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A Qualitative Study on Co-designing a Domestic Robot with Senior People: Attitudinal Differences Among the Profiles of Boomers and the Silent Generation

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A Qualitative Study on Co-designing a Domestic Robot with Senior People: Attitudinal Differences Among the Profiles of Boomers and the Silent Generation

Stefano Poli

Abstract: Integrating domestic robots into the lives of older adults reflects a possible solution to provide adequate caregiving to an increasingly ageing population. Still, it is unclear how older adults perceive domestic robots and whether they are willing to adopt them into their homes. This paper analyses the attitudes of older adults towards domestic robots by proving the results of a qualitative study conducted during an experience of co-designing a robotic prototype, addressing 30 community-dwelling over-65s who are residents in Genoa, Italy. Our results show how attitudes toward the robot differ both due to individual and structural characteristics, but especially owing to generational and cultural factors, particularly between younger-old baby Boomers and older-old respondents. In conclusion, our study provides interesting suggestions for designers and engineers to consider generational differences as predictive factors of acceptance of domestic robots by senior end-users.

Keywords: Domestic Robots, Senior end-users, Attitudes, Boomers, Silent Generation

Introduction. Home Robots and Senior End-users: Multiple Opportunities, Differing Attitudes

The conservation of autonomy and of independence in later life, even when facing disability and impairment, has become a main issue in orienting public policies and industrial design toward technological solutions aiming to allow older people to continue living at home whilst preserving habits and lifestyles.

The lock-down during the COVID-19 crisis dramatically worsened the risk of isolation of older people living alone (Poli, Pandolfini & Torrigiani, 2021), showing how exactly robots could potentially perform the role of health assistants, but could also create, maintain, and strengthen social relationships (Kim et al, 2021).

This renews the interest for combining domotics with Information and Communication Technologies (ICTs), Assistive Technologies (ATs), and Human–Computer Interaction Technologies (HCIs), toward "smart home" solutions, permitting a friendly atmosphere of assisted living, where robots and Artificial Intelligences (A.I.) represent innovative tools to support older people, particularly those living alone or unable to receive adequate care by relatives (Daniele et al., 2019; Siciliano & Khatib, 2016; Smarr et al., 2014; Mintzer et al. 2014).

However, such support involves both assistive technologies enhancing safety of older people at home and monitoring their health conditions (while controlling home healthcare costs), as well innovative automated solutions designed in a "social" sense, such as collaborative robots with advanced skills and socially acceptable behaviours, engaging in several peer-to-peer relations, reacting to human behaviour or actively encouraging social interaction via collaborative control, where the robot asks questions to the human in order to get assistance and to solve problems (Shishehgar, Kerr & Blake, 2019; Sallinen, Hentonen & Kärki, 2015; Breazeal, Takanishi & Kobayashi, 2008).

Still, research on older adults' acceptance of robots remains limited compared to the larger number of studies on the wide-ranging possibilities offered by robotics solutions (Daniele et al., 2019; Smarr et al., 2013; Ezer, Fisk & Rogers, 2009).

Indeed, robotic assistants at home continue to be perceived as mostly unusual or bizarre objects in the daily living of senior end-users, who often show heterogeneous and varying attitudes, ranging from enthusiasm and curiosity to scepticism, or even fear, depending on varying cultural traits and structural conditions (Daniele et al., 2019).

According to Eurobarometer studies exploring the public attitudes towards robots (2014/2021), older people, especially the oldest old and those with a lower level of education, self-assess themselves as lesser competent in terms of techno-scientific skill, showing a higher concern about uncontrolled and accelerated technological development, and reflecting more difficulties in representing the idea of robots, in giving them a possible shape, and in attributing functional traits or characteristics. Eurobarometer studies show also how the rejection of robots in the leisure and entertainment sectors arises among older people and declines among younger generations (30.7% of rejection among the over/65s vs 19.5% in the 18-24 age bracket). Similarly, older people are also more opposed to delegate childcare to robots (65.7% among the over/65s vs 50.0% in the 35-44 age bracket).

