Figure 1: MATY conceptual evolution through interviews using RtD.

MATY: Designing An Assistive Robot for People with Alzheimer's

Hugo Simão
Faculdade de Arquitectura
Universidade de Lisboa
hsimao@isr.tecnico.ulisboa.pt

Tiago Guerreiro
LASIGE
Faculdade de Ciências
Universidade de Lisboa
tjvg@di.fc.ul.pt

ABSTRACT

Caregiving to a person with Alzheimer's can be a very demanding task, both from physical and psychological perspectives. Technological responses to support caregiving, and improve the quality of life of people with Alzheimer's and their caregivers are lacking. Using a research through design approach, we devised a robot focused on empowering people with Alzheimer and fostering their autonomy, from the initial sketch to a working prototype. MATY is a robot that encourages communication with relatives and promote routines by eliciting the person to take action, using a multisensorial approach (e.g., projecting biographical images, playing suggestive sounds, or emitting soothing aromas). The paper reports the iterative, incremental design process performed together with stakeholders. We share first lessons learned in this process with HCI researchers and practitioners designing solutions, particularly robots, to assist people with dementia and their caregivers.

KEYWORDS

Alzheimer's; Assistive robots; Research Through Design

CHI'19 Extended Abstracts, May 4–9, 2019, Glasgow, Scotland Uk

ACM ISBN 978-1-4503-5971-9/19/05.
https://doi.org/10.1145/3290607.3313016

INTRODUCTION

People with Alzheimer incrementally lose their autonomy and require additional support and alertness. The increased prevalence of Alzheimer associated with aging brings forward the need for effective and scalable caregiving alternatives. One potential approach to support people with Alzheimer and their caregivers relies on robots. Recently, we have witnessed an increase in the usage of robotic appliances in the home and in social environments, offering opportunities to caregiving [6]. Particularly, in the case of Alzheimer's, a robotic approach may enable independence promotion, and consequently, mitigate the exhausting caregiver role [10].

Currently, there are robots to assist anxiety, depression, loneliness, and stress relievers through a multi-sensory approach [11, 13]. Other approaches focus on security and perceived security mainly employing medication reminders, social interaction inside institutions, and professionals' support through remote surveillance [2, 12].

Our approach is focused on a set of holistic needs while the person with Alzheimer's is at home. We propose a person accompaniment-robot to encourage autonomy and stimulate communication, from an early stage while at home, to later phases, eventually when in an institution.

In this late-breaking work, we present the evolution of the design of a domestic robot, iterated and discussed through several phases with stakeholders. These changes go from the robot's aesthetics and components to its roles. Part of these changes raise from from ethical challenges and highlight reflections on the relevance of Research through Design, an holistic approach to a problem intercepting multidisciplinary knowledge [15].

DESIGNING MATY

Current approaches, taken by professionals or using robots, focus on mitigating the cognitive limitations associated with Alzheimer, being highly focused on disability [5]. This approaches focus on a specific cognitive stimulation, reminiscence, company, stress mitigation and depression [14]. Currently, a continuous 24/7 home follow-up approach to the person with Alzheimer is lacking. This continual alertness is crucial on assisting the person with dementia and is the greatest caregiver paradigm, which can lead to a "burden state" [1].

Before starting the interviews, we conducted exploratory research, allowing us to define a start point based on late findings in the literature [3, 7]. After interviews, posterior reformulations were incrementally added according to appearance-based studies or suggested by interviewees. We started by developing the robot bidimensionally. These initial sketches served as a tool for exposing ideas and concepts, allowing two clinical psychologists, two occupational therapists, two caregivers and two people with Alzheimer in an initial phase (n=8) to critique our first attempt.

