

Big Sister: Exploring parents' trust in the Smart Home as a caregiver for children

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ABSTRACT

This showroom research focuses on exploring parents' trust in the Smart Home as a caregiver for children via a speculative design concept called Big Sister. This concept was published via social media channels together with a questionnaire which was then followed up with more in depth interviews. Via a thematic analysis of the qualitative questionnaire data, four themes regarding issues of trust were defined: emotional/social development, human contact/interaction, safety, and children rebelling against the system. These themes were verified and explored further through in depth interviews. Analysis of the quantitative questionnaire data and frequency rate of themes provided better insights into the concerns surrounding this future scenario across different age groups and experience levels with Smart Home Technologies (SHT). The results of this paper indicate that a concept such as Big Sister is not desirable and provokes negative emotions and feelings of distrust. The research provides insights regarding people's concerns with Smart Homes and SHT regarding childcare, which connects to the field of Human-Computer Interaction (HCI).

Author Keywords

Showroom research; Smart Home Technology; Smart Homes; Childcare; Children; Trust; Speculative.

INTRODUCTION

Our relationship with technology is becoming more and more intimate. It plans our days, cares for us, sleeps in our beds. The applications have become almost magical: we can adapt the lights in our living rooms via a few swipes on our watches; we can vocally ask a device to play our favourite music and leave a robot alone to vacuum the house.

Considering the rate of adoption and development of smart home technologies (SHT), it is becoming difficult to imagine a future without sensing, actuation and Internet of Things (IoT) in our living spaces. Although several objects and their particular systems (e.g. lighting, heating, fridges, vacuum-cleaners) already have been successfully "smartified", an

integrated system that adapts to the inhabitant, a true smart home, is not common ground.

Several research examples of smart homes have been developed, e.g. Mozer's House [31], Georgia Tech Aware Home [23] and MIT's house [18]. Today, the concept of a completely automated smart home is technologically within reach, and requires us to consider its ethical boundaries.

Apart from the clear benefits of optimizing energy usage within homes, SHT's can bring our lives more personal, intimate benefits. They can offer comfort [27], convenience [24], safety [2,52], and entertainment. But when we consider the inhabitants of these smart homes, often families, we cannot exclude children. It is important to assume that in the future, children will also be raised in smart homes [1]. As demonstrated in a promotional video by Beko in 2016 [6], smart homes can have this magical, almost human-like feel, especially when involving children's vivid imagination. This same human-like feel is already easily created by voice-controlled and responsive technology such as Amazon Alexa [3].

When we note the inevitable existence of smart homes and regard the current state of events surrounding childcare, it is interesting to explore a possible combination of the two. In the Netherlands today, to accommodate one's child elsewhere while going to work is becoming more normal than ever, especially because the amount of dual-income families is rising [33] while nannies and day-care are expensive as well as hard to find [40]. Many people have a negative image of group-based, outsourced child care because it can be impersonal, dangerous and expensive [36, 50]. Of course, multiple alternatives exist: "gastouders", sharing a babysitter, informal care and grandparents [38]. Nevertheless, parents still struggle to find a suitable and fitting solution.

But with the rise of SHT, do we even need human babysitters? Could leaving our children in the comfort of our own smart-home be the perfect solution? It could be easy to leave the kids with a robot, and watch what is going on in the corner of the computer screen [21]. However, one might

argue over the kind of role model the house would be, and whether this “might lead to a generation of social misfits” [21].

This question raises dystopian answers, as seen in Joaquin Fargas’ *The Nanny Robot* [15] or the 2019 Netflix movie *I Am Mother* [44]. Surely, one can question the preference to leave childcare completely up to technological artefacts, but is there a way for technologies, especially smart homes, to add positively to future childcare?

To explore the public opinion on this topic, the researchers propose this research paper in which parents’ thoughts on the speculative scenario of using the Smart Home as a new way of childcare are looked into.

We will do this by presenting a conceptual video explaining the fictional product-service-system *Big Sister*. This video will be placed on social media, from which users can leave their response in a connected online questionnaire. Aside from this, we will approach participants to have an in-depth semi-structured interview.

THEORETICAL BACKGROUND

For this research, a showroom approach is used as proposed in the 2012 book *Design Research Through Practice* by Koskinen et. al. [26]. The showroom approach is part of the larger theory of *Constructive Design Research* [51] and draws on philosophy, psychology and the social sciences, as well as building on art and design. It relies on debate rather than statistics and hypotheses. It questions the way in which people see and experience the material world and elicits change through debate [26].

RELATED WORK

Smart home as a concept

Academics and practitioners have been envisioning smart homes for at least 50 years, with commercial home automation technology being invented in the 1970s [10]. There are many definitions of the “smart home”. Schiefer defines it primarily as “a home that incorporates advanced automation systems to provide the inhabitants with sophisticated monitoring and control over the building’s functions [2]” while Alam et al. goes further to define it as “as a residence equipped with computing and information technology which anticipates and responds to its users needs” [53]. With the ability to anticipate and respond to the complexities of everyday life, the smart home is framed as a way to reduce costs [20,32] and energy consumption [12,32] while increasing convenience [24] and safety [50]. However the rapid adoption of SHT, widely attributed to home wireless networks and decreasing costs [4, 27, 29, 52] has also brought concerns about privacy [23] increased dependency on technology [52] and the devices abilities to fulfil their promises of energy reduction [20].

SHT Concerns and benefits

Jacobsson et al. found that user assumptions about privacy protections are contingent on their trust of IoT device manufacturers [19] while Streiff et al. found that a user’s perceived risk affects trust [39], and Mandour and Raja report that most influential factors affecting user’s trust in smart home devices are that the system should be reliable and easy to use, followed by guaranteeing the consumers integrity and confidentiality [37].

