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Robot roles, personality and interaction behaviours

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1 Abstract

The proportion of elderly in European societies keeps rising. Assistive technology (AT) in general and assistive robotics in particular may help to address the resulting increasing need for care taking. In the following, we present first research that has been conducted in the EU FP7 project ACCOMPANY aiming to develop an assistive robot that, as part of an intelligent home environment, will be able to support independent living of elderly in their own homes. We describe the results of a literature review concerning the needs of elderly living independently and the usage of assistive technology, particularly robots, in this context. As the literature review could not answer some relevant questions about elderly's needs and possible robot roles, we conducted in-depth interviews to identify the needs of elderly people and to infer roles that future robots could play in their lives. The study provided us with valuable information about the elderly people's daily activities, challenges and work-arounds as well as the persons or objects that play important roles in their lives. Furthermore, the results of the interviews revealed that loneliness, a low appreciation of one´s abilities and depressive mood are just as problematic issues as practical tasks like cleaning. Thus, robot roles are proposed that can help to improve people's lives in both respects. A first study is presented that researches the influence of task context and robot role on perceived social robot personality. The findings of this study suggest that people have different attitudes toward a robot's personality depending on its role. It is therefore relevant that we compare user responses to robot behaviours in a variety of contexts and robot roles. Further studies are proposed that focus more concretely on robot roles for interaction with elderly aiming to identify how the robot can be engaging and helpful to improve independent living. These studies are based on a memory game scenario that can be adapted to improve physical, social and cognitive health of elderly and to enable them to live independently in their own homes.

2 Introduction

The number of older people is growing in the population of industrialized countries. In 2008, the number of elderly people in the EU was relatively close to the number of children. However, in 2060 the number of elderly people is expected to be twice the number of children. This is due to a low birth rate, a decreasing inward migration and an increasing life expectancy [1]. This growth in the elderly population will lead to an increasing cost for elderly care. The need for cost-effective solutions is greater than ever before [2]. Assistive Technology (AT) in general and assistive robotics in particular may help to solve this problem. As an example of on-going research, the EU FP7 project ACCOMPANY aims to develop an assistive robot that, as part of an intelligent home environment, will be able to support independent living of elderly in their own homes [3].

Understanding the needs and requirements of the user, and having a deep understanding of the user's daily activities and interactions, is of paramount importance. Complementary to the work of our partners in WP1 who assessed the challenges of living independently and main factors that need to be resolved to remain living independently, we explore the ways in which elderly people live their daily life. We aim to understand not only the main challenges they encounter and work-arounds elderly people adopt to overcome those challenges, we also want to understand roles that people, animals or objects currently play in their lives, to consider possible roles for robotic technology. To this end, we carried out a contextual analysis that included in-situ semi-structured in-depth interviews with independent elderly people in their homes. The study provided us with valuable information about the elderly people's daily life activities, challenges and work-arounds as well as persons or objects that play important roles in their lives.

Building upon existing literature about the needs of the elderly, we draw conclusions from the contextual analysis concerning possible robot roles that could offer improvements in the lives of independently living elderly. Based on this analysis, we report the results of a first pilot study that investigated user preferences for a robot's personality in two robot roles: cleaning and museum guide. The findings of this study suggest that people have different attitudes toward a robot's personality depending on its role. It is therefore relevant that we compare user responses to robot behaviours in a variety of contexts and robot roles. At the end of the document, we offer the methodological design of studies for follow up experimentation to determine effective robot behaviours for AR in a number of relevant roles.

3 Theoretical Background

In this section we discuss relevant literature regarding the questions:

- What are the needs of elderly people with respect to independent living?
- What can state of the art Assistive Technology (AT) do to counter the challenges of independent living?
- In what way can robotics enhance AT to further support elderly people to live independently?

3.1 Elderly Needs for Independent Living

Much of the current research regarding elderly people centres around their Activities of Daily Living (ADLs) and the factors that impact independent living [4]. An increasing number of elderly people need help on a regular basis. In the U.S., 20% of non-institutionalized elderly aged 70 or older need help in performing at least one ADL [5]. Walters et al. assessed the met and unmet needs of elderly people from the point of view of elderly, health professionals and informal carers [6]. They found that the most frequent unmet needs from the point of view of the elderly participants were related to eyesight/hearing, psychological distress, incontinence and company. Professional and informal carers emphasized unmet needs concerning mobility, eyesight/hearing, accommodation and daytime activities. As part of the research by ACCOMPANY's WP1, Bedaf et al. conducted focus group sessions with elderly persons, formal caregivers and informal caregivers in the Netherlands, the UK and France in order to identify problematic activities in daily life that threaten independent living [7]. They clustered the identified problematic activities in three groups: self-care activities (such as washing oneself and dressing); mobility (for example walking and getting up); and isolation, which refers to low levels of interpersonal interaction. Other authors identified additional factors such as social pressure from others to apply for a place at a nursing home, loss of comfort and loss of affection as main predictors for considering elderly care residence [8]. A systematic review by Luppa et al. [9] proposed cognitive/functional impairment and the associated lack of support and assistance as the most important predictors of nursing home placement.

Current studies on factors that predict moving into care homes clearly report physiological and social reasons. To some extent this work acknowledges psychological reasons, mostly loneliness and cognitive decline. Intuitively, it seems that the way an elderly person 'feels' about living independently and the way her carers think the elderly person feels has a large impact on the decision to move to a care-facility. Feeling in control, capable and confident is important to live independently. Similarly, many elderly report feeling scared being alone at home [10]. Psychology offers a wide range of concepts that relate to attitudes and abilities to confront situations in life. Rotter [11] defines *locus of control* as "the degree to which individuals view themselves as controlling their own environment". Similarly, Bandura [12] defines *self-efficacy* as the "degree of confidence persons have in their ability to successfully perform specific behaviours". Another related concept, *coping*, is defined by Folkman & Lazarus [13] as "cognitive and behavioural efforts to manage specific demands that are appraised as taxing or exceeding the resources of the person". Adler stated that controlling one's personal environment is "an intrinsic necessity of life itself" and deCharms claimed that "man's primary motivation propensity is to be effective in producing changes in his environment" [14].

Greenglass et al. [15] measured proactive coping in a study with community-residing older people and found that coping was significantly associated with lower levels of disability. They also found an association between proactive coping and lower depression. Similar conclusions were reached in longitudinal studies by Mendes de

Leon et al. [12] and Rejeski et al. [16], where they found that high self-efficacy becomes especially protective when aged people's physical condition is challenged. Penninx et al. carried out a longitudinal study with 6247 subjects and found that depression in nondisabled aged persons increases disability risks and that this increase is higher than that of most other baseline chronic conditions [17]. Self-efficacy related factors become more important if they are indeed related to depression as the results by Greenglass et al. suggest [15].

