How To Train Your Robot.

Identifying Different Responses To Self-Learning, Personality-Displaying Smart Home Technology.

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ABSTRACT

The past decade has seen rapid development and integration of Smart Home Technologies (SHTs) in our homes. As these items take over tasks, their presence in the home greatly impacts our daily practices.

The objective of this research was to investigate the possibilities of creating an SHT that has a personality, goals and has its own social practices. This was done using an online research artefact in the form of an interactive video scenario about a smart robot vacuum cleaner. Using a mixed-methods approach, the perception of potential users to this type of SHT is investigated.

This study has identified five personas with different responses to the robot presented in the scenario, describes bounds in which SHTs with a personality, goals and social practices can be created and concludes: participants are okay with a device having social practices and goals as long as these are in line with theirs.

Authors Keywords

Smart Home Technology; Interaction Desing, Human Technology Interaction; .

Figure 1. Smart robot vacuum cleaner with Fikki on top.

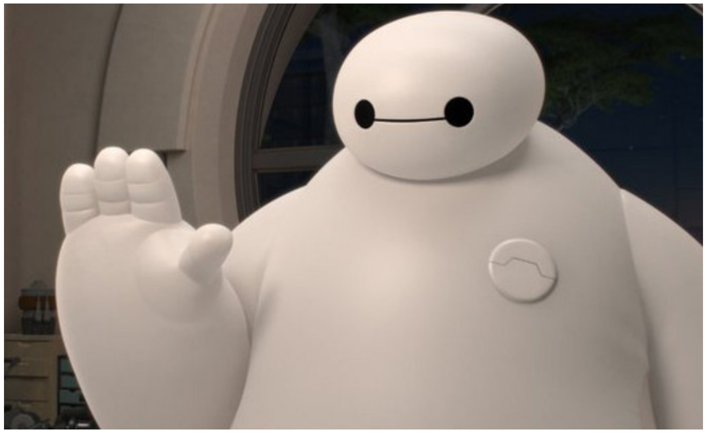

Figure 2. Baymax, healthcare robot from Big Hero Six (Disney) [14]

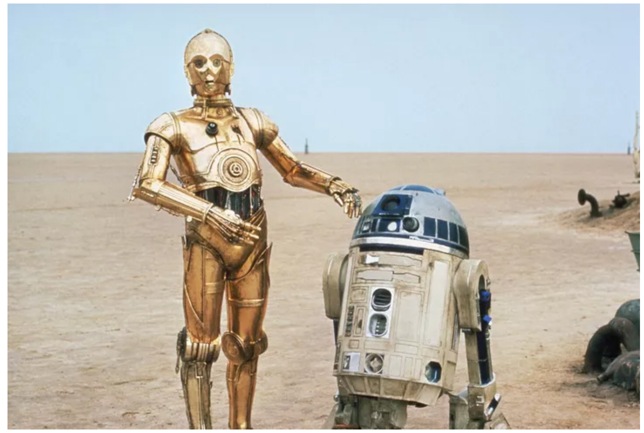

Figure 3. C-3PO (left) and R2-D2 (right) from Star Wars (Lucasfilm) [8]

Figure 4. Jim (left) and B.E.N. (right) from Treasure Planet (Disney) [33]

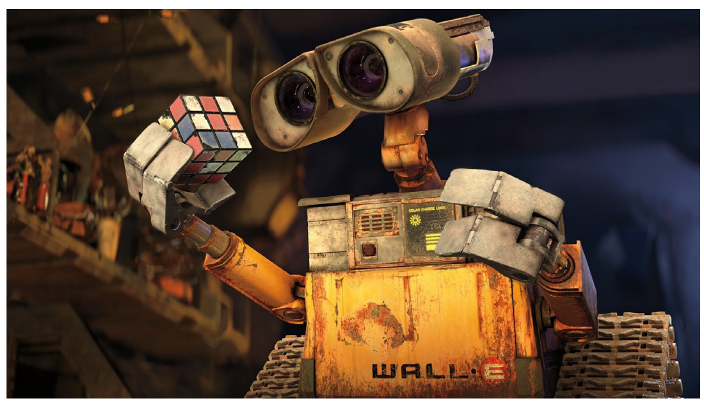

Figure 5. WALL-E from WALL-E (Disney) [30]

INTRODUCTION

SMART HOME TECHNOLOGY

Smart home technologies (SHT) are getting smarter every day. You will probably find one or two when looking around your home. A Google Home that can control the lights and turn on the TV, a vacuum cleaner that drives around the house, or a washing machine that you can turn on via your phone [6, 19]. All these devices either automate tasks or make them easier for humans to do. This automation of the home leads to the 'smart home' which has been envisioned for quite some time. In many ways [27] this vision is rapidly becoming reality.

This automation greatly impacts our daily practices and way of living at home. However, SHTs can have a more emotional aspect to them. Examples of this are the integration of SHT in the homes of older adults to support them in their daily activities or aiding them in remembering [13], or the usage of smart technology as a companion for therapy and education [11]. These SHTs are more closely related to Social Robotics [3], and through the COVID-19 pandemic, home technology supporting people emotionally and socially has started to rise [19]. This type of technology, sometimes called Transformative Technology, is like Social Robotics: specifically created to support the user emotionally.

