



"HOI" OR "MOI"

Is a regional language-speaking robot more easily accepted?



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1. Introduction

Due to the ageing population, the healthcare industry is experiencing an exponentially increasing number of people in need of care (Butter et al., 2008). This puts a strain on healthcare providers because the shortages in healthcare personnel that they already experience now are expected to increase (Combes, Elliot & Skåtun, 2018). Another challenge is that ageing can result in language loss for multilingual elderly (attrition), causing the elderly to retreat to their first language (Hummert, Garstka & Shaner, 1995). This is generally the language spoken in the family context. This can be a foreign language, but for a large group of people in the Netherlands (estimated more than 2 million), this is a regional language (e.g., Low Saxon, Limburgish, or Frisian). In this challenging health care environment, developing technological solutions to mitigate both problems are of utmost importance.

A possible way to cope with this problem is with the introduction of so-called social care robots. Social robots “are explicitly designed to establish social and affective relations with their users” (Pols & Moser 2009, p. 162). Therewith, they distinguish themselves from previous generations of technology and automation, e.g., cash machines, because they engage their users on a social level. With robotics developing quickly, social care robots have the potential to play an important role in assisting the elderly (Broekens, Heerink & Rosendal, 2009). According to Dahl and Boulos (2014), ‘robots that fulfill tasks in the medical world are about to become one of the most influential technological innovations of the 21st century’.

The goal of this research is to examine whether the acceptance of social care robots can be improved by using regional speech instead of the national language. We conducted our research using the commercial robot “Pepper”. Pepper is a robot designed to interact with humans, developed by the Japanese multinational SoftBank Robotics. Pepper is about 1.20 meters tall and has both robotic and human-like characteristics. Pepper is able to communicate via speech and via visual communication, which can be displayed at the tablet on the chest of the robot. The social robot is able to communicate in different languages via text-to-speech models, or it can be programmed to say certain sentences.

We have developed a text-to-speech synthesis of both a regional and a national language and implemented the speech into the robot. We use the regional language ‘Grunnegs’. Grunnegs is a collection of Dutch Low-Saxon speech varieties spoken in the province of Groningen, the Netherlands. Currently, the distinction can be made in five main varieties (Reker, 2007): Hogelandsters, Oldambts, Stads, Veenkoloniaals and Westerkwartiers. There are approximately 453,690 speakers of Grunnegs. Currently, the intergenerational transmission for Dutch Low-Saxon is constantly decreasing. In 1995, the child-parent interaction in Grunnegs was 7-8% (Driessen, 2005), while in 2011 it had fallen to 1-2% (Driessen, 2012).

In this study, we investigate whether the experience respondents have with technology improves if speech technology uses the native regional language, in this case Grunnegs. We conducted a field study where respondents interacted with a real embodied robot, the commercial robot Pepper, that was able to speak Dutch and regional language. Our results reveal that the regional voice was evaluated more positively compared to the

Dutch voice, yet the robot speaking regional language was also perceived as more eerie. This resulted in somewhat higher trust when the robot spoke regional language compared to the national language.

2. Conceptual Model

Previous literature in health care reveals the significance of language in the relationship between a patient and a care-taker. Literature for instance shows that sharing the same language, be it a regional or a foreign language, helps improving trust in and acceptance of the human caretaker (Kalbfleisch, 2009; Andrulis & Brach, 2007). Literature from the field of human-machine interaction reveals that accent can impact the extent to which an artificial actor is judged as trustworthy (Torre et al. 2018).

Trust is thereby viewed as a fundamental aspect of human communication, in particular in a health care environment. To make interactions with machines accepted and successful, they need to be able to also elicit trust (e.g., Torre et al. 2018). Following literature from the field of human-machine interaction, and general literature on customer relationships (e.g., Morgan & Hunt, 1994), we use trust as a measure of the extent to which the robot speaking regional language is preferred to the robot speaking Dutch.