Current studies also indicate that it is possible to intervene and offer the motivations for elderly to take control and to enable self-efficacy. Langer and Rodin carried out a field study in a nursing home [14]. The residents from the experimental group received a communication that emphasized the responsibility they had for themselves, their freedom to make choices and their active role in caring for a plant. The residents from the comparison group were told that the nursing staff would take care of them and the plant. After only three weeks, 71% of the residents from the comparison group were rated as having become weaker, whereas 93% of the people from the experimental group showed overall improvement. Furthermore, the residents from the motivated group became happier, more active and more mentally alert. A review on self-efficacy and physical activity by Lee et al. [18] concludes that the application of self-efficacy theory on physical activity programs may increase the adherence of participants to the programs. The authors describe the information sources of one´s self-efficacy and how they have been implemented in interventions. As pointed out in that review, Bandura describes four major information sources which correspond to the feedback that individuals receive when they perform an activity: *performance accomplishments*, which would include positive experiences in executing a task; *vicarious learning*, consisting in observing others realizing a similar behaviour; *verbal encouragement* from others to execute the behaviour; and *physiological and affective states*, which corresponds to the pleasure in carrying out a behaviour [18], [19].

Self-determination theory offers a framework to understand the types of motivations behind people´s behaviours. Self-determination refers to "true choice" when carrying out an action and can be represented on a continuum from highest to lowest self-determined motivations, including *intrinsic motivation*, *extrinsic motivation* and *amotivation*, correspondingly [20]. Intrinsic motivation refers to performing an action for itself, in order to obtain satisfaction or pleasure from it, whereas extrinsic motivation is present in actions where the goals are beyond the realization of the action itself [21]. There are two types of extrinsic motivation: *external regulation* (lower self-determination), which is driven by rewards or avoidance of negative consequences; and *identified regulation* (higher self-determination), which may resemble intrinsic motivation but corresponds to behaviours that are chosen as a means to achieve something different from the behaviour itself [20]. Finally, *amotivation* corresponds to the least self-determined behaviours, as these would be characterized by no purpose and no expectations of causing changes in the environment [20]. It appears that intrinsic motivation, followed by identified regulation, is mostly associated with positive outcomes (such as persistence), whereas external regulation seems to be associated with negative outcomes (for example depressive states) [20], [21].The evidence described thus far suggests that interventions in older people´s self-efficacy and related factors might make them less prone to give up independence.

From the studies above it can be concluded that the main reasons why people move into elderly care facilities are issues related to physiological decline (e.g. deteriorating eyesight and hearing), social decline (e.g. lack of company, affection) and psychological decline (e.g. distress, cognitive impairments). Apart from the challenges that reduced mobility, eyesight, hearing and continence bring, elderly people may feel lonely, a lack of support and at times feel pressure to move to elderly care facilities to unburden others. While we now understand which factors predict an elderly person's move into care, we are interested to understand what it is that allows others to remain independent. People who live independently may be healthier in general, receive assistance from family and professional carers or purchase services such as those from a cleaner, a nurse, or a bookkeeper. It could also be that they encounter similar challenges to those who move into care-facilities but have developed work-arounds that make it possible to remain independent for longer. It could also be that they make use of high-end household appliances or assistive technology. In the next section, we will explore the findings concerning the effectiveness of existing assistive technologies.

3.2 Assistive Technology for Independent Living

There are two basic models of coping with limitations in ADL's: personal assistance that people may receive from relatives, friends or caregivers; and technological assistance, which refers to the use of tools and devices that help disabled people perform their ADL's more independently [22]. Assistive Technology (AT) can be defined as 'any device or system that allows an individual to perform a task they would otherwise be unable to do or increases the ease and safety with which the task can be performed' [23]. Typical AT devices currently in use are described in an excellent overview by Miskelly [24], including community alarms, video-monitoring, health monitors, fall detectors, hip protectors, pressure mats, door alerts, movement detectors, smoke alarms, fire alarms, cooker controls, electronic calendars and speaking clocks.

Various studies indicate the potential of AT to at least partially substitute social and medical interventions [22]. Therefore, the time spent by caregivers or therapists may be reduced in certain tasks through the use of AT, freeing up caregivers time for less repetitive, physically taxing or mechanical tasks. For example, hydraulic lifting may support the task of bringing a disabled person from their bed to a chair. Portable oxygen tanks may increase independent mobility while reducing the supervision needed [22]. One study reported that people who employ AT need about 4 hours less of help per week, compared with people who do not use AT [22].

Apart from more effective use of caregivers' time, AT could also increase a persons' autonomy. Instead of requiring spoon-feeding and assistance with every drink, AT could assist those who are severely disabled, such as those who have paraplegia to regain control over their own lives, being able to drink and eat at their own convenience. Similarly, elderly people could make use of AT to take care of themselves in areas that may be experienced as embarrassing or demeaning to have performed by others. Examples could include shaving, toileting, getting undressed and so on. Thus, AT for these activities would facilitate the independent living of elderly people.

Some studies have focused on the acceptance of AT, whereby positive as well as negative responses were found. For example, Roelands et al. [25] found that elderly had positive attitudes toward devices that would partially replace human care. On the other hand, McCreadie and Tinker found three main caveats around the use of AT. First, there seemed to be a disparity between the needs of elderly as indicated by the professionals and the needs of elderly as indicated by themselves. Elderly people may prioritise needs different from those that professionals would. Also, professional carers may sometimes feel they know better than the patient what care is needed. Second, potential AT users value their homes and the interiors to a great extent. The acceptance of a new technology depends on the way in which it alters the home environment. Third, people reported discomfort about replacing human contact with AT [26].

While assistive technology offers new opportunities to efficiently use human expertise and give people more control over aspects of their lives, independent living is a complex interplay of people's desires, professional carers' needs, financial possibility, and public attitudes toward care. Any robotic technology developed for elderly assistance will need to adhere to this web of often conflicting requirements. In the next section, we will explore current work on robotic assistive technology specifically and evaluate to what extent the main stakeholders are considered in development and evaluation.

3.3 Robots and Elderly Care

Within the context of robots in clinical and home-care several areas of research can be identified. One area concerns robots for elderly people with serious cognitive impairment. Socially assistive animal-type robots have been used in therapeutic situations with elderly in order to investigate the social, psychological and physiological effects. The robot seal Paro is often cited in this context [27–36] although other pet robots such as the dog-like Aibo [37], [38], [32] and the cat-like robots NeCoRo [39] and Cat Robot may have the potential to play similar roles.

