finnish participants. For German participants, individuals who perceive lower benefits or joy in using VUIs also use them to a lesser extent. This applies to both stationary (Hedonic: $r_{pb} = -.332$, $p < 0.001$ Utilitaristic $r_{pb} = -.286$, $p < 0.001$) and mobile (Hedonic: $r_{pb} = -.380$, $p < 0.001$ Utilitaristic $r_{pb} = -.319$, $p < 0.001$) voice assistants. However, this does not hold true for Finnish participants, as no significant differences can be found neither for stationary devices (Hedonic: $r_{pb} = .205$, $p = 0.086$ Utilitaristic $r_{pb} = .119$, $p = 0.215$) nor for mobile devices Hedonic: $r_{pb} = .197$, $p = 0.095$ Utilitaristic $r_{pb} = .238$, $p = 0.056$).

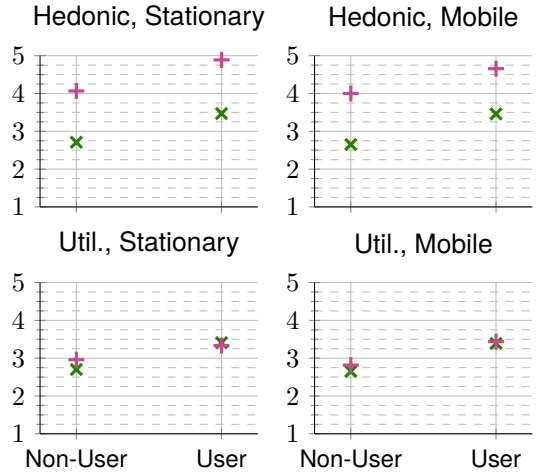

Figure 3: Mean Difference between hedonic and utilitaristic benefits and usage of stationary and mobile VUIs for German (×) and Finnish (+) participants (H3, H4).

For Hypothesis 5 and 6, as both variables are interval-scaled, meaning they are not dichotomous as in usage (1) non-usage (0), a Spearman correlation was conducted in this case. Regarding Hypotheses 5 on the relationship between perceived hedonic and utilitaristic benefits and trust in VUIs, there is a strong statistical effect for the German population no matter whether stationary or mobile devices are used (Hedonic. $r_s = .414$, $p < 0.001$ Utilitaristic: $r_s = .355$, $p < 0.001$). Also regarding the Finnish sample, there is a strong correlation between perceived hedonic and utilitaristic benefits and trust in VUIs (Hedonic: $r_s = .416$, $p = 0.002$ Utilitaristic: $r_s = .326$, $p < 0.013$). Thus, for both populations, we can state that high hedonic and utilitarian quality perception is associated with high trust.

Regarding Hypothesis 6 on the relationship between perceived hedonic and utilitaristic benefits and privacy concerns in VUIs, only for the German population a clear correlation can be found, regardless of a stationary or mobile device type (Hedonic: $r_s = -.314$, $p < 0.001$ Utilitaristic: $r_s = -.267$, $p < 0.001$). For the Finnish population, privacy concerns, just like in the hypotheses above regarding utilitarian quality, do not play a role here (Hedonic: $r_s = -.132$, $p = 0.191$ Utilitaristic: $r_s = -.144$, $p = 0.171$).

In Hypothesis 7, we assume that individuals with lower technology commitment use voice assistants

to a lesser extent. Significant differences in the German population and the Finish population were observed regarding technology commitment and technology affinity. While a significant correlation was confirmed for the German questionnaire in terms of all three scales and both stationary and mobile usage (technology acceptance: $r_{s-stat.} = .278$, $r_{s-mob.} = .334$, $p < 0.001$, technology competence belief: $r_{s-stat.} = .115$, $r_{s-mob.} = .217$, $p < 0.001$, and technology control beliefs: $r_{s-stat.} = -.132$, $r_{s-mob.} = .129$, $p < 0.001$), for the questionnaire used in the Finnish study regarding technology affinity, no correlation was found, neither for the stationary ($r_s = -.036$, $p = 0.407$) nor for the mobile usage ($r_s = -.069$, $p = 0.324$).

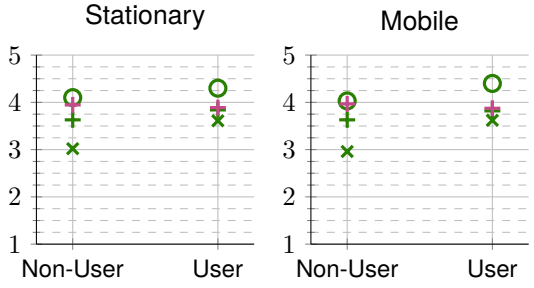

Figure 4: Mean Difference between technology commitment/affinity and usage of stationary and mobile VUIs for German (technology acceptance ×, technology competence belief ○, and technology control beliefs +) and the technology affinity (+) of the Finnish participants (H7).

Ragarding Hypothesis 8, Statistical correlations can be found between the Big Five dimensions of Neuroticism, Conscientiousness, Openness, and VUI usage. Significant differences in the German population and the Finnish population between stationary usage and the openness to experience scale (German: $r_{pb} = -.106$, $p = 0.005$, Finnish: $r_{pb} = .266$, $p = 0.037$). This observation aligns with theoretical expectations, as previous research suggests cultural variations in attitudes towards technology adoption and openness to new experiences (Bouwman et al., 2007). For other personality dimensions as well as for mobile usage, no significant correlations were found.

5. Discussion

The analysis of the data reveals interesting correlations between hedonistic and utilitarian benefits, trust, and privacy concerns regarding the use of voice assistants. Both in Germany and Finland, higher trust correlates with higher perceived quality of hedonistic and utilitarian benefits. In other words, the higher the trust in the technology, the higher the perceived quality of hedonistic and utilitarian benefits, and vice versa. In the German context, privacy concerns do not play a role in the perception of hedonistic and utilitarian benefits. This might be due to the fact that data privacy does not hold the same societal significance in Finland as it does in Germany, or it could indicate a higher level of awareness among Finnish participants. It should be noted that the current findings are based on a relatively small sample size, which may lead to potential underestimation of effects due to its limited scale.

Another interesting aspect is the relationship between technical knowledge and the use of voice assistants. While there is a clear correlation between technology commitment and voice assistant usage in Germany, there is no such correlation for technology affinity in the Finnish context. Further research should analyze whether this difference is due to openness to new technology or the level of technological education.

6. Conclusion

The present study offers insights into the relationships between trust, privacy concerns, hedonistic and utilitarian benefits, as well as technical knowledge and the use of voice assistants. The results indicate that higher trust in the technology is associated with a higher perceived quality of hedonistic and utilitarian benefits in both countries. However, privacy concerns do not seem to be relevant to the perception of benefits in Finland, unlike in Germany.

Another interesting finding is the difference in the relationship between technical knowledge and the use of voice assistants between the two countries. While technology commitment is associated with higher usage in Germany, there is no such correlation for technology affinity in Finland. This suggests potential cultural differences or differences in the level of technological education that should be further investigated in future studies.

These findings can contribute to optimizing the development of voice assistant technologies and developing targeted measures to promote their acceptance, both in Germany and Finland.

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