Finding the Right Voice: Exploring the Impact of Gender Similarity and Gender-Role Congruity on the Efficacy of Automated Vehicle Explanations

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Abstract

Automated Vehicles (AVs), acting as social robots, hold potential benefits for society. Prior research highlights how AV explanations can enhance passenger trust by clarifying the vehicle's reasoning and actions. However, an underexplored area is the impact of voice gender in AV explanations on this trust dynamic. To bridge this gap, our study, inspired by the gender-role congruity and similarity attraction theories, investigates the impacts of AV voice gender on user trust. The anticipated findings from our research are poised to play a critical role in designing AV explanations that enhance trust, thereby advancing the human-AV interaction landscape.

Introduction

Automated Vehicles (AVs) bear the potential to revolutionize the realm of transportation, offering enhanced safety, amplified efficiency, and a greater scope for travel convenience. However, despite the numerous advantages they bring to the table, recent studies illustrate a public sentiment marked by apprehension towards their safety and readiness for large-scale implementation (Du et al. 2019; Robert 2019; Taeihagh and Lim 2019; Zhang, Yang, and Robert Jr 2021). Surveys demonstrate that more than half of Americans view AVs as more risky than human-operated vehicles, with a notable 7% expressing hesitation to purchase a fully autonomous vehicle (Liernert and Caspani 2019). Such reluctance in embracing AV technology could hamper the full realization of its potential and deny society the multitude of benefits it offers. Therefore, to expedite the acceptance of AVs and their seamless integration into daily life, it is paramount to scrutinize the factors influencing the public's willingness to embrace these vehicles.

Among these factors, trust has emerged as a pivotal determinant in the adoption of AVs. Trust, defined as the willingness of the trustor to expose themselves to the actions of the trustee, has an influential role in the acceptance of technology, including AVs (Jian, Bisantz, and Drury 2000; Zhang et al. 2020). Studies indicate a direct correlation between the level of trust in AVs and the willingness to adopt them. The most commonly stated reason for drivers' reluctance to accept AV technology is a lack of trust in AV systems (Zmud et al. 2016). Further, Choi and Ji (2015) utilized the Technology Acceptance Model (TAM) to illustrate that trust significantly impacts perceived usefulness, both of which ultimately determine behavioral intentions to adopt AVs (Choi and Ji 2015). Hence, trust is a powerful predictor of AV adoption, and fostering trust can spur AV acceptance.

An effective strategy for enhancing trust in AVs involves providing explanations for the actions of AVs. Explanations illuminate the reasoning or logic that drives the decisions made by the AV (Zhang, Yang, and Robert 2021; Zhang et al. 2023). Such knowledge allows users to form an understanding of the system's functionalities and capabilities, enabling them to react appropriately in sudden takeover situations, predict future AV behaviors, and cultivate confidence in the technology (Du et al. 2019). Past research has demonstrated a significant positive correlation between the provision of AV explanations and trust in AVs (Du et al. 2019; Forster, Naujoks, and Neukum 2017). However, most of these studies focus primarily on auditory explanations in the context of human-AV interactions, with less emphasis on understanding how the characteristics of the voice, such as gender, impact user trust in AVs.

This paper seeks to bridge this knowledge gap by investigating the effect of voice gender on user preferences and their impact on trust in AV. Specifically, we aim to design an experimental study with a between-subjects design to address the research question: How does the gender similairty between human users and AV explanation voices affect the efficacy of AV explanations in fostering trust in AVs? Further, we will explore the extent to which gender-role congruity moderates this effect. This proposed research could provide valuable insights to the existing literature on AV explanations and trust, theoretically. Moreover, the study's results could facilitate the design of AVs that effectively and consistently promote AV trust and sidestep potential design pitfalls.