Paro´s benign appearance and pleasantness to touch facilitates the user´s positive associations when interacting with the robot. It has been administered in nursing homes in long-term experiments. Some of the reported positive effects of interacting with Paro included:

- People felt more positive and happier [29], [35], [33]
- Enhanced ability to overcome stress [29], [30], [35], [36]
- Reduced depression [33]
- Increased moments of joy and laughter [33]
- Users became more active [33]
- Better communication with each other and with carers [33], [36]
- Reduced stress-levels for professional staff due to a decreased need for supervision [35]

Other authors have compared the effects of pet robots to the effects of that of a living animal, a toy, another robot or the same robot switched off [37], [28], [31], [32]. Banks et al. [37] found that both a living dog and a robotic dog (AIBO) effectively reduced the level of loneliness in elderly people who lived in long-term care facilities, with no significant differences in their perceived performance. When Tamura et al. [32] compared the performance of an AIBO robot with an electronic toy dog, the latter was preferred to the former, probably because it resembled a dog more and triggered previously learned patterns of interacting with dogs. Kidd et al. [28] had elderly people interact with a Paro as well as a semi-robotic toy (a doll). They identified usability shortcomings in Paro, for example it was too large and heavy (considering that elderly people tend to be frailer). The same authors also found that the user evaluations were more positive if the robot was switched on. Taggart et al. [31] investigated this last aspect in more detail and reported a wide range of reactions to Paro when switched on, while when switched off users tended to remain quiet and unresponsive to the robot.

Wada et al. [34] found similar results with Paro turned on or off in elderly patients with dementia. They also recorded EEG when the patients interacted with Paro and reported that the robot fostered an improvement in cortical neuron activity. Tamura et al. [32] found the AIBO robot an effective rehabilitation tool in elderly patients with dementia. Marti et al. [29] introduced Paro in a nursing home and discovered that it contributed to a reduction of stress levels, an increase in positive feelings and a facilitation of emotional commitment in demented patients. In another study carried out at the same nursing home, Giusti and Marti [27] reported the participants' disposition to attribute internal states to the robot. It appeared that patients with severe dementia attributed a higher degree of agency to Paro (even when told it was just a robot). Libin & Libin [39] used robotic cat NeCoRo with participants that differed in age, cognitive impairment, cultural background, etc. They confirmed that persons with dementia could be engaged in interactions with a robotic companion and found that both NeCoro and a plush-toy cat produced positive effects on agitated behaviour and expressed affect. They also compared older (without dementia) to younger participants. It seems that NeCoRo met their needs more and was found to be a more desirable companion for elderly people than for younger people, since the latter considered NeCoRo less exciting and interesting.

Some studies with elderly employ conversational agents and robots. For example, Sabelli et al. [40] described the elderly's reactions to a conversational robot that was placed at an elderly care centre for 3.5 months. The robot seemed to be accepted into their community and the elderly appreciated particularly some behaviours such as its daily greeting and to be called by their own name. Heerink et al. [41–44] explored the effects of robots that are sociable, expressive or socially communicative to a higher or lower degree. Higher levels of these qualities elicited higher feelings of comfort and an enhanced expressiveness towards the robot.

Another context that offers studies with socially assistive robots is rehabilitation. Wade et al. [45] investigated how post-stroke patients interacted with Bandit, a socially assistive humanoid robot designed to guide the users when they were performing certain tasks. Among other results, users diminished their interaction with the robot when the concentration required was high, although in general the robot could be used to guide and motivate the patients during the tasks. Tapus et al. [46] worked also with post-stroke patients and a socially assistive therapist robot that helped in rehabilitation exercises. They focused on the relationship between the level of extroversion-introversion of the robot and the user and found evidence for a preference of personality matching (robot and user with a similar level of extroversion-introversion).

Very often, rehabilitation robotics does not focus on social interaction; the robotic technology that is developed is mostly task-oriented. For example, Lancioni et al. [47–49] investigate how rehabilitation robots effectively improve the performance of people with multiple disabilities at certain tasks. In [47] they explored the possibility of offering choices in the occupational intervention when interacting with the robot and found that it proved to be effective in fostering independent activity. The authors tested the usability of a rehabilitation robot that helped in various activities (such as transporting objects between two places) and found that the users easily learned to use the robot [49]. In [48] they compared the participants' performance at tasks with robot-assisted ambulation (robotic help to move around in a room) and un-assisted ambulation. Participants in the robot-assisted arm of the study had higher quantities of independent activities and showed higher percentages of ambulation.

Current research involves the assessment of elderly responses to robots in laboratory but also in care-home settings. These studies indicate that elderly people are exposed mostly to pet-like robots rather than humanoid or functional robots. Research on functional rehabilitation robots often concerns people with disabilities, which elderly may or may not have. We are specifically interested in robotic assistive technology that allows people to live independently. As such, these robots will need to operate in the context of people's homes. The next section will explore current literature on robots in the home.

3.3.1 Robots and elderly care in the home

There have been research projects to date that offer robotic help to the elderly who live at home. Examples of the robots employed in these projects or released to the market are: PEARL (Fig. 1), RoboCare, Wakamaru, U-bot, CareBot, Kompaï, Florence (Fig. 2), SCITOS A5, Care-O-Bot, RIBA and Charlie (the HealthBot, Fig. 3) [50]. Each of these robots possesses a subset from the following functionality:

Figure 1: PEARL robot

Figure 2: Florence robot

- Tele-presence and remote communication, facilitating the communication and supervision by carers and relatives.
- Coaching: for example, the robot offers mental stimulation.
- Companionship: for example, the robot displays conversational abilities.
- Reminding: for example, the robot reminds the user of appointments, important dates, drinking water and other daily life tasks.
- Data collection and surveillance: for example, the robot can warn the carers about an unusual behaviour pattern.
- Emergency handling: for example, the robot can detect a fall and make an emergency call.
- Manipulate the environment physically: a few robots have arms that allow them to remove obstacles, bring objects, lift the user, etc.

Figure 3: Charlie, the HealthBot

Early robotic projects to assist the elderly (1995-2005) developed robots intended to mimic a human personality. For instance, they were endowed with human-like heads. This anthropomorphization turned out to be detrimental as it raised too many expectations about the robot´s abilities. More recent projects present robots as household appliances or intelligent devices, even though they still can have a personality [50].