We expect trust in the robot on the one hand to be influenced by as how pleasant the voice is evaluated, and on the other hand by feelings of eeriness that may be triggered by the robot speaking regional language vs. Dutch. Regarding the evaluation of the synthetic robot voice, previous literature shows that non-native speakers find synthetic speech harder to understand. Furthermore, a local accent is viewed more positively than a non-local one. While previous literature has not looked at embodied robots speaking different languages, it is quite likely that these effects also hold for robots (Alamasaputra et al. 2006; Tamagawa et al. 2011). We will therefore expect the regional synthetic speech to be evaluated more positively regarding its intelligibility, naturalness and pleasantness. This should in turn lead to a higher trust in the robot speaking regional language compared to the robot speaking Dutch.

We will additionally account for the eeriness of the robot speaking Dutch vs. regional language. First, belonging to the same social group, the so-called in-group, has been shown to affect human-to-human social service interactions (He et al. 2012). Robots can also be presented as in-group or out-group members, with robots presented as in-group members (e.g., based on ethnicity or team assignment, Vanman & Kappas 2019) yielding more positive reactions and higher compliance (Sembroski et al. 2017). One important cue which consumers use to classify somebody as a member of the in-group or the out-group is language as an important indicator of ethnic identity and regional origin (Phinney et al. 2001).

Given previous research that shows that artificial faces belonging to the in-group were rated as more alive and more likely to feel pain than those belonging to the out-group (Krumhuber et al. 2015), we expect the regional language-speaking robot to be perceived as more human-like, which should according to the theory of the uncanny valley be perceived as eerier and more threatening (Mori et al. 2012; Gray & Wegner 2012). Second, a robot using synthetic regional speech may exacerbate feelings that a robot is not authentic, and also strengthen feelings of uncanniness. Higher feelings of

eeriness should therefore negatively affect trust in the robot. Our predictions are summarized in our conceptual model depicted in Figure 1.

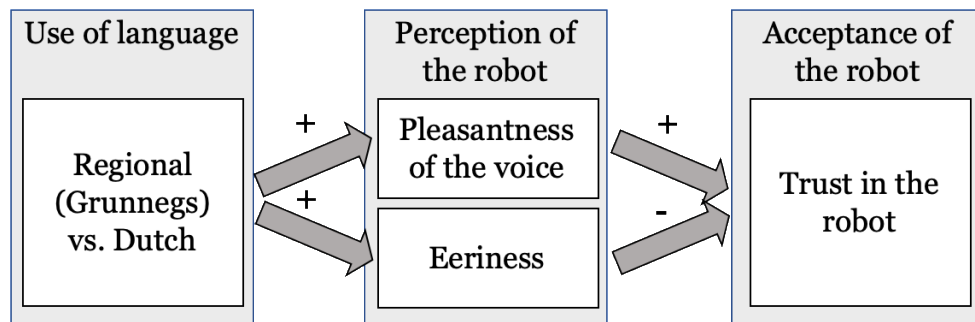


Figure 1: Conceptual Model

3. Field study featuring an interaction with a real robot

The quantitative research has been conducted at Forum Groningen, during the weekend of August 15th and 16th. The Forum is a building in Groningen designed as meeting place for the residents of Groningen. It was opened on November 29th 2019. The expected number of visitors is circa 1.6 million per year. At the moment, Forum Groningen has the status of the cultural center of Groningen, in which exhibitions, courses, lectures, movies, youth activities and debates are being held. Forum Groningen also provides the library function in Groningen.

3.1. Generation of the Dutch and regional robotic voices

We generated two synthetic voices, one in the regional language, one in Dutch. Two actresses, both female and of similar age, recorded either regional or Dutch speech in a studio. Of both languages, we collected two thousand sentences of short fiction and non-fiction excerpts (e.g., Wikipedia articles) in studio sessions lasting around 10 hours for each language. This resulted in around 2 hours of speech material (corpus) for each language. Regarding the regional language, we used the local speech variety "Hoogelaansters".

We used the Tacotron2 algorithm with the Griffin-Lim vocoder to generate our two synthetic voices because this algorithm can generate natural-sounding speech. It uses neural networks that are trained with speech examples and corresponding text transcripts. Following recent insights (e.g, <https://ai.googleblog.com/2018/03/expressive-speech-synthesis-with.html>), we trained our text-to-speech algorithm starting with a corpus in English comprising 24 hours of speech data (LJ speech) up to 600,000 steps. The final 75,000-100,000 steps were trained with either the regional or the Dutch corpus.