PERSONALITY

However, next to this automation and new social aspects of technology, another process is happening. Most robots just have a task, a clear goal that they are designed for. However, in a few cases, robots have been given personalities. They can get enthusiastic, annoyed, or even act happy and angry. Examples of these robots are Cosmo and Vector (Figure 6) [29], tiny robots designed to be companions. These robots do not have a clear 'goal' next to entertainment, yet people are

Figure 6. Vector, a tiny companion robot (Digital Dream Labs) [29]

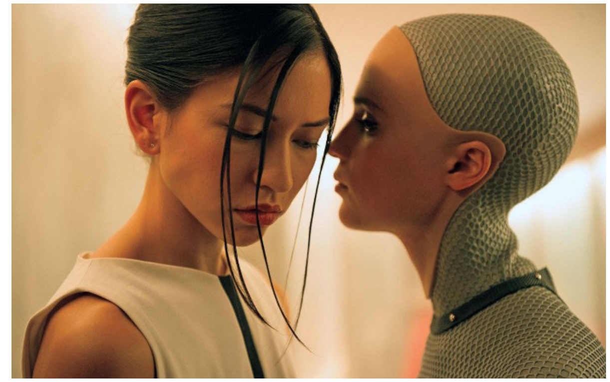

Figure 7. Kyoko (left) and Ava (right) from Ex Machina (Universal Pictures) [4]

intrigued by them. The idea of robots being able to interact with us on a deeper level can be found in many works of fiction. To name a few: R2-D2 and C-3PO from Star Wars (Figure 3), B-E-N from Treasure Planet (Figure 4), Bay-Max from Big Hero Six (Figure 2), WALL-E (Figure 5), and even Noo-Noo from the Teletubbies.

The movie Ex Machina (Figure 7) [4] takes the humanity of robots a bit further and tells a story about a society in which machines have awareness and are capable of stimulating our deep emotional attachment. Looking at the current developments in AI, like Sophia [10], this future might be just around the corner. Through this, the film poses the question: where should we draw the line between humans and robots, and how should we act as the distinction between organic and non-organic fades through technological advancement?

The paper by Sandoval, Mubin, Obaid [21] analysed such robots from popular fiction. Their conclusion: there seems to be a mismatch between the robots we imagine in fiction and what current robotics can do. However, technology in this field has developed fast over the years since this paper was written (2014), and the field of Human-Robot Interaction (HRI) is already posed with the challenge of ensuring good interactions with robots, specifically those with a social purpose.

The paper by Weis and Spiel [31] notes three main points: robot narrative (impacted by science fiction, the term robot itself, and assumptions on human-like intelligence), power balancing stakeholders, and the adaptivity of robots. The latter is specifically interesting when combining smart technology with the current advancements in (machine learning) algorithms that are becoming part of our everyday lives as well [1].

SOCIAL PRACTICES

With this interest in robots at home, in combination with the possibility of giving them a form of personality and having them learn from our actions, we as designers must take a look at the impact this type of technology might have. The social practices in the home - The everyday practices which are regularly and consistently executed in society are referred to as social practices [9] - can be greatly impacted when a non-human performer automizes a task, let alone one which also initiatives interaction with you and your pet. Strengers [24] speculates on this influence in her paper through the study of a Roomba as a non-human performer in the social practice. In this paper, she also includes other non-humans in the form of pets.

The views presented by Strengers encourage additional thought about the differences between non-humans and their diverse skills. Next, she encourages more thought about how non-humans and humans might be "defined, constituted, and positioned concerning each other through their participation within specific practices".

Building on their research, this study attempts to gather insights into the perception of self-learning robots and the influence humans can have on non-human performers in the home. Using the robot vacuum cleaner as an example, an imaginary robot vacuum cleaner that learns like a pet was created.

The first section of the paper will examine related works, followed by the methods and prototype used in this study, after which the limitations and results of the study are discussed and concluded.

RELATED WORK

(NON-) HUMAN-ROBOT INTERACTIONS

Strengers, our main inspiration for this paper, has explored alternative conceptualizations of dynamic non-humans in theories of social practices. Using the case of robot vacuum cleaners, their rising spread into households, and their intended purpose to "take over" the practice of vacuuming as an example [24]. Her paper not only asserts that "people in a variety of contexts adapt, improvise, and experiment," but also suggests that non-humans can do so too.

This is often not included in the ideation when creating a new robot, as the main focus of HRI is the human in the interaction. However, as robots and SHT are getting smarter, they could have interactions with non-humans without any humans being involved. As a result, there is the possibility that some practices, e.g. Roomba Riding, are impossible for humans to 'invent' or directly recreate.

When using this perspective, it is critical not to group all non-humans into the same category, as there are various kinds of non-humans as well as distinct 'materials' in theories of practice.

PERSONALITY

Because there are typically multiple interfaces involved, interacting with smart homes and Internet of Things (IoT) devices is still far from a smooth experience [22]. These agents are also starting to display human-like personality features, such as responding with humour or giving reminders.

Mennicken et al.[22] present insights concerning participants' preferences, how they responded to their prototype's proactive and sociable behaviour, and implications for the design of agent-based interfaces in the home in this study. They produced smart home experiences that exhibited various personality qualities and conducted lab research with forty-one individuals to learn about the value of personality features in the design of agent interfaces in smart homes. They used these two design samples as probes to see how people reacted to a smart house with personality.

They discovered that expressing personality features is a promising strategy for creating smart home agents. Designers, for example, could alter residents' expectations about the need for human intervention in the functioning of the home by conveying a specific level of proactivity.