4 Possible Robot Roles for Independent Living

4.1 Robot Roles

Robots have been designed with a great variety of purposes, such as performing dangerous tasks (in minefields, outer-space, etc.), home chores like mowing the lawn and vacuuming the floor, or entertaining humans [51]. Previous studies suggest that people prefer robots for jobs that require memorization, good perceptual skills and service orientation [52]. People were found to consider home robots especially suitable for the roles of assistant, machine or servant, fulfilling tasks such as vacuum cleaning, guarding the house, gardening and entertainment [53], [54].

A number of studies have investigated the behavioural responses and attitudes of elderly people towards robots [36], [41], [28] or the use of robots in therapeutic settings [45], [46]. Others have explored the possibility of robots to motivate older people for physical or cognitive activities. Osawa et al. [55] designed an anthropomorphized robotic vacuum cleaner that taught older people about its features. They compared the emotional state (motivation) elicited by learning with the robot to manual learning and found a significant difference in favour of the robotic vacuum cleaner. Other studies involved virtual agents or robots in the role of coach, which motivate elderly people to do more exercise or walk [56], [57]. In [56], a socially assistive robot played games with elderly people offering a series of interactive activities. Its performance was compared across two conditions. In one condition the robot showed behaviours that are known to improve one´s intrinsic motivation, such as praising the user upon completion of an exercise, providing reassurance in case of failing, showing humour or calling the participant by name. In the other condition, none of these features were included in the robot´s behavioural repertoire. The results indicated strong user preferences for the motivating condition over the neutral condition. Finally, several studies have focused on the design of virtual agents to teach users certain skills while increasing their feelings of self-efficacy [58].

It seems that, when interacting with agents or robots, users usually prefer robots to virtual agents [58–61]. The positive effects of the robot are suggested to be due to its embodiment which leads the user to perceive a higher social presence [59]. When interacting with social agents or robots, it appears that lonely people perceive the robots to have a higher social presence compared to non-lonely people. This suggests that social agents may be especially effective when used by lonely people [59].

This short overview shows that many roles of robots in the context of elderly care have been researched and that robots can actually have positive effects. However, these studies were mainly based on the assumptions of researchers regarding the kinds of robots elderly people could need. We took a different approach and - before designing the actual robot - investigated what the elderly themselves might actually want robots to do.

4.2 Contextual Analysis of the Needs of Elderly for Independent Living

The goal of the present study was to describe and understand the daily life of independent living elderly people, as well as their interests, hopes and dreams. We aimed to identify their needs for support and roles people and technology play in their lives to eventually help them maintain their independence. Contextual analysis is a qualitative approach to collect rich context data that is relevant to a small set of representative participants in order to gain a deep understanding into the relationships between important factors in people's daily lives. Seven elderly persons from a city near Madrid, Spain, participated in in-depth interviews carried out in-situ in their homes. The results from the qualitative data analysis indicated a great variability in the coping capacity of the participants. Feelings of loneliness and lack of motivation appeared as common burdens in their lives. Robot roles are proposed that could help fulfil the needs of independent elderly people. Self-efficacy and other related constructs are discussed which could have an influence on older people's motivations and their predisposition to disability. Finally, a "motivator" robot role is proposed that could enhance the self-efficacy of independent elderly in physical therapy contexts, hence decreasing their risk of losing independence.

4.2.1 Daily Life of Elderly People

Few studies have explored the daily life of elderly people and their activities. Horgas et al. [4] interviewed older persons and obtained the following results about how aged people spend their time. Obligatory activities (e.g. self-maintenance) take place most frequently during the day. However, leisure activities occupy most of the day, which are almost completely restricted to watching TV and reading. Resting also takes up a large portion of the day, namely about three hours. The authors report great variation in how aged people spend their time. They also suggest that observing older people's activities can provide insight into their goals, motivations and successful aging. For instance, a person who spends most of the day resting would indicate a worse aging compared to a person that spends his/her time participating in multiple activities [4].

In contrast to [4], our study did not aim to quantify how aged persons spend their time, but to have a deeper understanding of the meaning of their activities. Furthermore, in-depth interviews allowed us to learn about more than their activities, as for example about their internal world, their motivations and their feelings.

4.2.2 Methods

In order to identify the aforementioned aspects of the daily life of independent living elderly, the following methods were used.

Participants

The data analysis was based on seven participants, referred in this paper with fake names: Esteban (87) and Paca (83), who live together as a married couple; Estefanía (89) has lived with Pedro (71), her son-in-law, since the recent death of her daughter; Ana (67), Tania (70) and Nadia (72) each live alone. The ages ranged from 67 to 89 and the average age was 77. All lived in a city near Madrid, Spain, and had at least one child living nearby. As well as the choice of the country, the participants were a sample of convenience. Some of them knew each other: Tania and Ana were members of the church group of the recruiter and Nadia was the neighbour of Esteban and Paca. All participants lived at home and did not receive formal care.

Measures and Instruments

In-depth semi-structured interviews were chosen as the method for data collection. It was expected that the interview questions would provide valuable information about elderly's daily life, activities, people and things that have an important roles in their lives, as well as their problems and solutions to these that the participants found.

A brainstorming session took place where four participants (the two first authors, plus two other members of the same department) presented ideas about how to conduct the interviews and what questions they should contain. The questions explored functionality and activities from the International Classification of Functioning (ICF) of the World Health Organization (WHO) [62], Instrumental Activities of Daily Living (IADL´s) [63], potentially useful robot roles according to the brainstorming session and literature [53], [54] and factors that might lead aged people to give up their independence [8].

The questions that composed the interview were open and for each topic they started by being very general and becoming gradually more and more specific. For example, the first question of the interview was: *How are you? Tell me something about your current life so that I get to know you a little bit.* And for the particular topic of walking, the progression of the questions would be: *How is walking for you? How is walking at home? How is walking outdoors?*, etc.

The interview questions were written and printed as part of an interview protocol script (see Appendix). This was complemented by another script containing questions to seek information about activities, roles and problems/solutions (also see Appendix). For the activities and situations included in the interview protocol script and other activities that the interviewee might bring up during the interview, the interviewer would ask about details concerning the activity (i.e. *under what circumstances do you perform that activity*), the roles involved (i.e. *who is present during the performance of the activity?* Or *who does it?*) and corresponding problems and solutions (i.e. *do you find it boring or entertaining?* Or *what helps you make it better?*).

Procedure

A first interview was conducted as a pilot with an independent living aged person and several questions were removed from the interview script or modified as a result.