Despite these concerns, SHT is increasingly being offered as a solution to the rising elderly population [5, 30]. By tracking the overall health condition of the elderly [28] their day to day activities [16] and allowing for real time connection to medical professionals [34] and family [27], SHT helps to keep the elderly living at home for a longer period of time. As Chan et al. explain, smart homes allow greater independence, while helping to maintain good health and preventing social isolation for elderly people. In response to the smart home caring for the elderly, it is reported that SHT’s are readily accepted by older adults and their family members, healthcare professionals and carriers [30]. Children of the elderly users are particularly positive about the supportive smart home because the systems monitor their parents and, therefore, remove some of the concerns [16].

Ethical considerations regarding SHT care

The conversation surrounding the ethics of implementing care robots within elderly care is diverse with no true consensus. A comprehensive 2018 review of the ethical arguments by Van de Meulebroucke et al. [48] outlines the most often cited arguments. Most interesting to us is the ethical question of the particular care relationship [48]. This raises the point that since care robots lack the ability to emotionally care about someone, they cannot reciprocate by engaging in a meaningful relationship with care receivers [11,49]. If care robots replace caregivers, the care relationship is disrupted and loses its meaningfulness [35,41].

These ethical arguments could be applied to the smart home caring for our children as many parallels can be drawn between the two vulnerable groups [42]. Existing research surrounding care robots and children focuses mainly on physical care robots and not on the use of the smart home as a day care alternative. Robots have been introduced into day care centres [47], as tutors [22] and as companions [17,25]. It has been reported that children socialize easily with the robots, quickly empathizing with them and attributing them with high levels of intelligence [7,8,14]. The introduction of “smart” toys for children has flagged the need for more comprehensive regulation surround a child’s data security and parents must be made aware of the possible exploitation of their child’s personal information [45].

Children and SHT

However a child's interaction with smart devices has moved beyond just toys. In particular, the emergence of speech appliances as a user interface for in-home interaction has opened up a world of possibilities [4], with children being able to use smart home devices before they can read and write [13]. What will the future hold for children growing up in the smart home? Jones (2018), reports that psychology-informed appraisals of robot-assisted childcare, and of robots for children in general, are scarce [21]. Sharkey and Sharkey raise the issue that It is possible that exclusive or near exclusive care of a child by a robot could result in cognitive and linguistic impairments [43]. The long term psychological impact of smart home child care must also take into account attachment theory which holds that a consistent primary caregiver is necessary for a child's optimal development [46]. What if that consistent carer is a smart home?

With the number of dual-income families rising [33], day care solutions are in high demand. However nannies and daycare are expensive as well as scarce [40]. Many parents have a negative image of child care due to it's impersonal, high cost and sometimes dangerous nature [51]. This leaves parents seeking alternatives to traditional childcare. Combined with the advance of smart home technology, this demand could pave the way for the smart home day care. Within this growing body of work surrounding the smart home, and in particular its potential for care, we identify a need to add the voice of parents to the discussion.

DESIGN

For this showroom research, a speculative concept video [appendix A] was produced. It sketches a future child care scenario where a smart home takes care of a 3 year old child while the parents are away at work during the day. The video begins by showing parents worrying about their child going to day-care and explains that day-care is expensive and might not always be safe. The speculative product "Big Sister" is then introduced. Big Sister is advertised as everything you need to set up your smart home day care system, in one easy to install package. The video shows the parents receiving the package, plugging something in and then altering settings (nap time, lunch time) in an app. The video then shows how the system would take care of the child. By sensing the child's activity, Big sister makes suggestions for activities such as dancing and watching a movie. The system will then give feedback and reward the child. Big sister, the smart home that we proposed, also teaches the child manners of the parents' choosing, for example washing their hands before eating lunch. When the child begins to fall asleep outside of the set nap time, Big Sister turns on the lights to wake the child up and prevent them from sleeping. The video concludes with the parents arriving home to a safe and happy child.

The video purposefully did not give a time frame when the movie was set (present or future) and did not show the technical aspects of how such a system would work. The video was framed as if Big Sister was really available to purchase with the aim of evoking a reaction from current parents. At the end of the video, there was a brief text included which clarified that the product was speculative and that the video was produced to invite debate about the future of smart home child care possibilities.

METHOD

This showroom design research project aimed to collect qualitative data regarding the boundaries of trust that parents form when thinking about the future of the smart home as a day-care alternative. In order to collect nuanced and intimate reactions of participants to this speculative design scenario, both a questionnaire and a more in depth interview were used. As the showroom approach aims to go beyond knowledge, and ask novel, uncomfortable, but relevant questions [51], qualitative data was collected as it best captures the answers to those uncomfortable questions. Qualitative data offers respondents the opportunity to reflect and reason in a variety of ways [51].

For this research, an online questionnaire was used to gather respondents reactions to the speculative concept proposed in the video. The questionnaire [appendix B] consisted of five sections: a consent form and description of project, demographic questions, information about the number and ages of any children, usage of smart devices and the reactions to the video. The questionnaire contained open answers, multiple choice and scale based response options to collect qualitative data. Demographic and contextual information was collected to inform the qualitative data analysis. The questionnaire was first completed by a sample group of three respondents and then improved to make it more understandable based on their suggestions.

The video was then uploaded to both Facebook and LinkedIn via the personal accounts of the researchers accompanied by an eye catching title and a brief request to watch the video and respond to the questionnaire with the link provided:

“👉LET YOUR HOUSE CARE FOR YOUR KIDS👈

Never worry about finding the right childcare services again!

We are looking into smart-home childcare. With houses becoming smarter, could they take care of our children? Would you leave your kids in the safety of your own home while you go off to work?