We integrated our Dutch and regional language text-to-speech implementation in the commercial robot Pepper. The integration is created through a custom-made

platform. The platform allows adding text to the compute cluster which will transform the text into audio of the preferred language. Pepper is then able to use these files for speaking. Please note that we did not generate an automated speech recognition algorithm because that would have implied using several speech donors per language, which exceeded the scope of this project.

3.2. Data collection

We conducted a field study in a multifunctional area of the building featuring part of the library and a laboratory where the public can experiment with, e.g., technology on the 8th floor of the building. We set up a small area with a banner of the University and a few tables to let people interact with the robot and fill in a questionnaire afterwards. Given that this study was conducted during the Covid-19 pandemic, we also made sure that the appropriate distance was kept between the experimenters and the participants in the study. At that moment in time, mouth masks were not obligatory and therefore neither worn by the experimenters nor by the participants. Figure 2 schematically shows the setup of our study, where the red P denotes where the robot was standing.

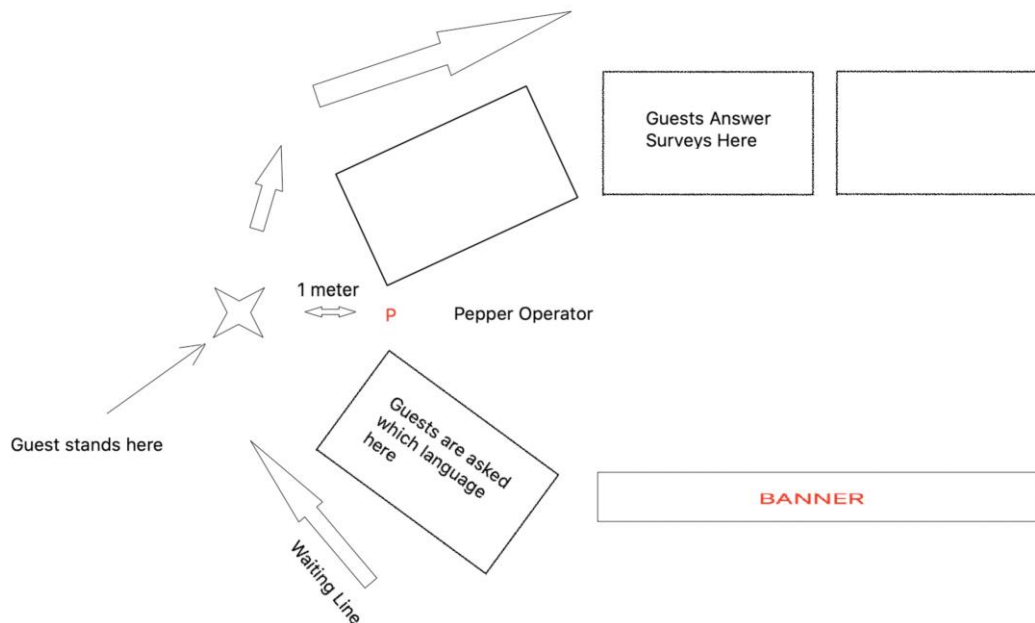


Figure 2: Set up of the field study

We invited visitors of the building approaching our area to participate in a study and told them that they could talk to a robot, either in Dutch or the regional language. Given the expected number of visitors and the needed computational capacity, generating real-time text-to-speech output in both languages was not feasible. We therefore generated answers to six questions in both languages and implemented them into the robot. One experimenter was standing behind the robot and unobtrusively triggered a sensor that was related to the answer (e.g., patted the head of the robot, touched a finger).

The participants would have a short conversation with the robot, one person at a time. The participants would choose themselves whether they would interact with the robot in Dutch or the regional language. We pointed the participants to two posters we displayed where six questions they could ask the robot were shown, on the first poster in the regional language, on the second poster in Dutch. We asked participants to stand on a spot marked with an x, and as soon as the robot recognized a human face, it started introducing himself in either Dutch or regional language:

“Hello! How are you? These are weird times; don’t you think so? Keeping distance all the time is difficult. Fortunately, I cannot get ill.”