Subsequently, the same interviewer visited the participants at their homes. After the introduction a brief explanation of the purpose of the study was given, emphasizing the importance of learning about daily routines of elderly people. The fact that the data would also serve to identify useful robot roles was not made explicit before the interview in order not to bias the participants´ responses. Before the interview commenced, the participants were given a consent form that they read and signed, which assured them that the discussion would be confidential and that they had the freedom to stop the interview if they wished. The participants were audio and video recorded during the interviews, which took approximately 2-3 hours. After the interviews the audio data were partially transcribed into English, leaving out most of non-relevant comments (for example, long remarks about others, politics, etc.)

4.2.3 Results

Data Analysis

The transcribed data were analysed according to the affinity diagram method [64]. Similar to grounded theory, this method encourages no preconceptions about the meaning of the data, allowing groups of concepts and their relationships to emerge.

Results from Affinity Diagram:

Sticky notes containing key points were created from the transcribed interviews by the first author. Key points concerned the research questions, problems, common patterns or influencing factors that could be important to currently impact the participants´ daily life. As an example, information about a household task that seems difficult to perform would be considered a key point. These key points consisted mostly in participants' quotes, or alternatively in observations noted during an interview.

The post-its were shuffled and two researchers from the same research team sorted them interactively and stuck them onto a wall, while grouping together those aspects that seemed related: *limitations*, *care*, *activities*, *social life*, *"I´d like to, but I don´t"*, *attitudes*, *facing problems*, *memory*, *religion*, *depression*, *anxiety*, *happiness*, *hygiene*, *open spaces* and *safety*. Groups that represented similar topics, such as anxiety and depression, were situated next to each other. Also, within groups, post-it notes with similar content were placed close to each other. New rearrangements took place among the notes interactively and finally the groups were labelled.

Description of Daily Life:

A detailed description of the results obtained during the interviews is provided below. The following subsections do not correspond with the clusters identified in the affinity diagram. Instead, the results have been regrouped into *health and psychological factors*; *physical tasks*, *leisure and social life*; and *roles played by people and technology*, hoping to show the results in a more understandable manner that fits the structure of the discussion of related work in this document.

Health and psychological factors:

All participants mentioned health complaints that impacted their daily life. Esteban and Paca were the participants who seemed to have the weakest health status. In most cases, these health problems involved a reduction in mobility, which implied in turn less frequent social interactions. For example, Estefanía stated *Many friends ask me to attend activities, but I don´t go because of walking problems*. Other health issues of the participants concerned heart disorders and eyesight and hearing impairments. Except for Estefanía and Nadia, the participants believed they had a bad memory. The associated memory problems ranged from small memory lapses to not cooking in order to prevent accidents (Pedro).

With the exception of Nadia, participants reported difficulties sleeping, which they tried to compensate for by using sedative pills. These difficulties seemed to have often a psychological origin, such as worries or obsessive thoughts (for example, about a child's welfare).

All participants seemed to be concerned about their future, in particular about becoming frailer and giving "trouble" to their children. Esteban and Paca were especially concerned about their health at present and how it will worsen over time. Nadia was sometimes worried about financial issues. Welfare of children and other relatives was also a major source of preoccupation. Another common worry concerned their safety at home, for example they were afraid that burglars might break into their homes.

The aforementioned worries seemed to be associated with anxiety and a depressive mood, having a big negative impact on most of their lives. Esteban and Paca reported several times how sad they felt. Ana talked about her nervousness: *I sleep very badly because I´m a nervous person. Also because I think about problems*. Tania´s anxiety towards her children in general and her son in particular seemed to affect her. Her husband had died a few years ago and she often felt down. She said: *Sometimes I find it difficult to wake up because I´m depressed*. Estefanía seemed to be a person with a strong personality. However, the grief over the death of her daughter had caused intense feelings of depression. Estefanía, Paca, Ana, as well as Tania, cried at some point during the interview.

When asked what they do when they are worried, all except Nadia explained that they take a tranquilizer or a relaxing infusion. Nadia explained her strategy: *When I´m worried I try to fight the thought, or I try to keep my mind busy*. Another strategy they reported was to go out for a walk. They discussed their problems mostly with their children, although Tania liked to share her problems with friends and Nadia discussed her problems with friends exclusively.

A frequent complaint that seemed to have a significant impact on their lives was a feeling of loneliness. Esteban and Paca referred several times during the interview to their loneliness. For example, Esteban once said: *Our problem is that we suffer from "lonelinitis"*. Also Tania and Ana reported feeling very lonely. Interestingly, those who reported most loneliness seemed to have frequent social contact. Esteban and Paca were visited every day, especially by relatives and occasionally also by friends. Tania had an active social life that included children, friends, church group, and various volunteering activities. During a break in the interview with Ana, her daughter revealed to the interviewer: *Actually she´s every day in our houses, she´s never alone, at least on working days*. When asked about feelings of abandonment, no participant reported feeling abandoned.

A reduced willingness or ability to perform certain activities was found in some participants, which did not seem to relate just to a general poor health but also to motivational factors. For example, even though Esteban and Paca seemed to have certain disabilities, especially regarding mobility, there were home chores performed by their grandson or others that they could have performed for themselves. It seemed that they, on one hand, and their family on the other hand, had accepted this delegation of tasks. When help did not arrive they actually fulfilled some of these chores without it, such as bathing or cooking. Ana mentioned many activities that she would like to do or to change while she actually did not. For instance, she said: *I have more clothes but I always wear the same. I'd like to dress better but I don't. I get in such a mood that I don't care.* She had excuses for not performing some of those activities which may not seem difficult for us to overcome: *I don´t read because I didn´t go to school* (she has the ability to read). She also showed negative impressions about her abilities: *If they had to do groceries for me, I´d feel even more useless than I am already.*

During the interview, Pedro asked very frequently whether he was participating correctly in the interview. He excused himself often before starting a statement by saying "I don´t know, I´m very ignorant, but I think that…" He also reported that he felt insecure sometimes while performing activities such as card playing or reading and then he stopped.

All interviewees expressed in different forms a need for open spaces. For example, Nadia liked the views from her window, which included a garden with trees, and regretted not having a balcony. She considered that going out is important: *If you stay alone at home too long, you start to feel lonely and become obsessed with certain things*.

Physical tasks, leisure and social life:

The participants reported spending most of the daytime doing leisure activities and resting. Household chores were performed mostly in the morning, so that they could have more free time in the rest of the day. These results are in accordance with the findings in [4].

All participants, with the exception of Esteban and Paca, reported little trouble with performing Activities of Daily Living (ADL's) and Instrumental Activities of Daily Living (IADL's) [63]. The most problematic activities at home were hanging/taking down the curtains, cleaning the upper parts of bathroom and kitchen and cleaning the windows. Some interviewees mentioned challenges also in using electrical appliances. Except Paca, all participants did their own groceries with certain regularity. Being alone at home after having children around has reduced the frequency of activities such as cooking and sewing.