>>>> *Do us a big favour and share your opinion in this questionnaire”.*

In total, twenty seven participants responded to the questionnaire of which twenty one were parents (table 1). Parents were chosen as focus respondents, thus the five non-parent responses were disregarded. From these twenty one

respondents, six were interviewed further to gain a deeper understanding of their answers. The interviews followed the general structure of the questionnaire and asked the interviewees to elaborate and describe the rationale behind their answers [appendix C], however researchers also deviated from the structure if an interesting line of reasoning arose. This offered greater depth to the qualitative data.

To analyse the collected interviews, a thematic analysis [attachment A] as outlined in six phases by Braun and Clarke was used [9]. The first phase of *becoming familiar with the data*, was fulfilled by initially reading through the collected questionnaire and in-depth interview responses and also through transcribing and translating the recordings of the interviews. The second phase of *Generating codes* was completed with two researchers independently open-coding the twenty one questionnaire responses. The codes highlighted the relevant and important content of the responses. The two researchers compared and discussed any substantial differences in the open coding. Having two researchers working independently increases inter-rater reliability of the coding. The third phase of *generating initial themes* was completed by both researchers examining the codes and identifying broader repeated themes and patterns in the data [appendix D]. Themes not only looked at individual codes but also the surrounding context and the relatedness of codes, or what the data actually *means*. For the fourth phase of *reviewing themes* two researchers independently reviewed how well the themes captured the data by classifying codes per theme. Here the in-depth interviews were coded by theme, offering greater insight into the rationale behind claims. For the fifth phase, *Defining and naming themes*, four researchers together looked at the raw data and the associated codes, and discussed if the themes captured the overall significant topics that were raised and the nuanced tone of the responses. Some themes were renamed to better reflect the tone of the data. The sixth phase, *Producing the report* was completed by outlining the significance of each theme for the research question, and analysing the co-occurrence of themes with certain demographic information.

While the process seems sequential, it is important to note that the coding process was cyclical and constantly evolving as interesting patterns and new insights emerged.

Age group	Amount of participants	Amount of participants with experience in SHT's	Age of children?
25-34	4	4/4	Between 6 months

			and 13 years old
35-44	6	4/6	Between 3 and 12
45-54	6	4/6	Between 9 and 24
55-64	5	3/5	Between 18 and 27, or older

(Table 1) - An overview of the respondents.

ANALYSIS

The data resulting from the questionnaire can be found in [attachment B]. This data was used to form the initial themes. The data resulting from the interviews [appendix E] was used to verify these initial themes which resulted in the final four themes as described below. Next to this, it provided greater insight into the reasoning behind the themes.

Responses to the concepts raised the issues of trust regarding the emotional/social development of the child, mainly because the Smart Home nanny does not have a physical body to hold, touch and help the child physically, as well as the system's inability to empathize and have human emotions. Another point made was that the child would have no interaction with other children, which participants believed to have a negative effect on the emotional/social development of the child as well. Therefore the corresponding quotes show that there is mistrust in the system's ability to interact with the child as humans would, which is believed by most participants to have a negative effect on the development of the child's social and emotional skills.

Furthermore there is a trust issue regarding safety. The quotes showed two themes regarding safety; "Medical Safety" and "Practical Safety". "Medical Safety" focuses on the health of the child. It was found that most respondents do not trust the system's ability to act in a sufficient manner when faced with medical issues. "Practical Safety" focuses on practical issues in the house and the system. It was found that most respondents do not trust the system to take care of emergency situations (fire, robbery, gas leak). Next to this, there is mistrust, especially from older people (age >45) in the reliability of the system, they fear malfunctioning.

Another theme is the mistrust in children's behaviour with the system. Some respondents believe their children will take advantage of the system and would not take it seriously or respect it as an authority.

In the upcoming sub-sections we will elaborate on and provide more evidence for each of the aforementioned themes

Emotional/social

Most of the respondents believe children need physical contact in the form of a hug, physical help with tasks (changing diapers, feeding, etc), and physical help when in need. The questionnaire quotes for this theme indicate that most respondents believe there should be some form of physical “being” in the room, to be able to touch the child. It also suggests that this physical “being” should be able to give hugs, help with tasks, as well as provide help when needed. As one of the interview quotes illustrates “*if they woke up from a nightmare and the only thing there was some voice telling them to go back to sleep because it’s sleeping time then that wouldn’t be very nice because they still need to be comforted when stuff like that happens.*” (I23) Next to this, almost all respondents talk about the system’s inability to empathize and its inability to have feelings. As one questionnaire respondent says “*You don’t get the love, conversations and upbringing from a robot.*” (P4) which illustrates the mistrust in the system’s ability to empathize with the child. This system’s inability to empathize and feel has according to many respondents a highly negative effect on the child’s development of emotional and social skills.

Human contact/interaction

The inability to interact with other children is also believed to have a negative effect on the child’s emotional/social development. This is illustrated by quotes such as “*I think human interaction is fundamental to develop emotional intelligence and empathy.*” (P8), and “*I would be most concerned about the development because they have less contact with other humans.*” (P20), and “*I would be most concerned about the development of their social skills... They do not interact with actual human beings with feelings and moods and unexpected reactions.*” (P16), “*No contact with other humans so the child becomes lonely.*” (P14). These quotes clearly show the mistrust in the system’s ability to interact with the child as humans would as well as the fear for the child’s emotional/social development.