The most applicable frameworks for understanding older adults' acceptance of robot assistance in the home continue to be the Domestic Robot Ecology (DRE) study and the Almere Model study. DRE is a holistic framework explaining older end users' acceptance of robots by the relationships that robots shape in the home, assigning a key role to the environment. Indeed, evidence from the DRE study suggests that the physical and social sphere, social elements, and tasks influence the dynamic relationships between domestic robots and older people over time (Sung, Grinter and Christensen, 2010). The Almere model (Heerink et al. 2010) is a validated technology acceptance tool, built on a Likert scale-based questionnaire geared towards measuring older users' acceptance toward socially assistive robots. Evidence from this model suggests that attitudes and perceptions play a fundamental role in older adults' intention to use an assistive social robotic agent.

Some experimental studies show that the acceptance of robotic assistance among older people seems to depend on the performed tasks, where robots are favoured by older adults over a human in instrumental activities, such as changing a light bulb or doing the laundry, but humans are preferred over robots in tasks such as caregiving and socializing (Smarr et al. 2014).

Broadbent and colleagues (2009), classifying the factors behind acceptance of domestic robots by older people, refer to three main headings, such as organizational factors (voluntariness, task profession), technological factors (individual/group, complexity, purpose) and individual factors (age, gender, experience, cultural background, intellectual capability).

Moreover, a controversial feature is the appearance of the robot, especially when dealing with the double side effects of an anthropomorphic look (Damiano & Dumouchel, 2018; Zlotowski et al., 2015).

Other issues emerged from recent studies including experiences on co-designing robotic prototypes with senior end users. Bradwell and colleagues (2019) observe in design activities a frequent misalignment of opinion between older end-users and developers on the desirable design features of robots, stressing the need for user-centred design. Not by chance, the practical demonstration of robot capability and user trials, especially for tasks in the home setting, emerged in several co-designing studies as a predictive factor of positive acceptance (Beer et al, 2017; Eftring & Frennert, 2016), even in countries with distant technological and cultural background (like Italy and Japan, D'Onofrio et al, 2019) Similarly, the co-design study of Lee and Naguib (2020) underlines the principle of affordance in appearance (based on functionality and anthropomorphism indices), the optimal balance between autonomy and controllability in interaction design, and the critical design criterion of dependability for invoking confidence as a trusted assistant for older people.

This paper aims to increase the understanding of the attitudes of senior end-users toward robotic home assistants, trying to catch the latent cultural factors, by reporting the results of a qualitative study developed in 2019-2021 in Genoa, Italy, realized by co-designing a robotic prototype to be used at home or in healthcare contexts.

Such study was part of the SI ROBOTICS (SocIal ROBOTics for active and healthy ageing) project, funded by MIUR and conducted by several public and private Institutes dedicated to the care of older people, together with public Universities (Scuola Superiore Sant'Anna, Milano Statale, Roma Sapienza, Genova, and Politecnica delle Marche), to develop novel solutions of collaborative assistive ICT robotics.

Methods: Co-designing a Robot with Senior End-users

The co-design study was conducted by a multidisciplinary team, composed of designers and sociologists of the Departments of Architecture and of Education of the University of Genoa in order to understand in an explorative way the main predictors of acceptance of a prototype robot by senior end-users.

A preliminary phase of the study was conceived with the aim of translating the possible functions into the hypothetical design features of the robotic prototype, defining the formal requirements of the proposed robotic system. Much importance was given to the possible humanoid characteristics and to the related solutions in terms of structural interactive supports (e.g., robotic arms, communication, etc.). To identify the formal characteristics of the robot in different scenarios, an in-depth analysis was conducted, comparing over 100 robotic models already on the market.

The operative phase involved co-creation activities with the end-users, holding a "design thinking" session in order to co-create the functional and structural characteristics of the robotic system by adopting a "participatory design game", a prototyping process that allows participants to express their needs and ideas through practical game actions and/or physical composition of the ideal robotic shape.

Concretely, this phase was developed through four in/person meetings at the University of Genoa, lasting about three hours, each one with 7-8 senior participants, and organized following the Nominal Group Technique (NGT). We involved a qualitative overall sample of 30 over/65=year-old community-dwelling residents, purposely recruited via the main local associations providing cultural and recreational activities for retired people. As described in table 1, participants were selected to maintain as much as possible adequate proportions in terms of gender (40% male, 60% female), age brackets (70% in the 65-74 age group, 30% in the over-75 age group) and levels of education (20% lower level, 50% average level, 30% higher level, according to the International Standard Classification of Education scale, ISCED 2011, where: ISCED 0-2= lower level; ISCED 3-4= average level; ISCED 5-8= higher level). Considering individual physical health, robust and prefrail/frail conditions were preliminarily evaluated via the FRAIL scale (Fatigue, Resistance, Ambulation, Illness and Loss of Weight; see Poli, 2015) and four participants (13.3% of the sample) resulted in pre-frail/frail conditions. One participant reported to be affected by mild cognitive decline evaluated via Mini-Mental State Examination, but she was fully able to be involved in participatory design activities.