ENCULTURATION

Embodied Conversational Agents (ECA) are multimodal systems with a wide range of verbal and non-verbal capabilities [18]. The user's harsh expectations for natural conversational behaviours are raised by their human-like look. However, what is considered "natural" is heavily influenced by our cultural profiles, which give us heuristics for behaviour and interpretation. Thus, integrating the cultural aspect of communicative behaviours in virtual agents and enculturating [16] such systems seems unavoidable. Culture however is a multi-defined domain, and thus several pitfalls arise which have to be avoided. M. Rehm [18] discussed some problems of enculturating interactive systems and techniques for avoiding them in connection to the typical ECA process.

Reviewing current approaches to this problem has revealed the enormous potential of this endeavour, such as in the areas of intelligent tutoring systems and persuasive technology. It also revealed the lack of a shared theoretical framework and research approach. The strategies given in this paper may serve as guides for establishing the appropriate methodological approach to face the challenge of enculturating ECAs and HCI/HRI in general, as this line of research is still in its infancy.

SOCIAL PRACTICES

The massive Amazon warehouse, which is constructed to welcome robots, is one of the most astounding examples of how AI creatures have transformed/are transforming our social practice [4]. Those warehouses are designed for robots, and humans find it difficult to navigate. When we consider today's wired environment, the possibility of "living Symbiosis with Robots and Embedded Agents" is closer to fact than fiction.

Robotic beings have infiltrated our environment and have effortlessly merged into our daily lives. To adapt to the changes and Iive with robotic beings, we must also develop the right behaviours for interacting with artificial beings, whether virtually or physically manufactured by humans. For example, in Japan, the country that has embraced socials robots the most fully, there is a proposal to establish and research 'robot cultures' [16].

While humans believe that robots are mostly under their control, it is often the artificial creatures who are reshaping our social habits. The penetrations of robotic beings will increase in the future and the "codes" of robotic beings will become more and more determinant for our social practice. As we are aware of this, many questions are asked about what the future should look like, and what roles and tasks robots and smart technology should or should not get [32].

Therefore, this explorative study attempts to gain an understanding of users reactions to a smart device having its own social practices.

METHOD

This study uses a mixed-methods setup, using a quantitative approach to find and identify clusters, followed by enriching with qualitative data.

PROTOTYPE

To conduct this research, a website* was created. This website, as seen in figures x & x, presented the participant with a scenario in text and video.

Website framework.

The website was created using HTML, CSS and JS. It consists of twelve pages which can be divided into three groups (Figure 8). The first page is the consent form, next, we have eight pages of scenario, followed by the results, a Microsoft Form and conclusion page.

Whereas part 1 and 3 consist of regular HTML pages linking to one another, the scenario pages consist of a single page in which the data in de different blocks is changed using JS (Figure 9). This is done to ensure people cannot go back to previous answers and means no cookies need to be saved, which ensures the data from the answers are deleted as soon as one clicks 'continue' on the results page, or if one stops during the scenario. This provides privacy and prevents any cookies from being saved on the computer.

When the participant completes the scenario, the data is mailed to a secure server on a protected home network. These results can only be accessed by the researcher and do not contain any personal information about the participant.

*(https://hannahvaniterson.nl/Hannah-RTFE/)