Safety

Another point of concern was safety. Most of the respondents in the questionnaire as well as the interview talk about this topic in various ways. The two biggest themes here are “Medical Safety” and “Practical Safety”. “Medical Safety” focuses on the health of the child, “*I would be most concerned about the child falling or injuring him/herself because he/she can’t help him/herself.*” (P2), “*I would be most concerned about emergencies, because a computer can not perform CPR.*” (P1). Respondents show not to trust that the system is able to act in a sufficient manner when faced with medical issues. As an interview respondent illustrates “*I won’t trust the system to take action in an emergency, where I would trust that my nanny would know what to do and act accordingly.*” (I21), this indicates that we have better trust in humans than in systems. The results of both sets of quotes indicate that this is due to the system’s inability to make ethical considerations, which then relates to the previous topic. The “Practical Safety” focuses on practical issues both in the system as well as the house. As one questionnaire

development

respondent illustrates “*(The concept) is fine unless something goes wrong, (like a fire, robbery)*” (P13), this shows the mistrust in the system’s capability to deal with these unexpected practical issues. Other responses are “*It’s a device. It can fail*” (P16), or “*I would be most worried about safety, because all computers have bugs in the system. Nothing is perfect.*” (P6) which shows the mistrust in the system’s malfunctioning. There are clear boundaries of trust in regards to safety both medical and practical, and there is little trust that the system is capable of handling these situations properly, mainly due to its inability to make ethical considerations as well as malfunctioning.

Many participants doubt the abilities of the technology proposed in the system, which can be seen in both *Emotional/social development* and *Safety*. The absence of physical touch disables the system to e.g. change diapers, feed the child, comfort the child. Furthermore, there is little trust in the reliability of the system regarding malfunctioning. Next to this, there is little trust in the system’s ability to deal with emergency situations. Respondents do not trust that technology is advanced enough to deal with those situations and tasks.

Children rebelling against the system

Some respondents do trust the system, but have little trust in their children. They believe their children will take advantage of the system and misuse it’s capabilities. As the questionnaire respondents said “*I think the child will easily take control over the situation. After the initial interest, they will start to use the fact that it is a computer program with specific functions and use it on his own benefit, doing his will and/or not paying attention at all to the Big Sister.*” (P8), “*Kids would rebel/dislike the Smart Home caregiver as often as their human caregiver*” (P12), “*I trust the system, but not the children, because they will not listen to it anyway*” (P15). This was backed up by two interview participants with quotes such as “*They would probably try to re-program it and they would think it’s hilarious that there was a voice telling them to do something*” (I22), and “*I think that some kids might take advantage of the situation*” (I14). With only seven out of twenty three people acknowledging this mistrust, it is not substantial enough to take as the truth, however could prove interesting for future research.

Besides the mentioned themes there are some general insights worth noticing. First of all, when asked the question “Do you think that the Smart Home could replace a human caregiver?” nineteen out of twenty one respondents answer no. However when asked the question “How likely do you find it that the smart home will replace traditional childcare in the future?” there are eight out of twenty one respondents with some kind of trust that the future will have smart home nannies (rated >3) (See figure 1). This seems rather contradictory and indicates that even though respondents personally do not want the Smart Home to replace human caregivers, they do believe it will exist and be used in the future. This is illustrated by quotes such as “*Many people struggling for money would find it appealing.*” (P3), “*Everything is getting more digital.*” (P10), “*Smart Homes*

already contribute so much, I think it is likely that some parents would use it and some children would enjoy it.” (P12), “People in general are obsessed with technology.” (P19), “I believe that big data will be able to be used to function as an intelligent system that can sense multiple environments, eventually there will be products that emerge from this and this might be an example of how such a system will be implemented.” (I14).

How likely do you find it that the Smart Home will replace traditional childcare in the future?

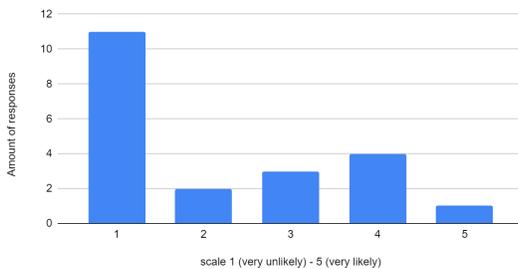


Figure 1 - Responses to the question “How likely do you find it that the Smart Home will replace traditional childcare in the future?”

Another remarkable insight is the rate of themes mentioned by comparing the different age groups [appendix F]. The age group 25-34 is most concerned with Medical Safety, whilst other age groups are scoring far lower on this theme. It is also interesting that in comparison with the other three age groups, the 25-34 year olds tend to mention Human contact/interaction as well as Emotional interaction far less often. This indicates that the youngest age group of parents have a more positive view on the Human-Computer Interaction and do not necessarily see this as a negative effect on the development of the child.

Next to this, it is noteworthy that people who have experience with Smart Home products tend to worry about the Safety issues, both Medical as well as Practical [appendix G]. This might be because they are aware of the limits of the current systems.

DISCUSSION

Limitations of method:

For this study, there are a few points which are important to note when evaluating the impact and reproducibility. The first is sample size and method. The sample size (N=22) is too small to be representative of the entire population, while convenience sampling did not guarantee a diverse range of respondents. The only current response criteria was parents based in the Netherlands. Responses received by non-parents (N=5) were disregarded. We would encourage future researchers to validate if our findings hold true across a larger, more varied sample group. It is also important to note that our participants, while including some parents of international origin, were all currently based in the Netherlands. Interesting future research could focus on cultural or national differences, or on comparing the

responses of non parents with parents. Despite the limitations of the sample group, the study was successful in triggering emotions and capturing the thoughts and feelings surrounding the topic. The collected qualitative data provided valuable insights for a small sample group and repeated themes amongst respondents added to the robustness of the study, while more nuanced differences offer interesting opportunities for future research.

Another limitation of the convenience sampling method was the familiarity of interviewer and interviewee. This could have influenced social behaviour and responses. The interviews were also conducted by various interviewers and therefore in a slightly different manner which could result in discrepancies. Furthermore, the interviews were conducted via telephone due to time constraints. This made it difficult for the researchers to sense the actual feelings of the other person because body language cannot be observed. For future research, it might be interesting to observe the participant while watching the movie to ask more questions about their emotional response. The in-depth interviews were also not conducted immediately after the first time the participant watched the video. Therefore, the emotional response might have been faded which might influence the answers on how the participants perceived the concept at first. However, we tried to capture these emotions through the questionnaire, since every interviewed participant had also filled in the questionnaire right after watching the movie.