Then, the participants could ask the robot questions in random order. The experimenter behind the robot unobtrusively triggered the sensor matching with the answer to the question that was asked. We designed the answers in a way that the robot also asked questions to the participants in order to simulate an interactive experience. The questions and answers were scripted as follows:

Participant: *“Who are you?”*

Robot: *“I am Pepper, the robot. I can speak Dutch, and Grunnegs. And who are you?”*

Participant: *“Where are you from?”*

Robot: *“I was born and raised in Japan. Later, I moved to the Netherlands, after being stuck in France for a while due to the Corona pandemic.”*

Participant: *“What do you think about Groningen?”*

Robot: *“Groningen is de most beautiful city of the Netherlands. There is nothing better than Groningen! In particular the building we are in today is beautiful – don’t you think so as well?”*

Participant: *“What can you do?”*

Robot: *“I can speak Grunnegs, and Dutch, yet I need to practice. I can also make the noise of an elephant. Do you want to see that?” <If participants say yes, the built-in elephant noise together with the movement of Pepper is activated>*

Participant: *“How old are you?”*

Robot: *“I am still young, but I have already seen a lot of the world.”*

Participant: *“Do you have a job?”*

Robot: *“I don’t have a job yet. But I would like to work in health care, either in this city or in the area around. That’s why it comes in handy that I am also able to speak Grunnegs. Do you think that I would be good at that?”*

In Dutch, the whole conversation was scripted as follows:

Robot: “Hallo, hoe is het met je? Het zijn rare tijden, vind je ook niet? Al dat afstand houden de hele tijd. Dat is wel lastig. Maar gelukkig kan ik niet ziek worden.”

Participant: “*Wie ben je?*”

Robot: “*Ik ben Pepper, de robot. Ik kan Nederlands praten, en Gronings. En wie ben jij?*”

Participant: “*Waar kom je vandaan?*”

Robot: “*Ik ben geboren en getogen in Japan. Dan ben ik via Frankrijk, waar ik nog een tijdje vastgezeten heb in verband met Corona, naar Nederland verhuisd.*”

Participant: “*Wat vind je van Groningen?*”

Robot: “*Groningen is de mooiste stad van Nederland. Er gaat niets boven Groningen! Vooral het Forum is een heel mooi gebouw geworden – vind jij ook niet?*”

Participant: “*Wat kun je allemaal?*”

Robot: “*Ik kan Gronings praten, en Nederlands, maar moet wel nog oefenen. Ik kan ook een olifant nadoen? Zal ik dat even laten zien?*”

Participant: “*Hoe oud ben je?*”

Robot: “*Ik ben nog heel jong, maar heb wel al veel van de wereld gezien.*”

Participant: “*Heb je een baan?*”

Robot: “*Ik heb nog geen baan. Maar wat me heel leuk lijkt is om in de zorg te gaan werken, in Groningen stad of in de provincie. Daar komt het goed van pas dat ik ook Gronings kan. Denk je dat ik dat goed zou kunnen?*”

In regional language, the conversation was scripted as follows:

Robot: “*Moi! Hou is t? t Binnen roare tieden, vienden joe ook nait? De haile tied òfstand hòlden.*”

Respondent: “*Wèl bist doe?*”

Robot: “*Ik bin Pepper, de robot. Ik kin Nederlaands proaten, en Grunnegs. En wèl bist doe?*”

Respondent: “*Woar kómstoe vandoan?*”

Robot: “*Ik bin geboren en getogen in Japaan. Loater bin ik, laangs Frankriek, woar ik nog n tiedje haar vaastzeten vanwege Korona, noar Nederlaand verhoesd.*”

Respondent: “*Wat vinstoe van Grunnen?*”

Robot: “*Grunnen is de mooiste stad van Nederlaand. Der gaait niks boven Grunnen! Veuraal t Forum is n hail mooi gebaauw - viens doe t ook nait?*”

Respondent: *”Wat kinstoe apmoal?”*

Robot: *”Ik kin Grunnegs proaten, en Nederlands, mor k mout wel nog ouven. k Kin ook n eulifant noadoun. Zel k dat even zain loaten?”*