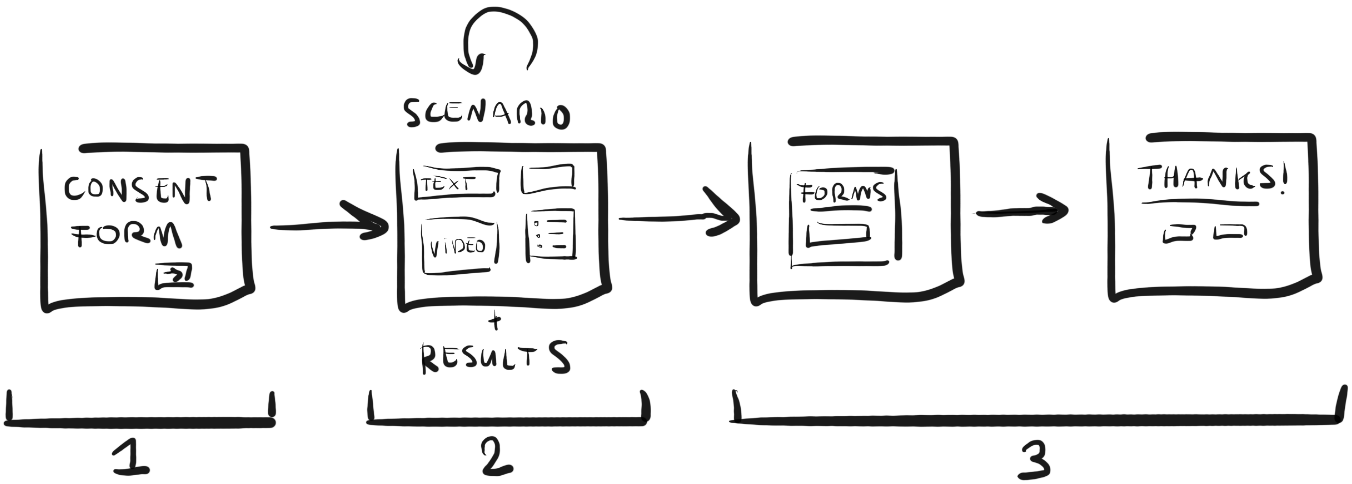

Figure 8. Wireframe of the interactive research product

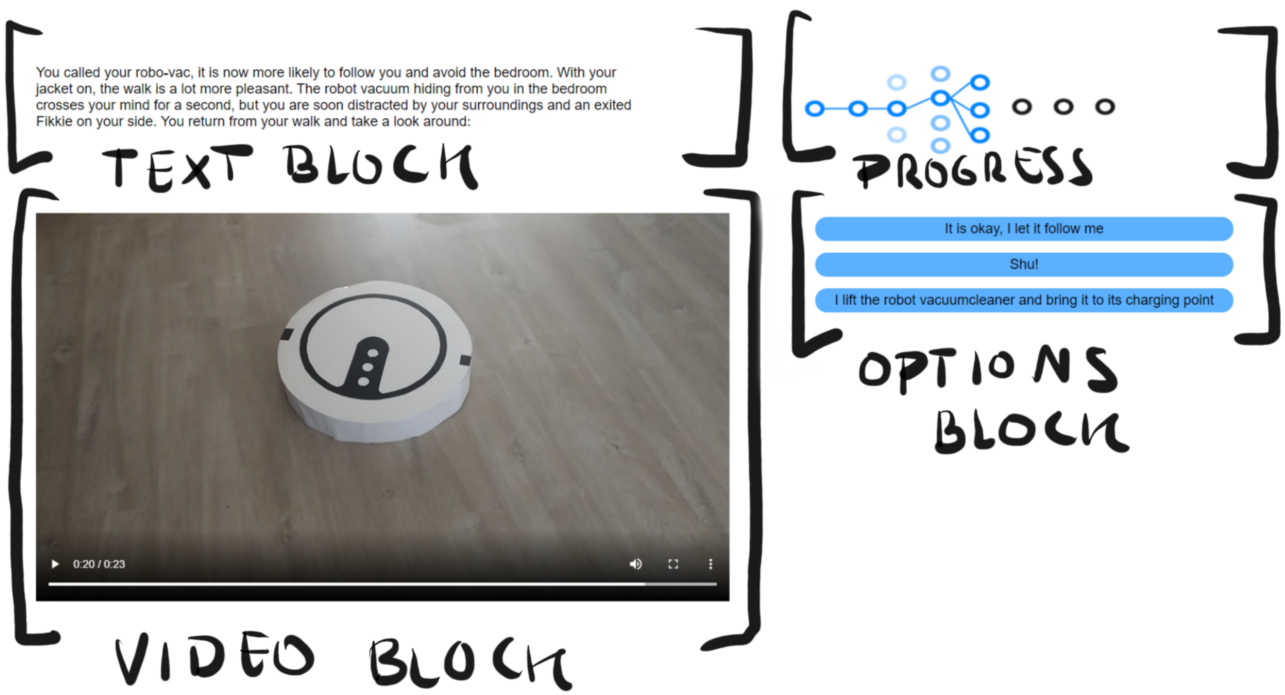

Figure 9. Page layout of the scenario pages of the research product

Figure 10. Decision tree of the scenario

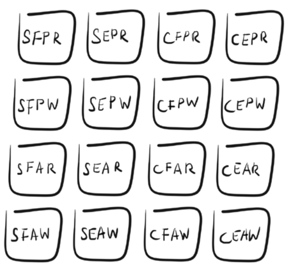

Figure 11. All possible personalities

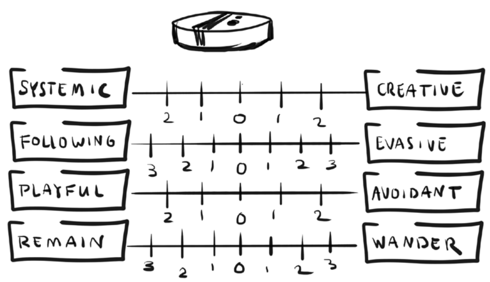

Figure 12. Personality axes

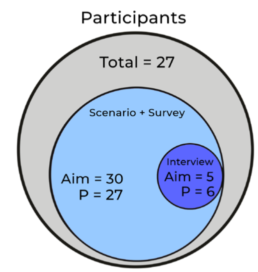

Figure 13. Visualisation of participants distribution.

Scenario.
The videos present the extrapolative scenario of an robot vacuum as seen in Figure 1. The participant imagines they own the robot and are having a free day, which they spend walking the dog, reading, and watching TV.

Throughout the scenario, the participant makes choices that influence the story, as well as the personality of the robot vacuum cleaner. Figure 10 shows a simplified version of the choices. In total there are 1152 possible paths, but for ease of analysis, there are sixteen results (Figure 11).

Personalities.
The personality of the robot is determined by four determinants, explained in Figure 12, resulting in a total of sixteen different personality types (Figure 11). Each answer in the scenario has a different effect on these personalities. At the end of the scenario, participants learn the personality type of their robot.

SETUP
Data was gathered using the research product from two groups: the Scenario & Survey group, and the Interview group.

Data overview.
Quantitative data was gathered via:
1) The answers given in the scenario.
2) The resulting personalit.
3) The closed questions in the questionnaire.

Qualitative data was gathered via:
1) The open questions in the questionnaire.
2) A semi-structured interview.

Participants.
The exclusion criteria for the participants were as follows: the participant is healthy, has a fair understanding of English and is familiar with working with a computer.

Scenario + Survey group.
This group of participants could participate via the website and participating in the scenario and survey. It was aimed to have 30+ participants in order to allow for statistical tests.

Interview group.
A convenience sample of participants was invited to, next to the scenario and survey, have a short (15 minute) semi-structured interview. In this interview, they elaborated upon the answers they had given in the survey and were asked about their experience and their view on the future that this robot might exist in. This sample was aimed to have at least five participants.