The visceral and emotional responses which we received highlight parents’ apprehension towards this future childcare scenario and proves that this area is worth exploring more in depth. Next to this, it is very likely that technology will be advanced enough to realize this concept and scenario in the future, which makes it desirable to explore the ethical boundaries of such a system. This research study can be used as a starting point for designers developing smart home childcare solutions as a basic insight into user feelings and concerns.

As we can read above, we found some interesting differences between the age groups. There is seen that the youngest age group mentioned Medical Safety far more often compared to the other age groups, and mention Human contact/interaction as well as Emotional interaction far less in comparison to other age groups. This indicates that they have a more positive view on Human-Computer Interaction and its effect on children's development. However, as mentioned above, the sample sizes were too small to state that these differences could be generalized, therefore the findings can also be coincidental.

Limitations of design:

The design that is used for this research has a lot of influence on the responses of the participants. If the design was

proposed in a different manner, for example as a robot nanny, the respondents might have given different responses and concerns regarding the advancement of smart home technology. For example, some respondents stated that they do not see how the system would change a diaper or how it would handle if a child would fall however if we had shown the smart home doing these activities in the video, these answers might have been different. Another drawback of the design is its speculative nature. Since people cannot experience the technology that is proposed in the system, it might be difficult to envision how this technically may work and thus cause more distrust in the system. Furthermore, in the animation it was shown how only one child would be taken care of. Families with multiple children are not taken into account in the presentation of the concept. It is also important to consider that the system proposed was a basic representation, here we did not introduce how the system would take care of the children and according to what kind of parenting style. This was up to the imagination of the parents, which of course also influenced the outcomes of this study.

CONCLUSION

All participants responded negatively to the concept of Big Sister. The thematic analysis of the questionnaire data resulted in several themes regarding issues of trust. The themes that were found here are emotional/social development, human contact/interaction, safety, and children rebelling against the system.

The issues surrounding emotional/social development focus on the absence of a physical body to hold, touch and help the child physically, as well as the system's inability to empathize and feel. The issues surrounding human contact/interaction focus on the absence of other children, which participants believed to have a negative effect on the development of the child. There is mistrust in the system's ability to interact with the child as humans would, which is perceived to be harmful to the social and emotional skills of the child. Furthermore, the issues regarding safety are divided into "Medical Safety", which focuses on the health of the child, and "Practical Safety", which focuses on practical issues in the house and the system. There is mistrust in the system's ability to deal with these emergency situations, as well as mistrust in the reliability of the system. Another theme is the apprehension towards children's behaviour with the system. Some respondents believe their children will take advantage of the system and would not respect it as an authority.

Besides the themes from the thematic analysis, the quantitative data from the questionnaire indicates that even though respondents personally do not want the Smart Home to replace human caregivers, they do believe they will exist and be used in the future by others.

There can be concluded that at this point in time, Smart Homes as caregivers are not perceived as desirable for

current parents, but there is a belief that it could happen in the future. There are many issues of trust which influence the overall desirability of the smart home as a day-care alternative. Next to this, we found a lot of complex feelings and emotions triggered by the concept. However, since the sample size was very small, it is hard to draw conclusions that represent society as a whole, therefore we recommend future research to dive in to this topic further, especially as technology is becoming advanced enough to realize this concept.

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Appendix A: Video

<https://www.youtube.com/watch?v=9Bu-S548JAE&t=23s>

Appendix B: Questionnaire (questions)

Consent form

This research is focusing on the reaction to a proposed future view of childcare in a smart home. The questionnaire will take about 10 minutes. The intention is to fill in the questionnaire **after** watching the movie. This research is conducted for the course Constructive Design Research at the Technical University of Eindhoven.

The results of this questionnaire will be published in the final research paper. Your information will remain anonymous and can only be accessed by the researchers: C.A. Kuijpers (c.a.kuijpers@student.tue.nl) , L.C.G. Voermans (l.c.g.voermans@student.tue.nl) , S.G. Beijer (s.g.beijer@student.tue.nl) and D. O'Neill (d.oneill@student.tue.nl) . And the supervisor S.C. Kuijer (s.c.kuijer@tue.nl) .

Declaration of Consent:

By signing this document I am giving my consent to the researchers to use the collected data, as stated above. Furthermore do I have a clear understanding that my participation in this research is voluntary. I have the right to refuse to participate or withdraw from the research at any point in time. I agree to provide written and verbal feedback throughout the research. I understand that all the data collected from my participation will be anonymized and used for the design research project and all the documentation concerning it and I agree it to be used in such a way.

I understand purpose of this research and allow the researcher to use my data anonymously. I agree to the terms.

Demographic

- Age

- Under 18 years old
- 18-24 years old
- 25-34 years old
- 35-44 years old
- 45-54 years old
- 55-64 years old
- 65-74 years old
- 75 years or older

- What is your occupation?

- Fill in

- Are you a parent?

- yes/no

- How many children do you have?

- 1
- 2

- 3
- 4 or more
- How old are they?
 - Fill in
- Do you have experience with smart home products already (e.g. Amazon Alexa, Google Home, Philips Hue, any smart thermostat or fridge, ChromeCast, automated vacuum cleaner, etc.)?
 - Yes/N
- Which ones do you use? (you can click multiple if applicable)
- What activities do you use these devices for?
- Do your children also use these devices? If yes, how?