Table 1. Characteristics of the sample

Variable	Modalities, counts and percentages		
Gender	Male= 12 (40%)		Female= 18 (60%)
Age group	65-74= 21 (70%)		75 and over= 9 (30%)
Education	Lower= 6 (20%)	Average= 15 (50%)	Higher= 9 (30%)
Health	Robust= 26 (86.7%)		Prefrail/frail= 4 (13.3%)

N=30

Each NGT was followed by a participatory debriefing conducted according to a live-drawing co-design activity, an experimental methodology involving previous participants with a professional illustrator, drawing sketches with a projector to co-create in real-time pictures the forms and appearances imagined by the participants and projecting them in actual dimensions, in order to envision and concretely visualise the shapes and the characteristics of the robot according to its possible functions in different hypothetical scenarios (at home; in a co-housing situation or a nursing home; in hospital working as receptionist, as support to therapist, or as monitoring system for bedridden patients).

The outline of the discussion in the NGTs was designed to promote the emersion of the multidimensional structure of the attitude toward the robot by older people (in terms of *evaluation*, *potency*, and *activity*, according to Osgood, Suci and Tannembaum, 1957), stimulating participants in possible scenario setting via the Critical Incident Technique (CIT, Flanagan, 1954). The qualitative analysis was conducted by the team according to the Positioning Theory model, analysing different attitudinal positions of respondents, together with reported narrative plots and linguistic expressions (Davies & Harré, 1990; Allen & Wiles, 2013). Credibility was performed by theoretical triangulation with the mainstream studies described in the Introduction and completed through adequate member-checking with participants in interpretation of results.

The discussion groups were conducted in Italian, digitally recorded, and translated into English using professional language services. Quotes reported in the following "Results" section are excerpts from the aforesaid discussion groups.

Results. R2-D2 Beats C-3PO: the Rejection of the Android

The design thinking sessions were conducted through four NGTs, organized in a participatory design game combined with a group discussion.

Firstly, after a presentation of the project, each participant was asked to create her/his ideal robotic form, by combining into a single 2D maquette some pieces of cardboard resembling possible shapes, previously cut in formal typology (square, rectangle, circle) and showing several schematic pictures resembling different robot parts taken from the previous market analysis of the robots. In a sort of bi-dimensional Lego game, the participants combined freely their ideal robot, merging a lower part (i.e., the "legs", or the mobility system), a central part (i.e., the "chest", or the middle chassis), and the upper part, (i.e., the "head", or the mainframe).

In a subsequent participatory debriefing, the obtained maquettes were classified by homogeneity into "android", "box-structure with monitor", and "amorphous" shapes, and the different forms were discussed in terms of advantages or critical aspects.

Narrative plots and expressions used in self-positioning by respondents were mostly negative toward android-humanoid form, while the majority of participants (irrespective of gender, age class or health condition) choose the shape resembling a box-structure with monitor on its top.

"I would not like to see some sort of mechanical person walking around. Not even to physically assist me. Certain tasks should be done by real persons, not by robots resembling humans. It would scare me." (Female, over 75 age group, frail, lower level of education).

"It must look like a thing, maybe like a toy, not like a human… I would prefer something like Star Wars' R2D2: cute, reassuring, and even funny." (Male, 65-74 age group, robust, higher level of education).

The debriefing was conducted by observing respondents' subjective perceptions and affective reactions to the robot shapes created, promoting the emergence of the typical latent dimensions of *evaluation*, *strength*, and *activity*, underlying an attitude according to Osgood, Suci and Tannembaum's model (1957).

Lastly, the tasks of the robot in possible scenario settings were evaluated, at home or in an institutionalized context (hospital or nursing home).

The Evaluative Factor: Characteristics and Shape

Once the box-structure with a monitor on its top had been selected over the non-human appearance, the discussion focused on the *evaluative* dimension, allowing each respondent to express her/his first glance reaction to each maquette (whether seeming "beautiful" or "ugly", "pleasant" or "unpleasant", "familiar" or "unfamiliar", etc.). In this sense, several respondents proposed that some sort of face for the robot should have been displayed on the monitor. The image of a female robotic face showing on the monitor emerged as the prevalent choice, regardless of gender, age group or clinical condition of respondents.