RESULTS

In this chapter, simple statistical analysis was used to find patterns in the quantitative data. The qualitative results are thematically analysed and grouped. The results of the two analyses are placed side by side, from which a set of persona's and a set of general requirements for personality displaying SHTs is presented.

QUANTITATIVE DATA

Because the dataset is limited, the data is not used to make hard statements, but rather is interpreted through finding trends.

Personality

Based on the filled-in scenarios of the 27 participants, the average personality of the robot resulted in a SFPR personality (Figure 15), meaning the overall preferred robot is systemic in its cleaning routines, follows the user, is playful with animals, and does not wander around the house.

Whereas this is an average, one of the factors that jumped out was the result that 17 out of 27 participants end up with a +2 systemic robot, and only 1 with a creative one (Table 1).

Looking at the answers given, instead of just the resulting scores, this result can be traced back to one of the first questions (Figure 14), where the robot bumps against the foot of the participant. 21 out of 27 participants picked the "I lift my foot" option, which gives a +1 for systemic. This could be caused by the fact that, in the flow of the scenario, this is the "choice of least resistance".

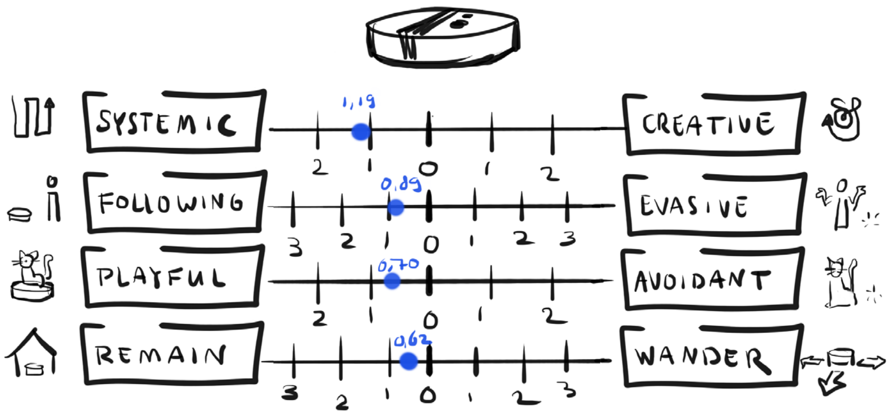

Figure 15. Average personality of the robot.

Table 1	Count of systemic
2	17
1	0
0	9
-1	0
-2	1
Grand Total	**27**

Table 2	Count of playful
2	6
1	10
0	9
-1	1
-2	1
Grand Total	**27**

Table 3	Count of following
3	4
2	4
1	8
0	7
-1	4
-2	0
-3	0
Grand Total	**27**

Table 4	Count of remain
3	1
2	5
1	11
0	5
-1	3
-2	2
-3	0
Grand Total	**27**

Table 1. Count of the different scores on the personality axes.

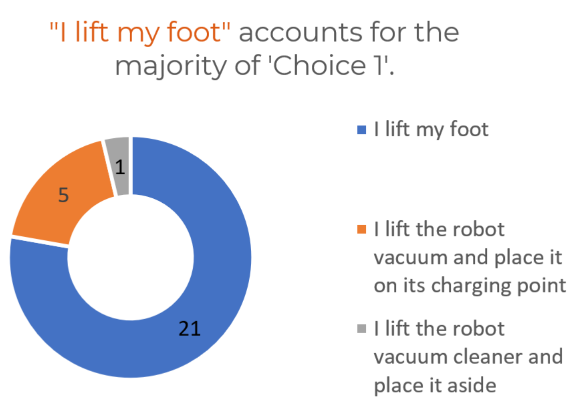

Figure 14. Visualisation of the option chosen in step 1 of the scenario.

Engagement

This tendency to pick the option which is the least effort could be a trend. When looking at the general 'effort' a choice would cost, a spectrum of effort/engagement of the user with the robot could be determined.

Looking at the answers, the participants showed either a clear disinterest in engaging with the robot, letting it do its own thing, were relatively neutral, or actively engaged with the robot (Figure 16). Next to the level of engagement, one who engages with the robot can do this in a positive and negative sense (Figure 17). This difference in behaviour towards the robot indicates that there is a difference in expectation or interest in the robot between participants.

Clusters and correlations

Next to looking using our human eye to find trends, online tools were used to find clusters in the data. Using TensorFlow [23], the 4 and 8 dimensional data resulting from the personalities and the answers was visualized, but this yielded few results (Figure 18).

RapidMiner [17] was used to identify any correlations in the data (Table 2). Interestingly, most robots tend to be both following and remaining, which seems to be moderately correlated [7].

Conclusion

Overall, from this data, it is interpreted that there are three 'types' of behaviours towards the robot. These behaviours suggest that there are different expectations towards the robot.