Background

Explanations and Voice Characteristic

Previous studies primarily relied on auditory and visual cues to provide explanations to users. While the auditory method is more commonly used, the research has employed diverse characteristics of auditory explanations, potentially neglect-

ing the impact of voice attributes on user perceptions. For instance, Du et al. (2019) employed a male voice with a standard American accent in a simulated environment. On the other hand, Forster, Naujoks, and Neukum (2017) utilized the natural voice of a female voice actor for explanations. Furthermore, Ruijten, Terken, and Chandramouli (2018) allowed participants to choose the gender of their automated vehicle's voice interface. However, previous studies on explanatory methods have not sufficiently accounted for the potential impact of voice characteristics, such as gender. These characteristics have been shown to significantly affect perceptions and behaviors in human-technology interactions. This highlights the necessity for in-depth research to explore the role of voice characteristics in the design of explanations and their impact on enhancing user experiences.

Voice Characteristic and Trust Preference

Anthropomorphism, attributing human-like traits to non-human entities, is a deeply ingrained human tendency which extends to computational devices (Nass, Steuer, and Tauber 1994; Nass et al. 2005). Even in the presence of minimal social cues, people often project features like gender, ethnicity, and age onto machines (Edwards et al. 2019; Nass and Gong 2000). Considering the critical role of voice in human communication and its escalating integration into technological devices (Nass et al. 2005), it plays a pivotal role in shaping socially interactive technologies.

Gender is a considerable factor in voice design. Many voice assistants either use female voices by default or provide exclusively female options, a choice allegedly rooted in anecdotal evidence suggesting widespread preference for female voices across cultural and gender demographics (He and Burns 2022; Feine et al. 2019). However, the universal implementation of female voices across all technological contexts is not beyond debate.

Research indicates that the perceived role of technology significantly shapes user preferences for voice gender, reflecting the social norms observed in human interactions, including gender stereotypes (Koenig 2018). Gender traits are generally classified into two categories: communal, which is often associated with women, and agentic, typically linked to men (Eagly and Steffen 1984). Communal traits emphasize care for others, whereas agentic traits are indicative of assertiveness (Eagly and Karau 2002). The Role Congruity Theory posits that the alignment of perceived roles with stereotypes can influence outcomes, including trust (Kim, Harold, and Holtz 2022). For instance, authoritative voices, which are often tied to male stereotypes, are preferred in purchasing decisions. This notion extends to technology, where users are more inclined to trust male virtual doctors for medical advice over their female counterparts (Pak, McLaughlin, and Bass 2014). On the flip side, when in need of assistance, users tend to favor comforting, cooperative voices, traits usually associated with women (Koenig 2018; Lynch and Campbell 2021). This is in tune with societal norms that portray women as helpers and men as authorities (Danielescu 2020). In the realm of technology, female voices gain more trust in contexts stereotypically deemed feminine, such as sociability and friendliness (Lee, Ratan, and Park 2019).

Moreover, the gender of the user significantly influences the preferred gender of a voice assistant. Research suggests that male users are generally inclined towards male robotic voices, while female voices are more likely to be preferred and trusted by female users (Edwards et al. 2019). Lee et al. (2000) corroborated this trend towards gender-congruent voices in their study on Text-to-Speech (TTS) voices (Lee, Nass, and Brave 2000). This tendency aligns with the similarity attraction theory, which asserts that individuals are intrinsically drawn to those with shared attributes (Montoya and Horton 2013). The theory suggests that individuals are more prone to form connections and harbor positive perceptions of others when they identify shared beliefs, attitudes, values, or interests (Goldberg 2005; Wells and Aicher 2013).

Despite these findings, the interplay between user gender, voice gender preference, and gender-role congruity within the context of AVs remains largely unexplored. Specifically, the impact of gender similarity and gender-role congruity is not thoroughly examined. This research gap presents an intriguing avenue for future studies, potentially enriching our understanding of user trust preferences and guiding AV system design. Thus, the aim of our proposed study is to investigate the effect of gender similarity between user and AV explanation voice on trust in AVs, and to assess the extent to which gender-role congruity can moderate such a relationship.

Methodology

This study will employ a between-subjects experimental design on an online survey platform. The following subsections provide details about the proposed study.

Participants

The population to be examined will be U. S. drivers. All participants will be screened using a questionnaire for inclusion criteria. Participants must have a valid driver's license. Before beginning the study, we will ask the university's institutional review board to review and approve this study design. We will perform a statistical power analysis to estimate sample size. The effect size (ES) in this study will be set based on data from a pilot study using Cohen (1988) criteria . With alpha = .05 and power = 0.80, the projected sample size needed with this effect size (GPower 3.1) can be derived for this within-group comparison.