> "I would prefer a female, not a male face… Maybe, a smiling robotic face on the monitor." (Male, 65-74 age group, robust, higher level of education).

> "I would not like a human face watching me from a monitor. It should be familiar, but like a sort of pet, not resembling a real person". (Female, over 75 age group, frail, lower level of education).

> "A human face could produce embarrassing emotions. I would feel like I am constantly observed, if not controlled or judged. The face of the robot should provide the possibility of personalizing the images oneself, like the PC desktop, where one puts the preferred photograph." (Female, 65-74 age group, robust, average level of education).

> "If I must conceive it as an interface, I need to dialogue, but I also need to see myself and be seen in some way; therefore, if someone must converse with the robot, even in terms of appearance, the face on the monitor should change depending on the interacting person." (Male, 65-74 age group, robust, higher level of education).

Other elements of evaluative patterns referred to visual aspects, such as the colour(s) of the robot, or to tactile sensations, for instance regarding the materials used to realize the device. The more educated respondents, usually younger-old profiles, reported more specifically than others the possible characteristics regarding the composition and the shade of the robot. In this sense, a more conscious self-positioning toward the robot appearances probably often derives from educational or professional competences, having experienced jobs in the past as engineers, designers, market experts, etc.

> "It should have a neutral colour, white or light grey, surely not dark, but also not too bright or coloured. If it is conceived for the market, it could even be created according to different consumers' desires. I would rather prefer something quite neutral and not too eye catching" (Male, 65-74 age group, robust, higher level of education).

> "If it must be used at home, it should be in tune with the domestic setting. It could become not only an assistant, but a real product of design." (Female, 65-74 age group, robust, higher level of education).

> "I would not like a synthetic, metal, or even plastic coating. Of course, it must be resistant inside and solid in the structure, but, externally, it should have the consistence of rubber, remaining soft at contact, even better if it could offer a sort of silky sensation." (Female, 65-74 age group, robust, average level of education).

> "It must be adequately sturdy if it is designed to assist people. It must provide them with safe physical support. Still, it must respect safety standards, being not too hard in case disabled people fall over it. Robust, stable, without edges, but also comforting and soft." (Male, 65-74 age group, robust, higher level of education).

The Potency Factor: the Importance of Maintaining Control

The second dimension was related to *potency* (or strength) and combined the previous evaluation dimension with emotional reactions, whether the different maquettes would seem, for instance, "reassuring" or "worrisome", "safe" or "dangerous", "simple" or "complicated", "stable" or "unstable", also regarding their size and the fact that they should be remote controlled or completely autonomous.

In terms of self-positioning toward the robot, being in full control of the situation during the interaction with the robot emerged as the main issue for all of participants, regardless of gender, age, and clinical condition. The robot should work autonomously, but unseen at the same time, permitting the end-user to switch it off whenever desired.

> "I must maintain control of the situation, the system should understand when to start autonomously some standard activities, but I

> should be able to stop it, or even deactivate it, whenever I want. I don't want to see it suddenly behind me." (Female, 65-74 age group, robust, average level of education).

> "It must work unseen and unnoticed, without being in my way, something that once has performed its tasks, it automatically retires in the storage closet, like an electric broom, maybe to recharge itself, but always ready to react to a vocal command." (Female, 65-74 age group, robust, average level of education).

> "Being still autonomous, I think I would hardly accept a human assistant at home in case of needing. If one day I should be assisted by a domestic robot, it should be something that I could fully manage, like I do with the common appliances. I need to feel that I'm not constrained or bounded to it. I must be able to decide when to switch it on or to switch it off." (Male, over 75 age group, robust, average level of education).

> "It should have both remote control and a self-learning system. In some situations, it could be controlled via vocal commands or through signals to a monitor. While, in other situations, it could operate via a self-learning system, taught by instructed reactions. I think this is something fundamental, you must have the power over the machine, you must control it." (Male, 65-74 age group, robust, average level of education).

The need to control the robot among frail respondents even emphasised a clear worry around remaining alone with the device. Generally, the human-robot interaction in case of disabled persons is conceived, or even accepted, only if mediated by the presence of another person, usually a caregiver.