Figure 2: MATY v1: based essentially on related work and MATY v2: a translucent unnoticed version according to interviews inputs

MATY Service to the person with Alzheimer and the Caregiver. We established MATY central service and action as being a proactive assistive robot for a person with Alzheimer - eliciting initiative to perform tasks through visual, auditory and olfactory clues, inducing certain actions at specific day times is MATY goal. An example would be at mealtimes. MATY goes near the person and alerts her using wall-projected suggestive images and dining sounds (dishes, cutlery) avoiding the indifference or forgetfulness concerning food.

MATY v1. MATY v1 rises from findings describing that people with Alzheimer's understand better simple forms [7]. This first prototype, Figure 2, incorporates a speaker and a projector to provide audiovisual inputs to elicit behaviors. In general, robot lies heavily on tasks performed by robots and not by humans. On the other hand, MATY intends to focus on the person with Alzheimer empowerment and autonomy, eliciting to action and task execution. Concerning this initial prototype, psychologists declare it too robotic and reminded a sentry, possibly conveying negative thoughts. A possible "invisible" robot presence is significant to highlight, considering one psychologist suggestion. Disease denial attitude often adopted by people with Alzheimer, or due diagnosis omission indicates that somehow, a robot might do its action without being noticed.

MATY v2. Adopting a less sentry perspective, we developed, still bi-dimensionally, a non-intrusive robotic presence, Figure 2. As a result, MATY v2 is, hence, a translucent robot enabling camouflage itself in the environment. Translucent characteristic did not produce consensus and raised controversy due to different clinical perspectives, inherently ethical. The two caregivers and one psychologist argued it could be a way to avoid confrontation with the diagnosis or even avoid confusion towards the robot in later phases. The second point of view claims, ethically, people must be informed respecting their clinical situation and be knowledgeable regarding true robot intentions. Moreover, a translucent unnoticed robot among people prompt to visuospatial difficulties can be dangerous. The authors agreed and felt more comfortable with this last argument. We initiated modifying characteristics to a third version. Psychologists mentioned suggested a social robot with a friendly looking could trigger better responses in people with Alzheimer. Additionally, based on 1 occupational therapist feedback, we added an olfactory functionality, to provide memory stimulation through scents. Consequently, the third version incorporates two compartments in the back of the robot to allow sprinkling aromas.

MATY v3. MATY v3, as shown in Figure 3, was our first physical version. We explored electronic requirements and some functional characteristics to obtain a reasonable level of interaction. This version walks and has LED eyes to increase its social presence [8]. This prototype allowed semi-structured interviews with a broader stakeholder sample (n=26, previous 8 included), to extract opinions and reformulations.

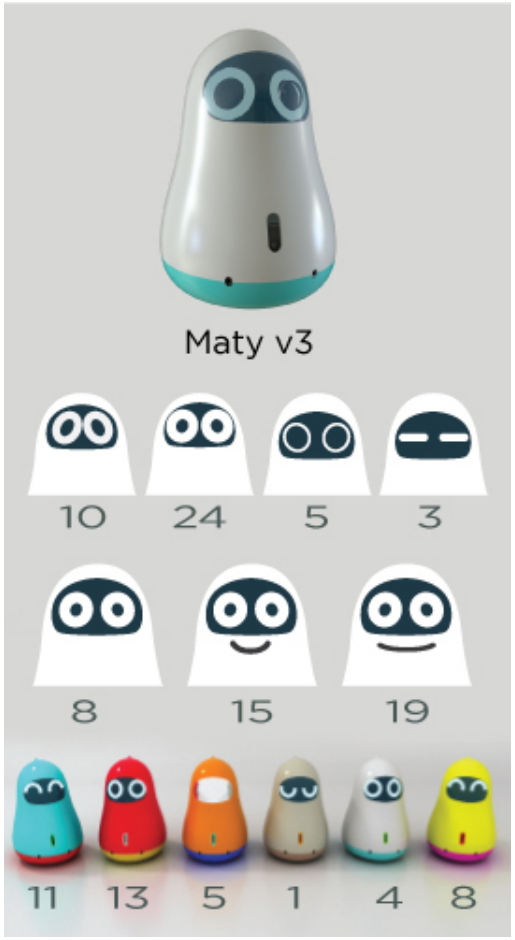

Figure 3: MATY v3: the first physical version and quantitative results of several options to ascertain future decisions regarding facial expressions and chromatic options to implement on MATY v4