Respondent: *”Hou old bistoe?”*

Robot: *”Ik bin nog hail jong, mor k haar wel al veul van de wereld zain.”*

Respondent: *”Hestoe n boan?”*

Robot: *”k Haar nog gain boan. Mor wat mie hail leuk liekt is om n de zörg te waarken goan, n Stad of provinzie. Doar kómt t handeg dat k ook Grunnegs kin. Denks doe dat k dat goud kinnen zól?”*



Figure 3: Interaction of participants with Pepper

Apart from the verbal communication, we also programmed head movements and gestures as nonverbal communication cues. We obtained the gestures fitting the scripted text by asking native speakers of both languages to speak the scripted texts and let the robot imitate their gestures and head movements as closely as possible. Please note that the nonverbal communication was the same for both the Dutch and the Grunnegs scripted conversation.

3.3 Measures

After interacting with the robot, the participants were asked to fill in a short survey assessing how the interaction with the robot was experienced. We also elicited socio-demographic information and asked respondents about their proficiency of the regional language in understanding, speaking, reading and writing. Given that respondents were not paid for their time, we kept the survey short.

We first asked respondents to evaluate how they perceived the voice of the robot with three items (“1 = completely not understandable” to 5 = “completely understandable”, “1 = very unnatural” to 5 = “very natural”, 1 = “very unpleasant” to 5 = “very pleasant”, Cronbach’s alpha = .65).

Eeriness was measured as “This robot is eerie” (1 = “not at all,” 5 = “very much so”, Mende et al, 2019). The trust in the robot is assessed with two items (“The robot is trustworthy”, “The robot gives me a feeling of trust”, De Wulf et al. 2001, $r=.68$).

4. Results

4.1 Sample

115 respondents participated in the survey. 101 surveys were filled in completely and therefore used for further analyses (51 females). 48 respondents spoke to the robot in the regional language, 53 respondents in Dutch. Most respondents were between 18 and 30 years old (33%), 10% between 30 and 40, 14% between 40 and 50, 25% between 50 and 60 and 18% older than 60 years. 47 respondents currently resided in the province of Groningen, 8 in Drenthe, 1 in Friesland, 44 were from other provinces in the Netherlands.

Of the 48 respondents talking to the robot in regional language, 33 resided in the province of Groningen, 6 in Drenthe, 8 in other provinces (1 respondent did not indicate current residence). As expected, proficiency in regional language was higher among the respondents that decided to have the interaction with the robot in regional language (understanding regional language: $M_{\text{regional}} = 3.44$, $M_{\text{Dutch}} = 1.81$; $F(1,99) = 58.92$, $p < .001$; speaking regional language: $M_{\text{regional}} = 2.65$, $M_{\text{Dutch}} = 1.32$; $F(1,99) = 49.46$, $p < .001$; reading regional language: $M_{\text{regional}} = 2.83$, $M_{\text{Dutch}} = 1.47$; $F(1,99) = 50.32$, $p < .001$; writing regional language: $M_{\text{regional}} = 1.77$, $M_{\text{Dutch}} = 1.21$; $F(1,99) = 15.45$, $p < .001$). People felt most able to understand spoken regional language, and least able to write it themselves.

4.2. Acceptance of the regional language-speaking robot

Evaluation of the robot voice. An ANOVA of language (regional vs. Dutch) on evaluation of the robot voice reveals that participants responded more positively to the regional voice compared to the Dutch voice ($M_{\text{regional}} = 3.31$, $M_{\text{Dutch}} = 3.01$; $F(1,99) = 6.08$, $p < .05$).

Eeriness of the robot. Respondents perceived the regional language-speaking robot as more eerie than the Dutch one ($M_{\text{regional}} = 1.73$, $M_{\text{Dutch}} = 1.26$; $F(1,99) = 4.74$, $p < .05$).

Trust in the robot. An ANOVA of language (Dutch vs. regional) on trust in the robot reveals a marginally significant higher trust if the robot speaks regional language vs. Dutch ($M_{\text{regional}} = 4.68$, $M_{\text{Dutch}} = 4.18$, $F(1,99) = 3.10$, $p = .08$).