> "Lacking full autonomy myself, even if supported by the robot, I want to always have someone [a human, A/N] with me. In any case, it would worry me to remain alone with it. I fear I could not be able to stop it." (Female, over 75 age group, frail, lower level of education).

> "If there are other people in the situation, like in a hospital or in a nursing home, it would be fine with a voice remote control rather than other solutions, because there is always the possibility that another person intervenes and interacts with the robot. But, if I'm alone at home, there must be an automatic function to support me if I'm in trouble, so it has to react independently, maybe checking my heartbeat, evaluating the situation, and calling for help." (Female, over 75 age group, robust, average level of education).

Also, the possible size and dimensions of the robot were considered, with a clear orientation towards smaller proportions, regardless of gender, age, and clinical conditions.

> "It should not be too bulky… Less invasive, taking up a minimum amount of space… Maybe, a smaller size, falling below the hip of a normal sized person. Otherwise, it could look worrisome." (Male, over 75 age group, robust, higher level of education).

> "The bigger, the worse it would be. The less you see it, the better. Of course, maintaining its functionalities, but it shouldn't get too much in the way or stand out." (Female, over 75 age group, robust, higher level of education).

> "I live in a small house; I would not know where to put it, if too big!". (Female, over 75 age group, robust, average level of education).

The Activity Factor: the Robot Moving Around and Performing Tasks

The third latent factor referred to *activity*, considering how it should move in a domestic setting when performing tasks, such as slowly or quickly, as well quietly or loudly in terms of phonetics, (e.g., a male-female-neutral robotic voice or mere signals or beep sounds).

A female voice emerged as the most preferred, even if some respondents imagined communicating with a robot also via a keyboard as a desirable feature (besides being able to receive and print paper documents).

Dynamic aspects, from kinetic to acoustic dimensions, played a key role, but most of the time the self-positioning of respondents toward the robot showed a latent negative emotion against a possible intrusiveness, defining the need for the robot being neither too fast nor too loud, in other words, the less present and evident in the context, the better.

> "It can have a human voice, possibly a female one. The more reassuring, the better. Anyway, it must move around without been seen." (Female, 65-74 age group, robust, average level of education).

> "I should be able to communicate with it also via a keyboard, not only by voice interaction. I should be able for instance to use the robot as a writing tool, so it must also be able to have the option for a printer." (Male, 65-74 age group, robust, average level of education).

> "I think that it should not move around too fast. Human reactions must be considered. It must move when the person, especially, if an old one, is still. It cannot move around representing an obstacle for a

> person with impairments." (Male, over 75 age group, robust, average level of education).

Similarly, multiple functions of the robots and possible problems were discussed. Basic functions were often connected to house chores, medical support and company and entertainment. In the perceptions of participants, the recreational-expressive dimensions emerged as being strictly connected both with Activities of Daily Living (ADL), related mainly to mobility, taking care of oneself and maintain the house cleaned, as well with instrumental Activities for Daily Living (IADL), like reminders for dates, medicines, and helping with ones' daily business. In this sense, the robot can be seen also as tool for telemedicine support. More educated respondents proposed more technical and elaborate activities, also considering the medical caregiving, while less educated respondents were more oriented to classic domestic activities, like cleaning or preparing food.

> "It should help in small house chores, being a nurse and a butler, but also a companion. For instance, it should be able to pick up and fetch small objects, buy I would really like if it could bring me coffee in bed. It should be designed with internal drawers to also provide food and beverages, and, at the same time, it should provide information and entertainment." (Female, 65-74 age group, average level of education).

> "It should be fully in communication with all home systems, like the phone, the TV, the heather, the lights etc." (Male, 65-74 age group, higher level of education).

> "It should memorize deadlines and daily dates, remembering important things, as well what is missing in the refrigerator or in the pantry. Also. It should be able to record and remind vocal notes… But it should also provide healthful suggestions and reminding, like eat fish today because you haven't eaten it for weeks, or use more olive oil to follow a healthy Mediterranean diet." (Male, over 75 age group, average level of education).

> "It should help disabled people in moving, like a walking support and for personal hygiene, helping to raise oneself, as well offering support against falls." (Male, 65-74 age group, average level of education).

> "It should have a medicine dispenser, with internal drawers, reminding also at the right time for the medicine to be taken, maybe being in contact with the doctor… It could be good also if it would measure parameters, like blood pressure, diabetes, or even an ECG, providing also first aid in case of emergency, while calling for assistance." (Female, 65-74 age group, average level of education).