MATY facial expression had no agreement. Some professionals warned that a smile absence gave him a poker face/ unfriendly appearance. On the other hand, some advised a neutral face does not generate other interpretations. The smiling inability was pointed out by one person with Alzheimer stating that the robot does not have a mouth to smile. The disagreement had also depleted on colors. On one side we have the discussion on people with Alzheimer higher adherence to intense colors [4]. Conversely, a different viewpoint argues intense/bright colors may be tiring or aggressive in medium-long-term exposure. Starting from this divergence, we evaluated chromatic and facial expression alternatives, explored ahead, with elderly individuals with and without Alzheimer concerning acceptance.

MATY Service to Professionals. Throughout interviews, we noticed joining institutions' scenarios useful, since people with Alzheimer often needs institutionalization at later phases. Hence, MATY at a late stage and inside a care home becomes a therapeutic tool for professionals and a transition channel - from home to an institution - for the person with Alzheimer. MATY provides auto bibliographic information (photos and videos of relatives, familiar places, and personal music) and previous home schedules and routines collected. To answer many professionals complaints, MATY's objective inside care homes is reducing the lack of autobiographical material and help in reminiscent therapy [9]. Reminiscent therapy recalls individual' life experiences to produce psychological well-being.

MATY v4. We did a questionnaire to clarify the lack of empathy. We used multiple facial expressions images examples to explore several eye shapes, smiles, and color varieties. Since older people are Alzheimer potential candidates, due to old age, we performed the test with people with Alzheimer (n=30) and older people without any cognitive impairment (n=12). Conventional (round) larger eye-shape are more natural recognized as eyes and more pleasant as analysis verified. Unusual eye-shapes are hardly understood as eyes, showed in Figure 3 by people with Alzheimer. Concerning the smile, there was a much higher adhesion to a face with a smile showed in Figure 3 . The questionnaire data analysis reported a robust cheerful and vibrant colors preference as seen in Figure 3. The last prototype, MATY v4, showed in Figure 4, is the final physical result with the reformulations coming from the last stakeholder's reviews. Robot size increased from 22 cm to 46 cm in height. Interviewees claim that a robot should be large enough to be noticed and avoid stumbling.

LESSONS LEARNED

Overall, MATY was well received. The most substantial changes were in appearance, ensuring that it is visible and noticeable, responding to ethical and safety issues. Most interviewees, mainly older people with or without Alzheimer claim minor technical knowledge, making them less prone to produce drastic technological shifts. A pleasant finding was the prompt adhesion to MATY which clearly expresses a lack of permanent care assistance in a domestic environment. Caregivers and professionals questioned how much it would cost and when it would be ready to use it routinely.