About the movie

- What was your initial reaction to the Big Sister concept?
 - Fill in
- How comfortable are you with the idea of the smart home taking care of a child?
 - Scale 1-5 (very uncomfortable, very comfortable)
- What makes you feel comfortable or uncomfortable about the scenario?
 - Text box
- How likely do you find it that the smart home will replace traditional childcare in the future?
 - Scale 1-5 (very unlikely, very likely)
- Why do you think that?
 - Why? (Text box)
- Please fill in the blanks: I would be most excited about ___ when leaving a child in a smart home because ___ (leave blank if nothing excited you)
 - Text box
- Please fill in the blanks: I would be most excited about ___ when leaving a child in a smart home because ___ (leave blank if nothing excited you)
 - Text box
- How likely are you to trust the system that is proposed in the video?
 - Scale 1-5 (very unlikely, very likely)
- Why do you think that?
 - Text box
- Do you think that the Smart Home could replace a human caregiver? Why or why not?
 - Text box
- If the Big Sister product was real, would you subscribe for a free trial period of the product/service? (please answer as if your children are (still) too young to live alone)
 - Scale 1-5 (very unlikely, very likely)
- Why or why not?
 - Text box

Thank you for participating!

- If you have other thoughts, remarks or feedback you can write this below!
 - Text box

Appendix C: Interview questions

Consent form

This research is focusing on the reaction to a proposed future view of childcare in a smart home. The questionnaire will take about 10 minutes. The intention is to fill in the questionnaire **after** watching the movie. This research is conducted for the course Constructive Design Research at the Technical University of Eindhoven.

The results of this questionnaire will be published in the final research paper. Your information will remain anonymous and can only be accessed by the researchers: C.A. Kuijpers (c.a.kuijpers@student.tue.nl), L.C.G. Voermans (l.c.g.voermans@student.tue.nl), S.G. Beijer (s.g.beijer@student.tue.nl) and D. O'Neill (d.oneill@student.tue.nl). And the supervisor S.C. Kuijer (s.c.kuijer@tue.nl).

Declaration of Consent:

By signing this document I am giving my consent to the researchers to use the collected data, as stated above. Furthermore do I have a clear understanding that my participation in this research is voluntary. I have the right to refuse to participate or withdraw from the research at any point in time. I agree to provide written and verbal feedback throughout the research. I understand that all the data collected from my participation will be anonymized and used for the design research project and all the documentation concerning it and I agree it to be used in such a way.

I understand purpose of this research and allow the researcher to use my data anonymously. I agree to the terms.

During this interview, we will ask you several questions regarding children, childcare and smart home products. First, we will ask a couple of general questions. Second, we will show a movie where a concept is explained. Third, we will ask questions with regard to the movie. If there are any questions at any point, you are of course free ask anything. Also, you are not obliged to answer all questions and can indicate any time if you feel uncomfortable or want to stop.

Background info

“Do you have children?”

“How many, how old are they?”

“Tell me about your experiences with childcare?”

Why do they have childcare, or alternatives, are they satisfied?

“How do you feel when a babysitter is watching your child?”

“Tell me about the relationship with this person?”

-Ask about trust

Smart home experiences

“Could you describe your experiences with smart products in a home? (e.g. alexa, philips hue, smart thermostat or fridge, Ipad, ChromeCast, Timers on devices, automated vacuum cleaner, etc.)”

“For what purposes do you use these devices?”

“Could you describe how your children are involved in using these products?”

“How do you feel about letting your child interact with alexa or google home?”

* show movie*

After seeing the movie

“How do you feel after watching this video?”

“Could you describe how you feel about a smart social system, such as could be seen in the movie, that can care for a child?”

-Could you describe in which scenarios this might be beneficial?

“What influence do you think such systems will have on your child?”

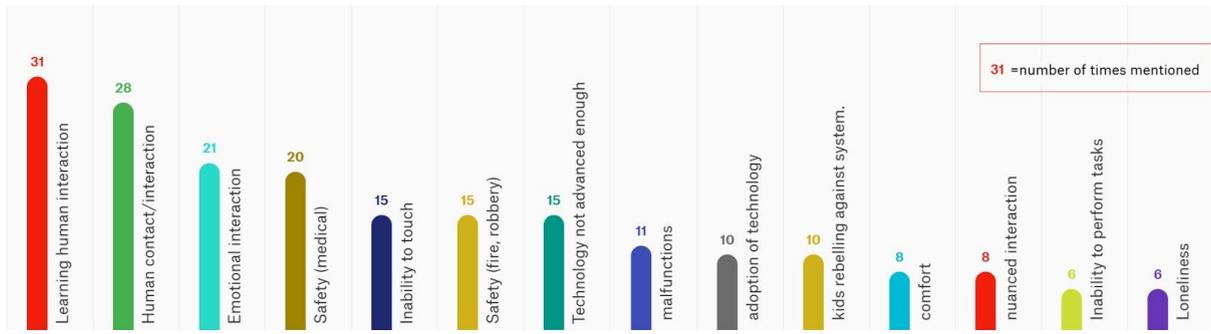
“Do you think that leaving your kid with a smart system is ethically appropriate?”

-Why yes/no

“How would you feel when you leave your kid with this system?”

“Would you want to buy this service?” “Why yes, why not?”

Appendix D: All themes



Appendix E: Interview results

Emotional & social development

“It’s kind of like they are cattle if we tell them when to sleep when to eat, when to move and you’re not really reading anything about them or what they’re feeling” – I22

“If they woke up from a nightmare and the only thing there was some voice telling them to go back to sleep because it’s sleeping time then that wouldn’t be very nice because they still need to be comforted when stuff like that happens.” - I23

“Having not so much human contact during the day and no peer contact so no other kids around that they can learn things from, like social interaction happens from such a young age will def have an impact. Especially once they transition to school and they don’t know how to deal with other real people. Or they have trouble socializing.” - I23

“I think it’s better and more fun for the kids to go to daycare so they can interact with kids their own age” - ” I21

“I think it’s sad if a child cannot experience a hug from a human.” I16

“He needs to play with others, the kid. Does not need to be so individual at a young age.” I2