> “The robot must be expandable and upgradable in functions, because we have many needs, each of us her/his own, and there are several forms of disabilities and impairments… It must be a sort of open system, somewhat editable, maybe not by the end-user, but by whoever manages it, also because not everyone is able to instruct the machine. However, the robot must have the possibility of being personalized for the user, maybe providing modular interfaces.” (Male, over 75 age group, average level of education).

The Possible Scenarios: Home Setting vs Hospital Context

Lastly, the discussion was concluded by a hypothetical critical incident technique (C.I.T.), imagining the robot in a domestic context for daily activities or performing tasks in a hospital or other institutionalized contexts (for instance, welcoming, providing information or monitoring patients), and considering potential strengths and critical issues in such scenarios. Different perceptions emerged among participants, showing both signs of acceptance and perplexities in different scenario, particularly those of home caregiving situations. The need of maintaining human relationships besides human-robot interactions emerged as a latent factor, leaving the device only as a mere instrumental tool.

> “In a hospital it could work well, both as an information assistant, and for monitoring patients or providing them medicines. Also, because in a hospital situation maybe the robot would be more accepted by an older person, rather than at home. Maybe it could be perceived as less worrisome, mediated by the context, due to the presence of real nurses and medical staff.” (Male, 64-75 age group, higher level of education).

> “The reception is a very delicate situation in a hospital. It’s better to be the medical staff to receive the patient. The robot can work as an informative tool, providing info, but not to welcome patients. Human relations are too important.” (Male, over 75 age group, average level of education).

Again, the need of having a person managing the robot besides the effective end-user in health assistance scenarios was often reported among respondents, especially among the younger-old with caregiving experiences, who were also the most sceptical toward an effective and efficient use of the robot in such situations.

> “It is hard to imagine using the robot to assist at home a disabled person. It would be difficult for me to remain calm leaving the robot alone to assist a relative when I’m away.” (Female, 65-74 age group, average level of education).

> "As a caregiver, I had a mother with senile dementia and there wouldn't have been any robot sufficiently suitable...We just needed human contact and that's it… So, in that case, it wouldn't have helped. Because, in case of dementia, it [the robot, N/A] doesn't give you security." (Female, 65-74 age group, average level of education).

> "What if it breaks? If I become heavily dependent on this support, of it breaks, everything freezes. Since the situation depends too much on the robot, as soon as the robot stops, you are in trouble. It could be very risky. The fact is that the more functions it covers, the more invasive it is, because the more indispensable it becomes." (Male, over 75 age group, average level of education).

Lastly, in a fictional scenario, respondents were prompted to self-position themselves regarding the robot in a potential home interaction. Narrative plots and linguistic expressions ranged from conceiving the robot as an "emotional interface", with a deeper level of human-robot interaction, where the robot reacts even to individual emotions, to a mere functional and instrumental purpose, reducing it to precise but limited tasks, like a common appliance or as a managing system for the remaining home equipment (refrigerator, heating system, TV, news, etc.). Fear of the risk of becoming too dependent from the device and loosing individual autonomy emerged as a latent aspect. More elaborate imaginary projections were usually offered by younger old and highly educated respondents, while more functional and instrumental scenarios were reported mostly by older and lower-average educated profiles.

> "If it has to help me, it must become an important part of my daily life, therefore it has to become a sort of second 'myself', an external tool of recognition of my identity, that has to be detached from myself, and, at the same time, conscious of my needs or my conditions… Therefore, for me the robot is essentially a communication tool, i.e. it communicates with me when it gives me an answer and I interact with it, training it to 'learn' how I feel and what I need. I should be able to communicate to it my joy or my discomfort, my pain or my needs. It has to become an emotional interface also in order to increase its acceptability by the senior end-user, who often has reluctance to use certain tools… And the fact of having something a little 'more human' can help the level of acceptance." (Male, 65-74 age group, higher level of education).

> "It's a matter of mere use and functionality… My emotions, my forms of personal communication… I hope they are separate… Therefore, the machine must be a machine, like the coffee machine, it remains a machine." (Male, over 75 age group, average level of education).