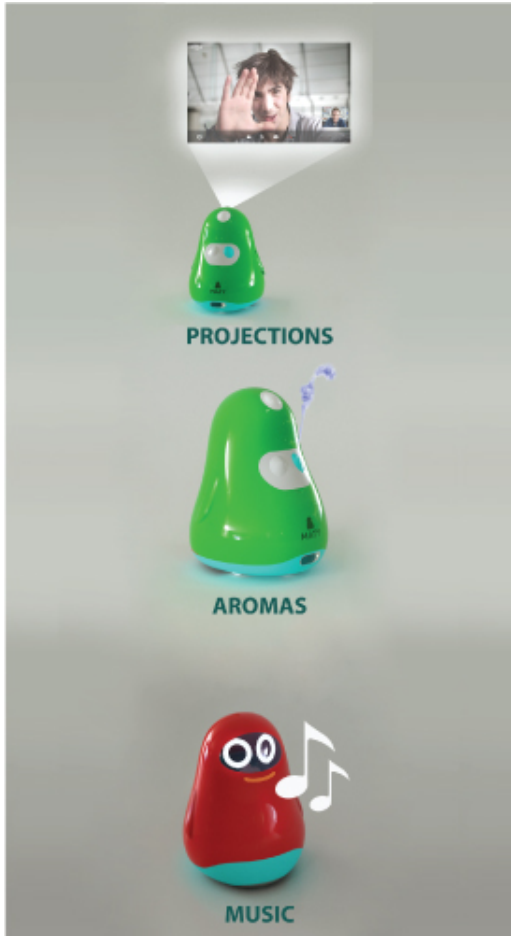

Figure 4: MATY v4: the last prototype materialized expressing examples of the multisensorial service provided to elicit the person with Alzheimer through the day

Being a robot created through RtD to a specific niche from the first sketch, many expectations and concerns raised during the construction process. RtD strengthens the concept, democratizes people influence in developing technology for their obstacles, and increases intervention success rates of the artifact produced. [15]

Ethical Discussion. One of the significant challenges concerns the ethical issues raised. A person with dementia remains a person, whom, at some point, will not be fully aware of herself, space and people around. When it is intended to use an autonomous robot to support a person with dementia, there must be a fair balance between the person's conditioned freedom and the caregiver gain. It is essential that any robotic solution took by the person with dementia is included in the first dementia phase. Mandatorily, one has to be aware of the implications, benefits, and objectives of this type of solution. A significant issue is the omission of the diagnosis by family and even some doctors. The introduction of MATY presupposes that the person with dementia is aware of his clinical diagnosis, which is not always the case. This situation could lead to constraints on possible abusive behavior by a caregiver without people with Alzheimer becoming aware of the MATY purpose.

A note to Research Through Design. The research through design approach, opens new perspectives for interviewees group, offering realistic and achievable expectations as they become more aware of the current state of robotics. Using prototypes was valuable since some professionals have suggested during the sketch phase, characteristics for the robot such as hovering in the air. Nowadays, robots present in society tend to rise, yet they are still away from general knowledge (or highly ahead due to cinematic influences). There is no single path using research through design [15]. Interviewees cultural experiences will determine the crucial design aspects. These background variations make the stakeholder-centered direct contact essential, allowing reviewing different aspects related to their problem. With a more intercultural sample and different degrees of technical proficiency, the inputs provided may differ and change the final design.

CONCLUSIONS

People with Alzheimer and their caregivers face challenges in their daily circumstances that can eventually be mitigated with the aid of technology. We set out to design a robot that supports them in maintaining daily routines, furthering communication, and contributing to a security sense - needs that pervade their lives but are often left unattended given the burden already carried by the caregiver. A research through design process unveiled a desire and acceptance of robots as assistive technology for Alzheimer's at home. The theme of domestic assistive social robots is relatively new, which requires experimentation and validation of its benefits in real contexts. For future work, we will need further exploration studies in real life environments to measure the effectiveness of MATY relieving caregivers work while promoting a person with Alzheimer's autonomy.

ACKNOWLEDGEMENTS

This work was partially supported by FCT through the strategic funding of the LASIGE Research Unit, ref. UID/CEC/00408/2019. We would also like to thank the participants of our studies.

REFERENCES

[1] Marina Bastawrous. 2013. Caregiver burden–a critical discussion. *International journal of nursing studies* 50 3 (2013), 431–41.

[2] Joost Broekens, Marcel Heerink, and Henk Rosendal. 2009. Assistive social robots in elderly care: a review. *Gerontechnology* 8, 2 (2009), 94–103. https://doi.org/10.4017/gt.2009.08.02.002.00.

[3] Elisangela Carmos, Marisa Zazzetta, and José Costa. 2016. Robótica na assistência ao idoso com doença de Alzheimer: As vantagens e os desafios dessa inetrvenção. *Estudos Interdisciplinares do Envelhecimento* 21 2 (2016), 47–74.