Safety in medical/practical emergencies

“I won’t trust the system to take action in an emergency, where I would trust that my nanny would know what to do and act accordingly ” I21

“The video freaked me out a bit because it seems like the kid is about 3 or 4 and that scared me just from a health and safety point of view.” I22

“You miss the human factor, handling the situation if a child falls down cannot be done by the system. There are too many things that the technology cannot do yet.” I2

Malfunction of system/kids trying to break it

“They would probably try to re-program it and they would think it’s hilarious that there was a voice telling them to do something” I22

“I think that some kids might take advantage of the situation” I14

“However, it misses intelligence. It cannot sense the different scenarios and act accordingly.” I14

Teaching manners

“The system cannot sense emotions, it cannot learn the different levels of “wrong”. Because a parent reacts on a child sometimes very gently and sometimes very direct, but it is

dependant on the child's behavior. He thinks that a system cannot do this. Maybe in the future, but now the system cannot function so optimally. Does not have fine skills of parenting." I14

Teaching general skills

"It's kind of nice to have someone other than the mum orchestrating activities." I22

Age group

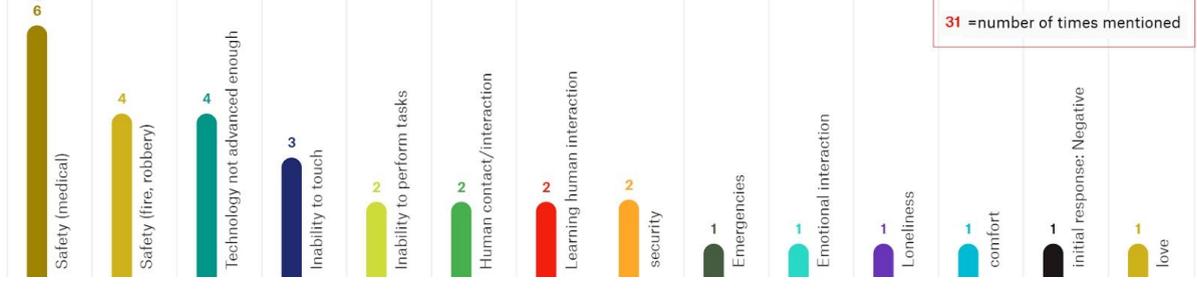
" I was thinking this is quite good because I don't really need a nanny but this is someone to tell them, go do this go do that... but I think that only works because they're 10 and 13." – I22

"I don't think I would do it at night though, not at the age that our kids are now anyway." I23

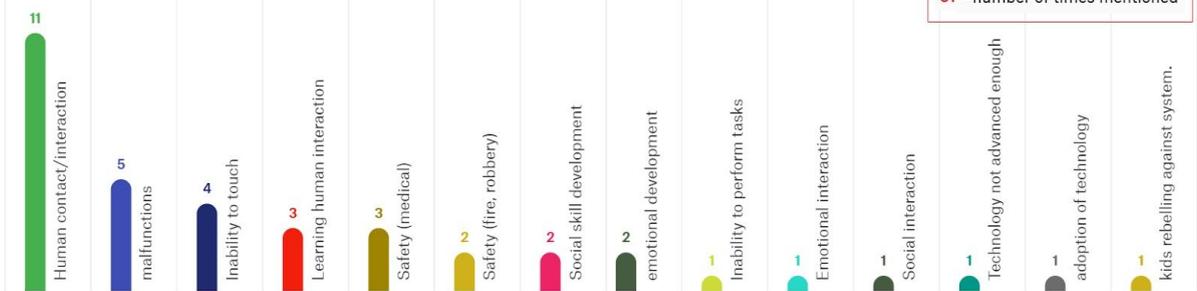
"Or if it was going to be a really long day, like the school holidays for example and i had no other option then why not! They are already pretty self sufficient." I23