Watching TV was the leisure activity on which they spent most time, as also found in [4]. Other common indoor leisure activities were reading, sewing, knitting and cooking (the last three can be considered as hobbies or household chores depending on the participant). Nadia was the only participant that used a PC and an e-book reader. Four of the interviewees lived in pairs, which allowed them to perform certain activities together. For instance, Pedro and Estefanía played cards daily.

Tania, Nadia, Pedro and Estefanía used to go or were still going to a sports centre where they could participate in special activities for the elderly. Tania and Nadia tried also to walk frequently to stay healthy.

Most of the social life of the participants revolved around their children and grandchildren. Except in the cases of Tania and Nadia, contact with friends was infrequent. Visits by children and grandchildren took place usually on a daily basis. They also received phone calls from their children daily, usually several times per day, and as with visits they tended to receive the phone calls but not to initiate them.

Some participants were doing activities outside the home that involved social contact. For instance, Tania participated every week in NGO activities because she liked helping people and the social contact. She also visited old people at nursing homes and hospitals as a volunteer. Nadia attended courses offered at the municipality.

Roles played by people and technology:

All participants did most household chores themselves. However, all participants received sporadic help from children or grandchildren. For instance, one of Nadia's children helped her to turn around the mattress on her bed and a relative sometimes did the grocery shopping for Pedro and Estefanía. Paid housekeepers helped none of the interviewees at the time of the interview since their opinions about cleaners seemed rather negative.

Esteban and Paca were the two participants who showed the most frequent and diverse need for help, carried out by children and grandchildren. Other ways children offered their help were: transportation, since none of them drove a car, and grocery shopping that involved the use of car; administrative issues or paperwork; controlling their welfare and daily condition; giving them money (Nadia); looking after their dog when the owner (Tania) is absent, etc.

Participants were supervised by their children for their own safety and welfare. In some cases, the children or grandchildren motivated the interviewees to perform certain tasks. For instance, the granddaughter of Esteban and Paca encouraged them to bath and offered them her help. Also, children and grandchildren seemed to play an important companionship role. In Tania´s case, her dog also fulfilled this role. She explained that it offered her good company, representing a great social support. Tania also listened to radio or music throughout the day because that "makes her feel less lonely".

Some interviewees offered help to their children. For example, Tania and Ana picked up their grandchildren from school and looked after them.

A series of objects were identified that helped the participants cope better with difficulties in daily life. For instance, they used shopping trolleys that helped them carry the shopping to their homes. Esteban, who walked on two crutches, took a rucksack instead. The most problematic ADL for Esteban and Paca was bathing. When they did not receive help from others, they put a stool in the bathtub on which one can sit while being washed by the other. Besides using the phone as the rest of the interviewees, Nadia also used her PC and certain smartphone applications to be in contact more often with her children.

Finally, some participants found a great support in religion and in the figure of God. For example, Estefanía believed that God helped her and Ana felt safe at home "because she trusted the Lord".

4.2.4 Discussion

The objective of this study was to understand the daily life of elderly people in order to identify possible robot roles that could facilitate independent living. Few studies have explored the daily life of elderly people and their activities [4]. Whereas the methodology in [4] follows a quantitative approach, the qualitative interviews in this study allow a deeper understanding of the daily life of each participant, including not only activities but also psychological factors.

Thus far, the daily life of the participants has been described. We will now discuss how robots could foster the independence of elderly users by fulfilling various roles and their corresponding behaviours.

Despite the small size of the sample, the participants showed a great variation in many aspects of their daily lives. Most were able to successfully fulfil the majority of household chores and other obligatory tasks. The most challenging physical tasks involved mobility. As problems in walking significantly impact their lives, a trainer role could be suggested for a robot companion. These problems in walking were the consequence of heart diseases or physical disorders in the legs. A robot trainer could help to maintain the current physical condition or train mobility before any mobility related disorder appears. The most problematic physical tasks inside the home were hanging/taking down the curtains and cleaning the upper parts of kitchen and bathroom. These tasks would correspond to the roles of cleaner or butler, which most people would like to have included in a robot´s functionality [53], [54]. Some participants reported difficulties with their memory. Here, a monitoring robot could take on the role of reminder, for example reminding to take medicines, helping find objects or ensuring that the cooking process is carried out without dangers. Using certain electrical appliances was challenging for some participants. A robot could incorporate the technology of a particular device so that its use becomes easier, or to motivate and teach the user how to use it [55].

From the results described above it seems that the most problematic aspects of the daily life of independent living elderly people did not concern obligatory activities, such as house chores. However, the interviews revealed the presence and profound impact of negative emotions, thoughts and attitudes.

While all participants shared the characteristics of being old, having health problems and living alone (or with another person), the way they perceived and faced their situation seemed to vary significantly among them.

An informal interview with Nadia took place after the official interview, where she was asked about loneliness. She proposed that elderly people feel less lonely when they stay busy and participate in activities outside the home. This may suggest the possibility that feeling lonely depends on more factors than just the amount of social contact. In this respect, a robot might be able to help certain older persons by providing company [59], or as Nadia's comments may suggest, by influencing behaviours and attitudes that could reduce the feeling of loneliness.

Besides feeling lonely, other negative emotions and behaviours may also have an attitudinal origin. Esteban and Paca could learn how to use electrical appliances, like the washing machine or the TV remote control, so as to become more independent. They could also manage at home with less external help. They seemed to be at least partially aware of their delegation of tasks. However, the belief that they are very 'unable' seems to prevail both in their impressions about themselves and those of their relatives. The fact that Ana gave many excuses to explain why she did not do the things that she would like to do, together with declaring feeling "like useless", might reflect also a low appreciation of her own abilities. Finally, also Pedro might have a negative impression of his abilities since he described himself as "ignorant" and he stopped certain leisure activities due to feelings of insecurity. Perhaps self-efficacy or coping interventions could help them regain self-confidence at certain tasks, increasing the frequency of behaviours that facilitate their independence and promote their wellbeing.

All the evidence described thus far suggests that interventions in older people´s self-efficacy and related constructs might make them less prone to give up independence. Virtual agents [58] or robots [56] that take the role of motivator might be able to be part of such interventions. In particular, therapeutic programs that promote physical exercise [18] might offer suitable contexts to employ self-efficacy based motivating robots.