> "It depends on how important the robot becomes in my living context; it can even arrive to become the main interface for all the rest of tools and functions at home, in other ways, becoming so invasive to turn out to be our point of reference. For instance, basically it can switch on the television on the preferred channel, but in case it's needed, if I feel unwell, I must be able to count on the robot. Similarly, living alone, the robot can work as home control, being automatically able to roll the blinds up and down, giving me help for individual security with a camera, so it can monitor me and the house, practically acting as a receiver and a manager of all the possible functions in the apartment." (Female, 64-75 age group, average level of education).

Discussion: Structural, Cultural, and Generational Differences in the Attitude Toward the Robot

Summarizing our results, the preferred form resembled a non-human shape, with a monitor showing a female-robotic face in the upper part, mounted on a central chassis (provided with supports to lean on), and moving on a wheeling base. Created with a solid structure, adequately resistant to offer stability, it should be covered with a soft surface to avoid impact and improve sensation.

The appearance traits differed significantly from other studies on robot design, showing preferences humanoid, or even pet-like robots, others shifting to more non-human forms (Kim et al, 2021). Also in our study, the appearance emerged as an important trait, while confirming a clear preference to a service-oriented non-humanoid shape.

The desired functionalities and possible tasks for the robot expressed by our sample resemble the results of other studies, including house chores and personal services, as well considering the possible medical applications (Luperto et al., 2022; Smarr et al., 2014; Bugmann & Copleston, 2011). Still, among more educated profiles, a desire can emerge for more elaborate functionalities in search of a deeper human-robot interaction (for instance, conceiving the device as an emotional interface).

Moreover, in the dimension of interaction, the robot should have a female or neutral voice (similarly to other studies, see, for instance, Cherng-Shiow Chang, Hsi-Peng & Peishan, 2018) in some ways resembling both a more delicate and reassuring form of communication, both the persistence of a latent ancillary stereotype insisting on a female genderization of assistive technology, for house chores or as a caregiver.

Interestingly, for someone it should have also a keyboard, and even to be able to receive and to print paper docs.

This latter functional aspect probably reflects how the different self-positioning toward the robot could reflect the technological gap between those respondents fitting fully and adequately themselves in a digital culture (often younger-old profiles, highly educated and with past professional technological affinities), and those respondents expressing a more nostalgic attitude toward an analog culture (with older age and lower level of education as a predictor factor).

Most of all, the toy-appearance, the smaller size, and the discreet, understated presence of the robot lead to interpret a clear superior self-positioning and a need for control to be exercised by the respondents toward the device. Such need for control, combined with a sort of scepticism and latent mistrust toward the robot, can be interpreted both considering structural and cultural differences.

In terms of structural differences, particularly clinical conditions and impairments deriving from pre-frailty or full-blown frailty play a key role. Robust profiles consider the robot only in a distant and projective vision, mostly non-self-referred, or in an indirect perspective in case they already provide caregiving for relatives and family members. In this case, the robot remains a caregiving assistant, not the main caregiver, a role that is held by themselves. As emerged in other studies (Smarr et al., 2013), also in our sample among pre-frail or frail profiles the desire prevails for being helped by real persons, sometimes even expressing a clear fear of the device itself (especially if shaped in android form).

Among the more educated respondents the robot's characteristics are reported as more detailed, elaborate, and even conceived in terms of strengths and weaknesses for a market situation or for technical design. Among the less educated, on the other hand, the robot is primarily conceived as a standard household appliance, mainly used for to chores or recreational activities, sometimes resembling a more imaginary and indolent perspective, imagining it as a sort of house servant dedicated to the development of own personal idleness.

The previous considerations reflect how generational differences could work as a latent interpretative factor for our results. Indeed, the clearest differences emerge between the younger-old (usually 65-74 years old) respondents, pertaining to the first cohort of Baby Boomers, and the older-old (over-75s) respondents of the Silent Generation (Poli, 2021). The first cohort of Baby Boomers was born between 1946 and 1954, nowadays has just entered the first stages of later life and represents the generation of those who were often politically involved during their youth in the cultural revolution of 1968 and in the consumerism during the peak of the affluent economy of the second part of the last century, and nowadays maintains a progressive younger-old attitude and lifestyle (Leach et al, 2013). In contrast, those born before the end of the Second World War are typically named the Silent Generation due to their more traditionalist and conservative attitudes, more attached to the past and often conditioned by frail and vulnerable conditions of older old profiles (Badley et al., 2015).