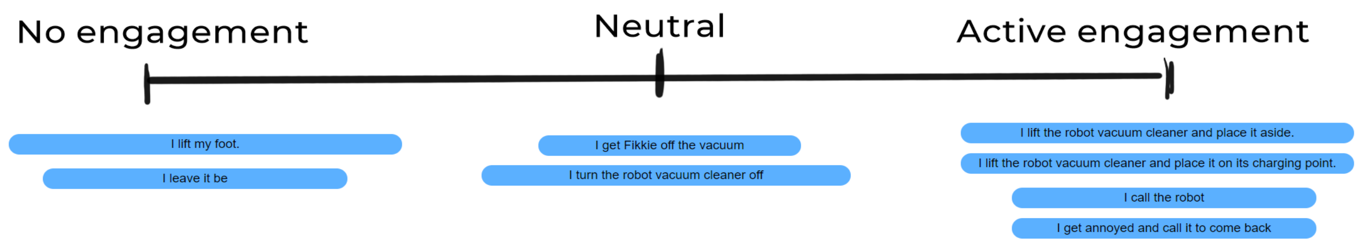

Figure 16. Example of different answers on the scale of no vs active engagement with the robot

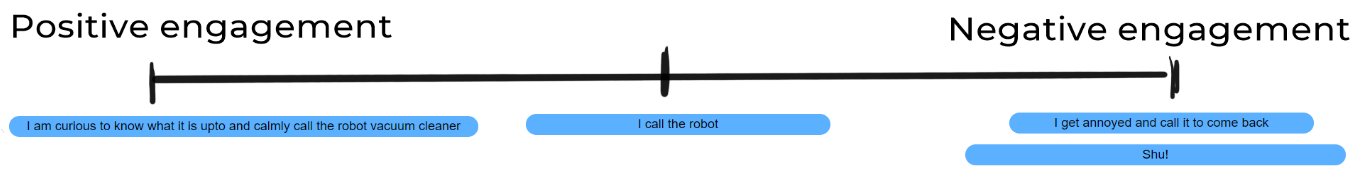

Figure 17. Example of different answers on the scale of positive vs negative engagement with the robot

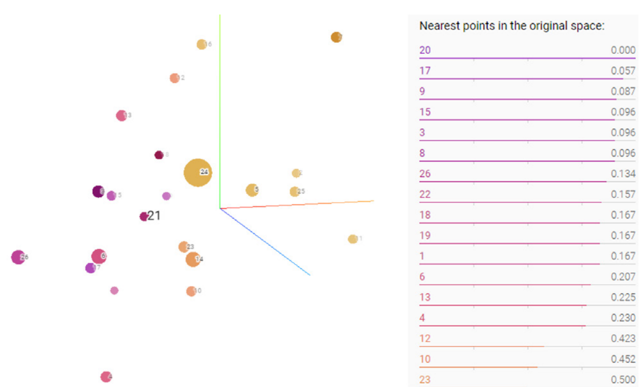

Figure 18. Visualization of data in TensorFlow [23]

Attribut...	Sysema...	Creative	Following	Evasive	Playful	Avoidant	Remaini...	Wander...
Sysematic	1	-1	0.356	-0.356	-0.085	0.065	0.428	-0.428
Creative	-1	1	-0.356	0.356	0.085	-0.065	-0.428	0.428
Following	0.356	-0.356	1	-1	-0.239	0.127	0.504	-0.504
Evasive	-0.356	0.356	-1	1	0.239	-0.127	-0.504	0.504
Playful	-0.085	0.085	-0.239	0.239	1	-0.955	-0.403	0.403
Avoidant	0.065	-0.065	0.127	-0.127	-0.955	1	0.340	-0.340
Remaini...	0.428	-0.428	0.504	-0.504	-0.403	0.340	1	-1
Wanderer	-0.428	0.428	-0.504	0.504	0.403	-0.340	-1	1

Table 2. Results from RapidMinder[17]