Appendix F: Age categories

Age 25-34



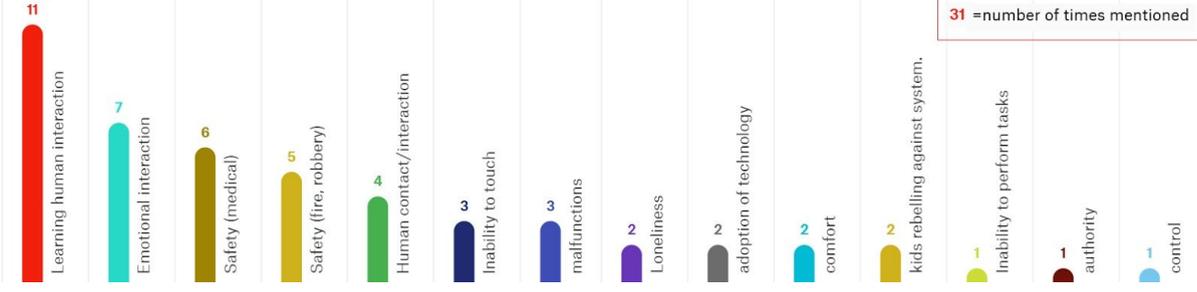
Age 35-44



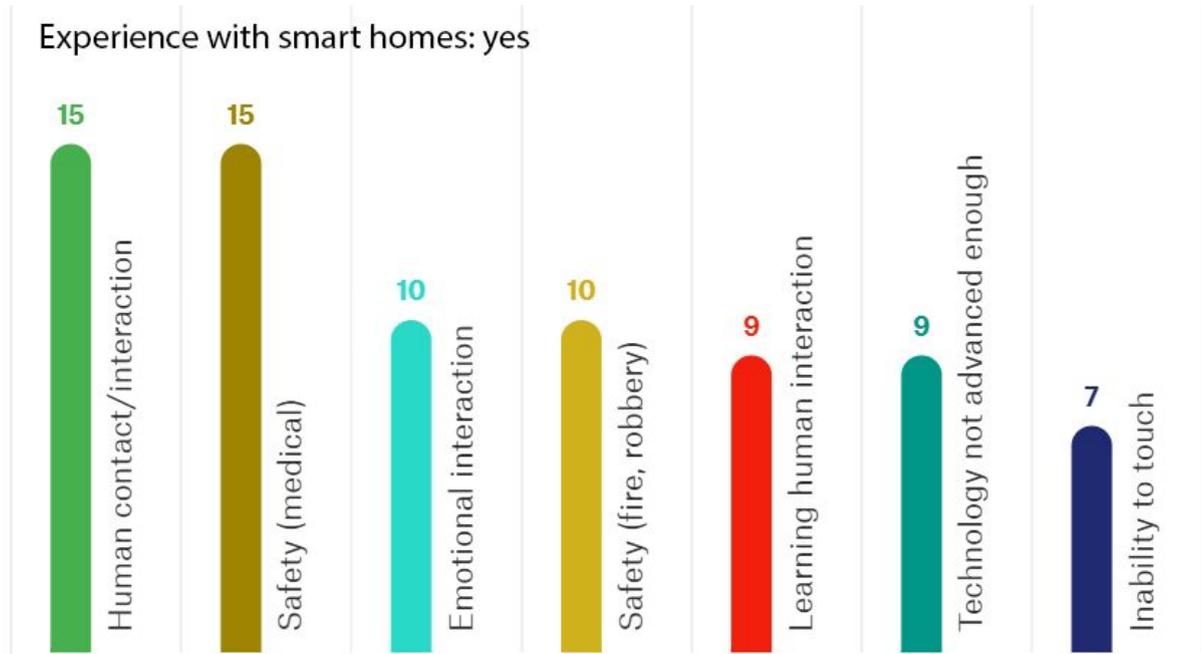
Age 45-54



Age 54-64



Appendix G: Experience with smart homes: yes



Appendix J: Authors backgrounds

Daisy O'Neill

Daisy O'Neill is a 1st year master student of industrial design at Eindhoven University of Technology. She believes that great design should foster authentic human experiences which means taking a step back from our virtual existence and interactions mediated by screens, and fostering real-world connections between people, their emotions and their environment. She takes advantage of the latest technological trends by exploring how they can be translated into interactions grounded in the human condition, whether that be our need to be understood, our love of play or our connection to nature. It is her vision to use technology to foster rich, real-world understanding as opposed to disabling it. This means that she is critical of where she introduces technology into her designs and conscious of the impact it makes.

In this research project Daisy worked on the production of the video, including the concept, storyboard, filming, editing and voice over. She was active in both benchmarking related projects and reading relevant academic literature to frame and positioning the research within recent related work. Daisy also worked on creating the questionnaire, and was responsible for 2 of the in depth interviews. She analyzed both the questionnaire and interview data through thematic analysis and was the main writer of both the method and related work sections of the report.

Sanne Beijer

Sanne Beijer is a 1st year master student of Industrial Design at Eindhoven University of Technology. She did her bachelor Industrial Design also in Eindhoven, for her FBP she did a research project on a haptic display of breathing techniques. This was a research that had a lab approach and was therefore different from this showroom approach. I like how thoughts, beliefs and behaviour are intertwined. People are easy to influence, even unconsciously. I find it interesting to look at human behaviour within design projects. Humans intrigue me. Because people are easy to influence, we must be sure of the consequences and the benefits to the user when something new is introduced. This is in line with this project because the boundaries of Smart Homes are researched.

In this project Sanne had a role in creating two visuals for the video. Further, she made the first draft versions of the introduction, related work, method and discussion section and created the paper strategy. She had an active part in creating the structure of the overall research set-up. She worked on creating the consent form, questionnaire and interview set-up and was responsible for three in depth interviews. She gave the presentation together with Loes and in the end she finalized the method, design and discussion section of the paper together with helping on the other aspects.

Loes Voermans

Loes Voermans is an industrial designer based in Eindhoven. She works in the field of critical and social design and sees design as a medium to support and trigger conversations. Her designs trigger people's feelings and empowers them to form opinions around complex

topics as well as function as a support tool for discussions and conversations. She loves working with complex and controversial problems and gets energy from heated discussions.

In this research project Loes worked on the production of the video, including the concept, storyboard, filming and voice over. She has gathered and read input for the related work, both academic as well as newspapers and TED Talks. Furthermore, she worked with Sanne on writing the first drafts of the paper. She has participated in defining the strategy for the project as well as the social media strategy for the concept. Together with Daisy she analyzed the questionnaire and interview data and was responsible for the findings. She is the writer of the analysis and findings part of the report as well as the conclusion. She was responsible for the final presentation together with Sanne.

Charlotte Kuijpers

Charlotte Kuijpers is a first year master student Industrial Design at the University of Technology Eindhoven. She is a designer with interests in the field of future living and intimate objects. For Charlotte, design is a tool to shape society. She uses her interdisciplinary skillset to create services, systems or products that challenge the established. She likes to stretch boundaries and research opportunities to use technology for a more sustainable world of tomorrow. For example, her bachelor graduation project was a designed system for peer-to-peer sharing of clothes, by making use of the trending NFC technology applied in fashion.

Throughout this project, Charlotte was active in selecting and defining the subject and theme of the design and research, designing the research probe and writing the paper. Charlotte took an active role in collecting and processing related material: designs, academic papers and popular media. She worked on the production of the video, including concept, storyboard, sound and editing of the voice over. Charlotte created almost all the drawings used in the video, helped editing the video in Adobe After Effects and created the Big Sister logo. She developed the online “campaign” to go with the social media posts and conducted an interview. She wrote the final version of introduction, part of related work and offered support throughout the paper, be it with grammar checks, content and syntax. She put all the sections together and made sure references were used correctly.