Study Design

This study will implement a between-subjects experimental design, premised on a two-factor matrix, namely gender similarity and gender-role congruity. Both factors will be classified into two categories, thus leading to a 2x2 experimental design. The research aims to probe the effects of gender similarity between human participants and the voices utilized in the AV explanations. In addition, it investigates the potential moderating effect of gender-role congruity on trust in AVs.

Independent Variable In this study, we focus on two key independent variables: gender similarity between humans

and the voices of AV explanations, and gender-role congruity. For gender similarity, participants will be grouped based on whether the gender of the AV explanation voice matched their own. This resulted in two subgroups - similarity and dissimilarity. The similarity group includes participants who heard an AV voice of their own gender, whereas the dissimilarity group consisted of participants hearing an AV voice of the opposite gender.

As for gender-role congruity, we will consider participants' perceptions of AVs' roles and whether these match the gender of the AV voice. We will classify AV roles into two categories: 'driving assistant' and 'driving supervisor.' Participants will identify their perceived role of an AV on a slider scale, and we align the AV voice gender with the perceived role following prevailing gender stereotypes (i.e., male for 'driving supervisor', female for 'driving assistant') (Nag and Yalçın 2020; Habler, Schwind, and Henze 2019; Danielescu 2020). Participants who perceive the AV as a 'driving assistant' and hear a female voice were categorized under the gender-role congruity group, while those perceiving the AV as a 'driving assistant' but hearing a male voice will be placed under the gender-role incongruity group.

Throughout the study, participants will engage with six video scenarios showcasing AVs from the driver's perspective in various contexts, including urban, highway, and rural environments. Each scenario, demonstrating the AV's appropriate responses, includes a thorough "what+why" explanation given by the AV voice. These explanations detail the AV's upcoming actions and the rationale behind them, thereby educating participants on the AV system's functionality and reasoning capabilities.

Dependent Variable This study aims to evaluate trust in AVs. We will adopt a seven-item measure from McAllister (1995) and Lee and Lee (2022) studies, which we will tailor to fit the AV context. Participants will be asked to evaluate each item on a 7-point Likert scale, ranging from "1" (strongly disagree) to "7" (strongly agree). An exemplar item is: "If people were more informed about the automated vehicle, they would monitor its performance more vigilantly." To ensure the validity of our questionnaire, we will initially carry out a pilot study, followed by a Principal Component Analysis (PCA) to uncover underlying components and verify the internal consistency of our data.

Discussion

We anticipate the results of this study to augment existing literature in several ways. Primarily, the findings will underscore the significance of explanatory elements within the context of AVs. By unraveling the effectiveness of explanation in fostering user understanding and trust, we hope to shine a light on critical facets of AV interaction design.

Second, this research aspires to provide decisive insights into the longstanding debate around the preferred gender of the voice in AVs. While historical trends lean towards the use of female voices—valued for their perceived soothing presence in technological environments—it remains uncertain if this preference is universal across diverse contexts and user groups. Our study aims to clarify whether the choice of voice gender should remain static or become a dynamic variable tailored to the user's gender and their perceived AV role. This understanding could pave the way for a more profound connection with and trust in AV systems, enhancing user interaction and fostering deeper engagement.

Furthermore, we foresee that our study's outcomes will serve as a compass for future research, pointing towards further voice characteristics worth exploring. This research can thus catalyze more in-depth investigations into how various voice attributes can shape user perceptions of AVs, laying the foundation for more user-centric and intuitive AV systems. By encouraging such explorations, we hope to foster a more holistic understanding of human-AV interaction, opening doors for advancements that could potentially revolutionize how we interact with technology.

Finally, this study primarily concentrated on the impact of gender-related voice characteristics, while not delving into aspects like other demographic factors (e.g., age, race/ethnicity, education level), personality traits, and cultural differences. It sets the stage for future research to examine the intricate interactions between these varied human and voice attributes and their potential effects on human-AV interactions. Insights from such research will be essential in shaping the design of upcoming AV systems.

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