4.2.5 Conclusions

This study explores the daily life of independent living elderly people in order to identify robot roles that could foster their independence. In-depth semi-structured interviews allowed gathering significant amounts of data with richer content than quantitative methods. The affinity diagram method was employed to analyse the data. Significant variation was found in the behaviours, emotions and attitudes of the participants, which were described in detail. Despite the fact that the study originally intended to focus on activities, roles and problems of independent elderly, the results contain numerous references to emotions, thoughts and attitudes. In the discussion robot roles are proposed that might help fulfil the needs of independent, aged persons. Since loneliness, a low appreciation of one´s abilities and depressive mood appear to be the most problematic issues in the lives of the participants, evidence is sought that indicates the important role of self-efficacy and related constructs in causing or preventing disability. In addition, other studies are reported which suggest that elderly people´s motivation can be influenced, that their self-efficacy can be trained and that robots might be able to participate in interventions that promote elderly´s welfare, such as physical activity programs.

The proposition that self-efficacy and related constructs are relevant in explaining the welfare of independent living older people is loosely based on the results of this study, since the participants did not undergo any formal psychological assessment. On the other hand, the results cannot be generalized due to the small size of the sample, the fact that the participants live in the same area and because convenience sampling was used to recruit the participants. Specifying how exactly robots can influence elderly people’s motivation and other psychological factors is considered outside the scope of this study. Future work might promote a better understanding of the daily life of independent living elderly and how robots can foster their independence.

5 Problem Statement

The contextual analysis of elderly people’s daily life revealed insightful aspects about their interests, hopes and dreams, as well as their needs. A key finding in the study was that psychological distress appeared to be a major burden in the life of independent elderly. That is, beside health problems and disability, there are factors of psychological origin to take into account, such as feelings of loneliness, lack of motivation and depressed mood. These psychological aspects are relevant not only because of the distress they cause, but also because of their association with disability.

Robot roles have been described above that might facilitate independent living in elderly. Unlike most robot roles, roles such as “physical trainer” and “therapist” involve not only an interaction but also a change in the user. The remainder of this document proposes experiments that aim to increase mobility and improve motivational factors by influencing attitudes and beliefs of the user. In a first step we introduce a study that relates robot roles and personalities with each other.

6 What you do is who you are: The Role of Task Context in Perceived Social Robot Personality

Fong et al. [65] distinguish social robots from conventional robots by emphasizing that social interaction with users plays a key role. Social robots are envisioned to autonomously interact with humans in a socially meaningful way [66]. To work with humans in environments designed for humans, robots should be designed optimally for such conditions, in form, behaviour, and personality. The robots' appearance should match the characteristics of the task [67]. Failing to do so could result in the robot being judged as untrustworthy because the (social) signals being emitted by the robot, and unconsciously assessed by humans, will seem 'not right'. Starting from these general characteristics, in the following we will shed some more light on two theoretical concepts that are particularly relevant for our study: personality and occupational images.

6.1 Theoretical Background

6.1.1 Personality

Personality greatly impacts human behaviour and interpersonal communication. McCrae and John have provided one of the best known definitions of personality: "the most important ways in which individuals differ in their enduring emotional, interpersonal, experiential, attitudinal, and motivational styles" [68]. For years, researchers have looked into determining personality traits (or dimensions). A personality trait can be defined as a characteristic of an individual that exerts pervasive influence on a broad range of trait-relevant responses [69]. Theorists proposed any number between three, sixteen or even 4000 different traits, however, in recent years, there has been a general consensus on five traits, also called the Big Five personality traits or Five-Factor Model [70]. This model measures individual personality differences using five different traits: extraversion, conscientiousness, agreeableness, neuroticism and openness to experience. These measures capture attitudinal, experiential, emotional, interpersonal and motivational styles of the user [71].

We assume that people do not only attribute certain traits to other people, they also attribute those traits to technology. This behaviour can be explained by means of the media equation theory, which states: "Individuals' interactions with computers, television, and new media are fundamentally social and natural, just like interactions in real life" [72]. Because robots tend to have anthropomorphic features, it is generally expected that people respond to robots in a similar (social) way as they respond to people [73]. Concerning perceptions of the robot's personality, especially the extraversion / introversion dimension of the Big Five Personality scale has been applied, for instance in studies on human robot distancing [74], non-verbal cues from interactive characters [75] and perceived robot personality [73]. Besides "recognizing" a machine as a person, Reeves and Nass discovered that people also hold computers to a personality-based social norm [75] based on their own personality. Two theories exist: the similarity-attraction and complementary theory. According to the similarity-attraction rule, people seek out people (or intelligent agents) who have similar personalities (e.g., demographics, ethnicity, political attitude.). In the complementary attraction theory, people seek out others whose personality complement their own and thus provide a counter-balance [75], [66]. In HRI, support has been found for the similarity-attraction rule when working with robots [26-32] and for the complementary rule for virtual agents [66], [75]. Thus, the factors that are at work have not clearly been identified. Therefore, we propose that other factors are at play and influence the users' preference for a robot's personality. One of these factors could be the context of the task, the role the robot has, and stereotypes connected to these.

6.1.2 Occupational Images

The stereotype images people have of people in a certain field of work are called occupational images. They have, among others, been researched for scientists [76], salesmen [77], accountants [78], librarians [79], lawyers [77], [80] and college students of different faculties [81]. Interestingly, if people have a positive image of a certain occupation, they will be more likely to consider it as a career choice [76]. Research on occupational stereotypes confirms that images of occupations are actually images of people who hold those jobs. What we know about jobs, in other words, has more to do with what we know about people in those jobs than the tasks the jobs actually involve [82], [83]. According to Gottfredson [83] "people perceive occupations similarly no matter what their sex, social class, educational level, ethnic group [...], and occupational preferences or employment", which, according to Glick [82] leads to the conclusion that people organize their images of occupations in a highly stereotyped, socially learned manner.

There is a widely accepted model to categorize occupations linked to personality profiles: Holland's RIASEC occupational model [84]. This model clusters occupations according to personality types for people that typically flourish in the particular job category. The six different occupation codes are realistic, investigative, artistic, social, enterprising and conventional. Most U.S. jobs are in the realistic (66.7%), conventional (13.4%) and enterprising (11.1%) categories [84]. There have been attempts to match the Big Five personality traits with the Holland codes. For instance, Barrick and Mount [85] found that high extraversion, agreeableness, and conscientiousness scores were predictors of managerial behaviour. In another study, the extrovert people were mostly associated with enterprising and social jobs, while openness was more associated with artistic and investigative occupations [86]. Similar evidence was found by Barrick, Mount and Gupta [87]. In a meta-analysis of 21 studies containing 41 samples ($N=11559$), they found extraversion for instance correlated with enterprising ($p = .41$) and social ($p = .29$) and less with the other four occupational types (realistic, investigative, artistic, and conventional). These results are in line with the findings of Broday & Sedgwick [88], who also showed that introversion was correlated with realistic and artistic occupations and extroversion with enterprising and social occupations.