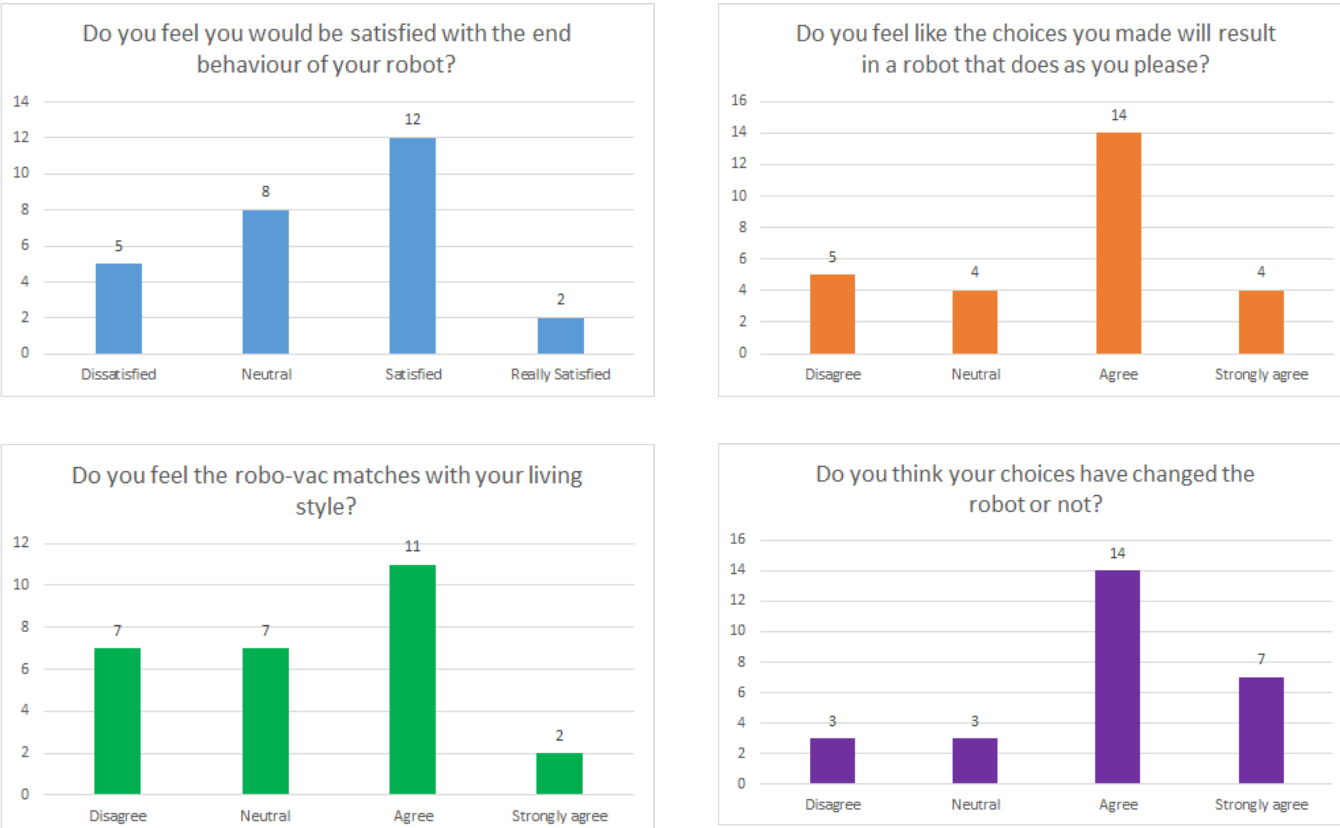

Figure 19. Overview of answers given in the closed questions of the survey.

QUALITATIVE DATA

In addition to indicating whether the participants agreed or disagreed with certain statements, as shown in Figure 19, they were asked to explain their answers and identify other points for attention (Figure 20). Even though not all participants answered these questions, some still gave some interesting insights.

We categorized these insights into four topics:
1) Seeing the vacuum as a pet or as a machine.
2) Feel empathy for the robot.
3) Having a connection with the robot.
4) Being enthusiastic about the concept.

Pet vs machine

Although the vacuum cleaner got a personality in our research, most participants still saw the vacuum cleaner as a machine. The reason mentioned for this is "the vacuum cleaner should just clean and shouldn't be playing around". There was one person who disagreed, stating that having a vacuum cleaner as a pet was an amazing outcome and was the best result to hope for.

Empathy & connection

The answers on the forms show that people do tend to feel more empathy for the vacuum cleaner now it develops a personality. One even stated that they took the vacuum cleaner off the couch because they were concerned about it. This development of empathy, in combination with the personality, seems to establish a stronger connection with the robot. One person stated that personalities in robotic devices will eventually lead to a more natural connection with our devices.

Vision of the future

Concerns Concerns which were expressed on the technology we presented vaired. For example, that we would become much more dependent on systems, that interaction with them will lead to injuries, or that they think that a vacuum cleaner who takes on their personality will be too uncomfortable. There were even wonders about what would happen if the vacuum cleaner took over their hate for cleaning. One person stated getting "*terminator vibes*" from our concept and thought that the vacuum cleaner might kidnap them in order, so it wouldn't need to clean the house anymore.

Expression of indiviuality Next to concerns there were also those who were enthousiastic. Stating that this type of technology could be the ultimate expression of personalized devices, and speculated that building relationships with your device would lead to more sustainability.

A new market On a different topic, one of the participants stated that it could be fun looking at all the possibilities regarding the different personalities. The participant even imagined that there would be guides available on how to create certain types of vacuum cleaners and people who swap their vacuum cleaner type for someone else's type. Or even sell specific personalities like a special collector's item. They also wondered what the 'default' personality was, and if training could be done before the device entered the market.

Improving technology integration Finally, someone mentioned that this type of technology would make it easier to persuade people to use technology. If your robot behaved like a pet, even elderly people would maybe find it much easier to take on robotic appliances. So personalities would make robotics more accessible to different kinds of people.

Figure 20. Mapping of responses in the survey and interview on four different themes

	Ralf	Tina	Sam	Hans	Anja
Employment	Design student	Highschool teacher	Junior engineer	Retired cook	City hall employee
Level of comfort with technology	Comfortable	Somwhat comfortable	Very comfortable	Not comfortable	Somewhat uncomfortable
Level of acceptance of technology	High	Neutral	Very high	Low	Neutral
Preferred personality of robot	Preferse creative robot	No preference	Experiments with the extremes of the personalities	Prefers no personality	No preference but only small displays of personality are okay
Behaviour towards the robot	Sees it as an extra pet. Will initiate Interactions	Sees robot as pet/machine. Will not initiate interaction.	Sees robot as pet/machine. Open to interactions	Sees robot as robot. Will not initiate interactions	Sees robot as mostly machine. Has empathy for the robot, but a bit suspicious of it, will most likely not initiate interaction
Expectations of the robot	Expects the robot to do its work, and expects a form of initiative and interactivity from it	Expects convenience	Expects the work done, but it is not a hard must as fun is expected with the experimentation	Expects the robot to do its job	Expects the robot to to its job
Quotes	I'm pretty much excited to know how a creative vacuum cleaner would behave and what kind of behavioural changes I need to give to it to get him as creative as possible	I would like that it learns that it needs to vacuum clean when I am going to bed. Like lights out, vacuum cleaner on.	Oh it's going to learn things? That's so cool	Generally speaking, I don't think it's a good idea. I get Terminator vibes from it. Maybe it's going to kidnap me so it has to clean.	A robot vacuum cleaner should only vacuum clean... and not playing around.