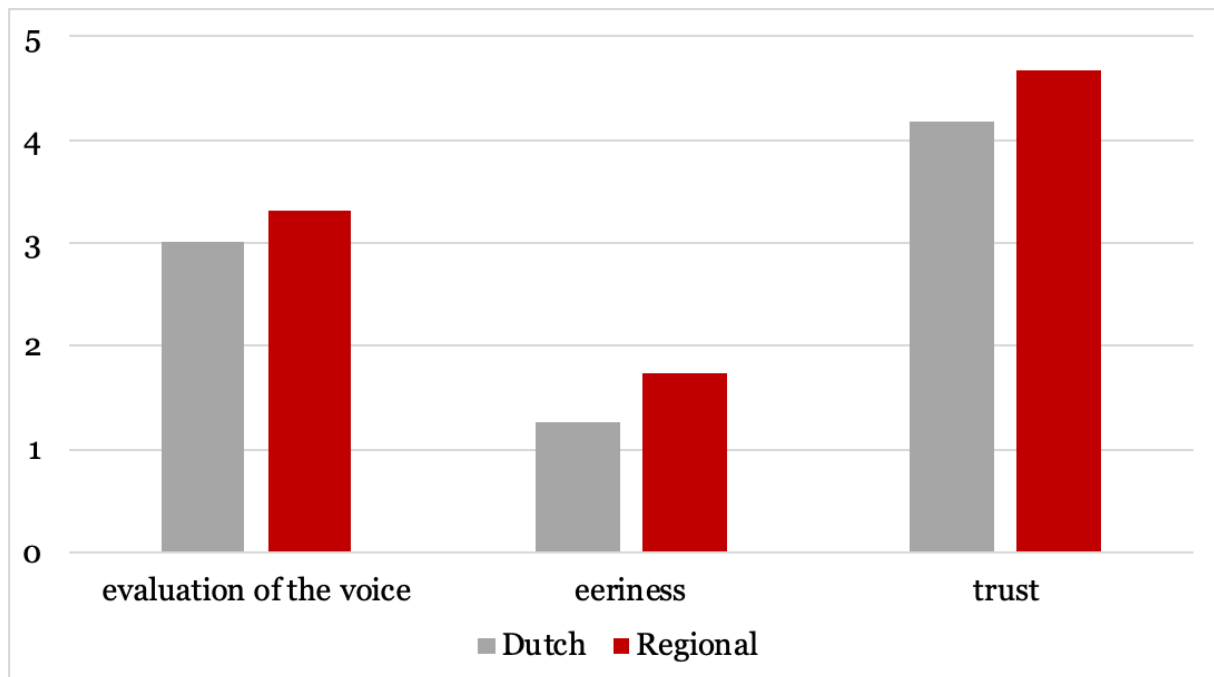


Figure 4: Evaluation of the regional language vs. Dutch-speaking robot

Mediation analysis. We conducted a parallel mediation analysis to examine whether the evaluation of the robot voice and eeriness mediated the relationship between robot language (regional language vs. Dutch) and trust in the robot (Hayes 2015, Model 4). The results revealed a parallel mediation where the regional language-speaking voice is evaluated more positively ($a = .26$, $p < .05$), increasing the trust in the robot ($b = .63$, $p = .01$), at the 95% confidence interval ($a \times b = .17$, 95% CI: .01, .44).

At the same time, the higher eeriness of the regional voice ($a = .49$, $p < .05$) leads to lower trust in the robot ($b = -.35$, $p < .01$) at the 90% confidence interval ($a \times b = -.17$, 90% CI: -.38, -.01). The mediators rendered the direct effect marginally significant ($c = .53$, 90% CI: .03, 1.03). This suggests partial mediation through the evaluation of the voice and eeriness. The more positive evaluation of the regional voice increases trust in the robot, while the higher eeriness of the regional language-speaking robot decreases it. As a result, implementing a regional voice into a robot only marginally increases trust in the robot.