[4] Paul A. Cernin, Brenda K. Keller, and Julie A. Stoner. 2003. Color Vision in Alzheimer's Patients: Can We Improve Object Recognition With Color Cues? *Aging, Neuropsychology, and Cognition* 10, 4 (2003), 255–267. https://doi.org/10.1076/anec.10.4.255.28971 arXiv:https://doi.org/10.1076/anec.10.4.255.28971

[5] Jiska Cohen-Mansfield, Marcia S Marx, Khin Thein, and Maha Dakheel-Ali. 2011. The impact of stimuli on affect in persons with dementia. *The Journal of clinical psychiatry* 72, 4 (apr 2011), 480–6. https://doi.org/10.4088/JCP.09m05694oli

[6] Maartje M.A. de Graaf, Somaya Ben Allouch, and Jan A.G.M. van Dijk. 2016. Long-term evaluation of a social robot in real homes. In *Interaction Studies*, Vol. 17. 461–490. https://doi.org/10.1075/is.17.3.08deg

[7] By Habinteg and Thomas Pocklington Trust. 2010. Design Guidance for people with dementia and for people with sight loss. (2010).

[8] Younbo Jung and Km Min Lee. 2004. Effects of physical embodiment on social presence of social robots. *Proceedings of Presence, 2004* (2004), 80–87. https://doi.org/10.1145/1349822.1349866

[9] M. F. Kamaruzaman and R. P. Mohd Riaz. 2013. Conceptual framework study on dynamic visual reminiscent therapy in Alzheimer psychosocial treatment. In *2013 IEEE Business Engineering and Industrial Applications Colloquium (BEIAC)*. 189–191. https://doi.org/10.1109/BEIAC.2013.6560111

[10] Francisco Martín, Carlos Agüero, José María Cañas, Gonzalo Abella, Raúl Benítez, Sergio Rivero, Meritxell Valenti, and Pablo Martínez-Martín. 2013. Robots in therapy for dementia patients. *Journal of Physical Agents* 7, 1 (2013), 48–55.

[11] Hayley Robinson Msc, Bruce Macdonald Phd, Ngaire Kerse Phd, and Elizabeth Broadbent Phd. 2013. The Psychosocial Effects of a Companion Robot: A Randomized Controlled Trial. *Journal of the American Medical Directors Association* (2013). https://doi.org/10.1016/j.jamda.2013.02.007

[12] Ma Salichs, Á Castro-González, and Ip Encinar. 2012. A First Study on Applications of Social Assistive Robots for Alzheimer's Disease Patients and Their Caregivers. *Workshops.Acin.Tuwien.Ac.At* (2012).

[13] Meritxell Valentí Soler, Luis Agüera-Ortiz, Javier Olazarán Rodríguez, Carolina Mendoza Rebolledo, Almudena Pérez Muñoz, Irene Rodríguez Pérez, Emma Osa Ruiz, Ana Barrios Sánchez, Vanesa Herrero Cano, Laura Carrasco Chillón, Silvia Felipe Ruiz, Jorge López Alvarez, Beatriz León Salas, José M Cañas Plaza, Francisco Martín Rico, Gonzalo Abella Dago, and Pablo Martínez Martín. 2015. Social robots in advanced dementia. *Frontiers in aging neuroscience* 7 (2015), 133. http://www.ncbi.nlm.nih.gov/pubmed/26388764http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC4558428

[14] Bob Woods, Elisa Aguirre, Aimee E Spector, and Martin Orrell. 2012. Cognitive stimulation to improve cognitive functioning in people with dementia. *The Cochrane database of systematic reviews* 2 (2012), CD005562.

[15] John Zimmerman, Erik Stolterman, and Jodi Forlizzi. 2010. An Analysis and Critique of Research Through Design: Towards a Formalization of a Research Approach. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems (DIS '10)*. ACM, New York, NY, USA, 310–319. https://doi.org/10.1145/1858171.1858228