Attitudes toward the robot among Boomers reflected their technological openness and their higher level of education, as well as their consuming attitudes (Cherng-Shiow Chang, Hsi-Peng & Peishan, 2018) 2018). Boomers also discuss the robot in terms of its possible development for the market, and even view the robot as an object of identity expression, potentially linked to a more consumerist propensity often emerging in this generation. Most of all, Boomers remain lovers of control, and, aside from the possible imagined characteristics and functions, they need to be the ones operating the robot, and not vice versa, and even when they talk about the opportunity of automated medical support or physical assistance to impaired relatives, they do so in a non-self-referred and indirectly projective sense, both avoiding imagining themselves as in need of receiving care from the robot, and considering themselves as better caregivers than the robot itself.

On the other hand, the older Silent Generation respondents, often exposed to a higher risk of health instability, hold a more traditional and conservative approach, based on the need for human relations, especially in personal assistance and caregiving. This often reflects fear or scepticism, being worried by the slippery slope of a robotic assistant gaining the upper hand on them without being able to switch it off.

Among the Silent Generation the distrust of the robot arises also from the exasperation of the digital divide, especially among people with a lower level of education or in frail health, or rather in the typical embeddedness of this generation in analog cultural models (Kunonga et al., 2021; Oh et al., 2021; Olphert & Damodaran, 2013; Operto, 2011). The fact of having long been socialized within an analog culture makes the digital divide even more difficult in an increasingly technocratic postmodern culture (Alvarez-Garcia et al., 2019).

Thus, a robot roaming the house would be seen not only and simply as a strange or unusual (if not pervasive) device (especially if in human form), but it would represent also the definitive cut from the security of a traditional industrial society, based on an analog culture, in which they have been embedded for most of their lives and that shaped their ethos and value systems.

Besides several implicit limitations of the study (mainly derived from a limited non probabilistic and non multi-centric sample, with a reduced number of pre-frail and frail respondents), our study, the main point of strength is the evidence of how differences in the perception of robots by older people derive not only from the individual traits in terms of gender, age or clinical conditions, but, most of all, from the multidimensional changes in terms of generational profiles, as predictive factors of such heterogeneity of attitudes, providing an additional element for multidimensional evaluation of predictive factors in domestic robot acceptance by senior end-users.

Conclusions: Should We Educate Older People to Use Robots, or Should We Educate the Technicians and Designers to Understand Senior End-users?

Our results provide several suggestions for refining models of technology acceptance and for developing robots that are more likely to be accepted by older people, stressing how attitudes of senior end-users should be better focused and understood according to the deep heterogeneity of older people in terms of cultural perspectives and structural conditions characterizing contemporary ageing populations.

Contemporary robots, even partially with the characteristics requested and imagined by our sample, are already in our homes, from cleaning robots to artificial intelligences. What is missing on the market are devices combining all-in-one the several possible features, and, in particular, being adequately (and, most of all, acceptably for the end-users) autonomous to completely overpass the intermediation of a human manager (i.e., a human assistant, or the caregiver), especially when the end-user is disabled or impaired.

In this sense, the robot itself remains commonly conceived among senior people as a futuristic device, but this attitude shifts from a clear scepticism or mistrust in case of older-old profiles of the Silent Generation (definitely tied to the comfortable traditional analog culture of the industrial society) to a wider open-mindedness of the first cohort of Baby Boomers (more socialized to the advantages and to the different forms of the post-industrial digital culture).

Moreover, Baby Boomers, conscious of how their potential longevity could not necessarily reflect in full autonomy for the remaining years in the latter phase of life, look forward also to the opportunities of innovative assistive solutions, perfectly embodied in domestic robots, potentially helpful not only in providing them with physical support in case of impairment, but also preserving control over their own life and helping them maintain full expression of their identity.

This underlines how generational differences must be considered by engineers, technicians and designers when planning robots, considering not only the possible functions, shapes, and characteristics of such devices, but adapting them to the structural and cultural differences characterizing the complex heterogeneity of senior end-users, according to a life course perspective of ageing dynamics.

In conclusion, although robotic technologies could bring some innovation into aged care, more research is needed to design and develop robots to be of assistance and support older populations in maintaining an independent lifestyle, and exactly the predictive potential of generational differences could represent a driver in realizing new technological solutions better accepted by senior end-users.

Compliance with Ethical Standards

- Conflict of interest: the author declares that there are no conflicts of interest.
- Informed consent: all participants were required to sign informed consent before participation. Data were treated in anonymous form according to privacy norms.

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