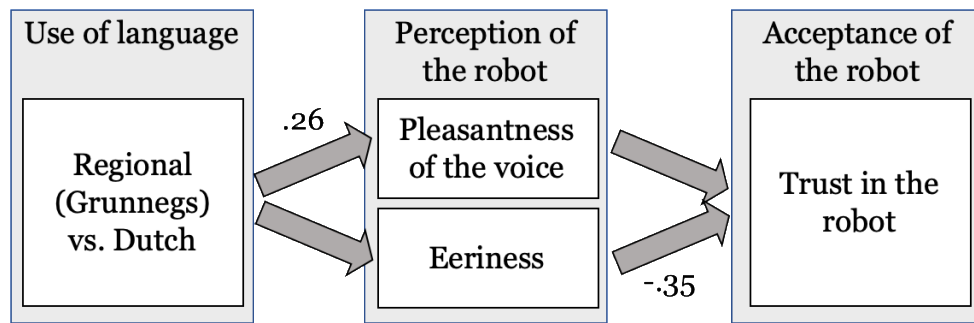


Figure 5: Mediation analysis

All in all, our mediation analysis confirms our conceptual model (see figure 5).

5. Conclusion

Many service industries, in particular health and elderly care, turn to robots to overcome severe personnel shortages, demonstrated by the 61% increase in sales of robots for professional use from 2017 to 2018 (Industrial Federation for Robotics 2019; Rijksdienst voor Ondernemend Nederland 2017). The COVID-19 pandemic further boosts the use of service robots. Robots disinfect schools, deliver meals, and perform social tasks to alleviate isolation and loneliness of particularly elderly patients (Belpaeme 2020; Vervaeke 2020). However, previous literature shows that for many people, accepting robots performing these tasks is rather challenging, and robots are viewed more negatively than human service providers (Caic et al. 2019; Mende et al. 2019). The goal of this project was therefore to explore whether bringing the robot closer to people by letting it speak their regional language helps to increase trust in the robot.

We conducted a field study in Groningen, in the North of the Netherlands, with the commercial robot “Pepper” where respondents could interact with Pepper speaking the regional language “Grunnegs” or Dutch. For both languages, we generated natural synthetic voices based on a corpus obtained from two speech donors. We find that implementing a regional voice in a robot is a double-edged sword. On the one hand, the regional robot voice is evaluated as better understandable, more natural, and more pleasant than the Dutch robot voice. This is an extension to previous literature showing that a local accent of synthetic voices is more positively viewed than a non-local one (Alamasaputra et al. 2006; Tamagawa et al. 2011). This higher evaluation leads to higher trust in the robot.

On the other hand, the robot voice is also perceived as more eerie. This supports our reasoning that a regional-language speaking robot may be perceived as an in-group member and therefore as more human-like, which according to the theory of the uncanny valley translates to higher eeriness (Krumhuber et al. 2015; Mori et al. 2012; Gray & Wegner 2012). We are the first to demonstrate that this also holds for a regional voice implemented in an embodied robot. In line with our expectations, eeriness negatively affects trust in the robot.

Yet, at the bottom line, we do find a marginally significant positive effect of a robot speaking regional language instead of Dutch on trust in a robot. This implies that it is worthwhile bringing robots closer to people by using local and regional language. However, one should be aware about making the voice not too eerie. The voices we developed sounded very natural, which may have contributed to their eeriness. Moving forward, developing a voice that sounds more robotic may be a worthwhile direction for future study.

This research has multiple limitations, which at the same time are promising avenues for future research. First, we did not develop automated speech recognition, which would enable a truly interactive experience. This, however, would require numerous speech donors from different parts of the region to capture different versions of the regional language, which was beyond the scope of this project. Second, our synthetic voice did not have vocal prosody and could therefore not express emotions. Third, in our study respondents self-selected which language they wanted to speak with the robot. Moving forward, it would be better to randomly assign regional language-speakers to either the Dutch or the regional voice. A challenge here is to recruit a sufficient number of regional language-speakers though. Fourth, we did not implement a regional language-speaking vs. Dutch robot within a real health care service setting because this was not feasible due to the Covid 19 pandemic. This is something that should be done in the future. Fifth, we did not examine constructs that could also affect how a regional language-speaking robot is evaluated compared to a Dutch-speaking one, such as authenticity, warmth, competence, or satisfaction.

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