Figure 21. The five identified personas

COAGULATION OF DATA

Using the results and conclusions described earlier, a set of five personas was created: Ralf, Tina, Sam, Hans and Anja (Figure 21). Their different levels of acceptance of technology in their daily lives, and the level at which they trust and feel comfortable working with that technology influence their interaction style with the robot vacuum and what they expect it to do.

The perferred personality of the robot was based on the results from the scenario, in which three distinct behaviours from the user toward the robot: engaging, neutral and dismissive were identified.

Behaviour towards the robot was based on this aswell, in combination with the answers from the survey and interviews in which the view of the robot as either more a machine or pet was identified.

The expectations of the robot: do users only expect it to clean, or also to show initiative and engage with them? This was mostly based on the answers given in the interview.

An example, *the robot vacuum robot presented in the research product would probably not be accepted or bought by Hans and Anja, for it displays behaviour and can act quite erratically. Tina might consider it, but may feel like the robot is not learning to be the most effective, and is playing around too much. Ralf and Sam are both comfortable with technology and would most likely either see it as a challenge to train the robot, or take it as a pet.*

Conclusion

Generally, we argue that there, while there are individual differences, participants are open to a robot vacuum cleaner having its own social practices, goals and displaying personality, as long as these do not interfere with the goals and social practices of the user. There is no "one robot fits all" due to the multitude of factors influencing the expectations, wishes and needs of different user groups. This should be taken into account when designing a device which displays a personality and has its own social practices.

DISCUSSION

While this study has provided some valuable information that can be used for further development of Smart Home Technologies, it was limited by time and the number of participants.

A more complex research prototype, in combination with more participants, would have yielded more generalizable results. Additionally, a longer study could have given us more insight into the integration of the STH over time, as well as the social implications of this technology.

In this research product, the number of choices in the scenario was limited by the perception of the researchers and the restriction of time, as one addition could lead to hundreds more possible paths in the website's design. Because of this, the number of reactions possible was limited, and participants may not have acted as they normally would.

Additionally, the determinants of personality and the consequences of the choices made in the scenario were determined by us, the researchers. As we are not experts on personality, we are biased by our perceptions of whether something is creative or systemic, or if an action would cause one to be creative or not. Because of this, it is important to remember that our mental model of action and reaction in terms of human-robot interaction is not universal, and other views may be more fitting.

CONCLUSION

This research, build on the research by Strengers [24] on smart agents in the home, sought to answer two questions:

How do people respond to smart home technology, which displays a personality through its behaviour?

What are the bounds within which a personality and the device having its social practices would be accepted by users?

Our research shows that people generally accept social practices and a personality of a robot if:
1) It does not interfere with their social practice.
2) The device still does what it is intended to do.
3) When users do not feel the device has 'goals' of its own.

However, The results of this study indicate that there are at least five different personas to be aware of when designing smart home technology with a personality and its own social practices. Each of these different personas has different wishes and needs, may have a different level of trust towards technology, or expects different things from the technology they buy. Therefore, there are different ranges of designs and interactions which are possible and acceptable within the bounds of the different personas.

Therefore, we would recommend looking into the general traits of your intended user group and try to determine the specific level of social practices and personality your specific SHT can and should display for it to be accepted.

Finally, through speculating the future of this type of personality-displaying technology, the responses have proven to be widely ranged.

To conclude, with this research we contributed: a clearer view of what is acceptable behaviour in terms of social practice of smart home technology, have started the creation of an overview of different user types and their wishes and expectations of such technology, and finally we hope to inspire further research in this field and the implication it might have on our future everyday lives.

FUTURE WORK

Several questions, ideas and future visions have come up in this research, which opens up many new avenues yet to be explored.

Concerns

Fear is something that has been mentioned in our research. Especially the Terminator characteristics are what makes people doubt buying machinery that has a personality. To help people get past this fear we could humans have control in every situation, by making it possible to overwrite every movement or behaviour. If this is a feasible option, and would gain a user's trust is yet to be investigated.

Another possibility would be to let the human gain empathy for the robot. Interviewees told us that they accept our vacuum cleaner more because they feel empathy for it. Ways for creating empathy for robots should be reviewed and implemented. Addtionally, further research might explore what other traits influence the acceptance of this type of technology and identify other personas for designers to be aware of.

Improving technology integration

Another find was that people expect that raising robots like pets would make robots more accessible to people who don't understand technology. Especially older people since they are more familiar with pets than with technology.

The adoption of technology is something that has been studied often, and this might be a valuable option to explore. Researching the way people communicate with their pets might be a good starting point. This would require both the robot and human to learn from each other to understand their needs and wishes.

A new market

Interviewees came up with creative future more market-focussed ideas for this specific technology, such as the possibility of giving out a manual to create certain personalities, or people creating these themselves.

While these options would be hard to research or study, the investigation of this happing in the future is valuable on its own. Through exploring the world in which the technology is trained, we might learn what to expect..

Ecosystem

Another look at the future, if all appliances in the home get social practices and a personality, we imagine relationships will begin to form between them. This would likely be either a sibling relationship, or a clear hierarchy. Imagine your Google Home telling your vacuum cleaner what to do if you're not at home. This might bring out some Toy Story scenarios with your appliances. Like the exploration of the market that could arise, this future vision is one to be further investigated and ideated upon, perhaps through exploring how users would experience a home in which appliences may be above them in hierarcy.

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