Based on these finding the goal of this study is to gain a deeper understanding into the extent to which task context influences the preference for and perception of a robot’s personality. In fact, some research in HRI has already shown the importance of the tasks on users’ perception of robots. One concept that came up in the context of this research is the matching hypothesis.

6.1.3 The Matching Hypothesis

Knowing that people attribute specific personality traits to others in particular occupations, it is possible that people also attribute personality traits to robots, depending on the task of the robot. A social robot helping elderly in their home will probably require a different personality than a security robot checking people's ID at a security desk. Goetz et al. [67] found evidence for this matching hypothesis, which states that appearance and social behaviour of a robot should match the seriousness of the task and situation. First, in an online survey, participants were given the choice which robot they would want for a given task. Participants preferred a human-like robot for artistic, enterprising, conventional, and social tasks, while the mechanical robot was chosen for investigative and realistic tasks. Two Wizard-of-Oz experiments by Goetz et al. [67] found further evidence for the matching hypothesis. Participants complied more with a playful robot in a playful jellybean-tasting task than a serious robot, and in turn more with a serious robot in a serious exercise task. Moreover, the playful robot was rated as more extraverted, entertaining, and intelligent while the serious robot was perceived as more intelligent. This is in line with the findings regarding human occupations.

Similar support for the matching hypothesis was found in an experiment that exposed participants to tasks with different levels of sociability (teaching, tour guide, entertainment, and security guard). Li, Rau and Li [89] found that participants had higher active response in the tasks with higher sociability (teaching, tour guide, and entertainment) than in the task with low sociability (security guard).

6.1.4 Suitable Tasks for Robots

But which tasks do people want a social robot to perform? Takayama et al. [90] found that people prefer robots for jobs that require memorization, perceptual skills, and service orientation, whereas people are preferred for jobs requiring artistry, evaluation, diplomacy, and social skills in general. These results are roughly in line with the results from Dautenhahn et al. [53] who found people were more comfortable with a robot performing household tasks than social tasks like looking after children. Furthermore, a large percentage of the participants wanted the robot as an assistant (79%) or machine (71%). The robot should also behave in a predictable (90%) and highly controllable (71%). Similarly, a survey of 442 participants showed people would like a robot in their house to do household tasks like vacuuming and packing the dish washer, preparing their food and watering the garden [54].

6.2 Hypotheses

Based on the literature review above, we expect that attribution of robot personality traits is not only dependent on people's own personality, but also on the task of the robot and their stereotype expectations of people that carry out such tasks. We therefore expect:

H1: People's preference for a robot's personality is dependent on the context of the task; specifically, in accordance with the matching hypothesis, people prefer an introverted robot for an introverted task, and an extroverted robot for an extroverted task.

Given that stereotype expectations with respect to occupations are engrained in human minds, people will project their expectations on the robot regardless of its actual behaviours. This leads us to expect:

H2: When a robot's personality does not conform to the matching hypothesis as stated in Hypothesis 1, people will still perceive the robot’s behaviours as congruent with the personality associated with that task.

In our study we tested these hypotheses with two tasks that are described in more depth in the following section: a cleaning task and a tour guide task. We expect that people hold stereotype expectations of a cleaning robot as introverted, while a tour guide robot will be expected to be more extroverted, even regardless of the personality-related behaviours they display.

6.3 Method

A controlled 2x2 between-group lab experiment was conducted to investigate the effects of task on attributed personality. The robot personality was manipulated (introvert / extrovert) as well as the task (tour guide / cleaning task).

6.3.1 Sample

A total of 45 participants (39 males and 6 females), aged between 18 and 29 (M=21.22, SD = 2.51) participated in the study. 91.1% of the participants had Dutch nationality. 48.9% of the participants had a background in Information Science and 40% in Artificial Intelligence. 42.2% of the participants indicated they had seen social robots before and 20% previously interacted with them. 37.8% had no prior experience with social robotics. Each participant was randomly assigned to one of four conditions.

6.3.2 Independent variables

The robot used in the experiment was a 52 cm Aldebaran Robotics NAO robot, operated using pre-defined scripts. These two scripts (cleaning and guiding) included actions such as NAO pointing its arm at certain angles toward either paintings or objects, making cleaning motions on the floor with a cloth, telling something about a fictional artwork using the built-in speech synthesizer and walking a few steps forward. NAO did not use its light-colours or any of its anti-collision features. The extrovert and introvert cleaning tasks lasted 127 and 140 seconds. Tour guide tasks lasted a little longer, 155 and 195 seconds, the latter due to the slower speech rate of the robot.

Figure 4. Cleaning condition

Figure 5. Tour guide condition

The introverted/extraverted robot behaviour manipulation was developed by programming the robot based on existing literature on human-robot interaction. These differences can be divided into two categories: kinesics and paralinguistic cues [91]. The extrovert robot used larger, faster and more frequent body movements (use of arms). A faster speech rate, higher volume and more varied pitch are indications of an extrovert personality, as well as the amount of speech [92]. In the experiment, the extrovert robot talked more, and the speech volume of the introvert robot was set to 70% of the normal /extrovert volume while the speech rate to 65%. Furthermore, the introvert robot would bow its head down slightly when talking to the participant.

Both tasks were set in a non-descript neutral environment with a wall with three paintings and a desk in front. The cleaning task consisted of the robot cleaning the desk area in front of the paintings (Figure 4). The participants had to remove two obstacles (cans) to help the robot clean. In the tour guide task, the robot pointed the participant to each painting and provided information about the three artworks (Figures 4 and 5). During the tasks, the robot moved from the right corner of the desk towards the participant who was seated on the left in front of the third of three paintings.

6.3.3 Dependent variables

A post-experiment questionnaire consisting of 59 items was developed based on previous work. This questionnaire was developed to measure the following constructs: Extraversion of the participant using ten items from Internet Personality Inventory, a short five-factor personality inventory from the International Personality Item Pool [93]. These ten items were measured using 7-point Likert scales.

Since people might expect human-like robots to conform more to social rules than mechanical robots, perceived human-likeness of the robot was measured using a 7-point Likert-type scale consisting of seven items developed by Ho & MacDorman [94].

Trust conveys a lot about the users' attitudinal response towards the robot. We therefore included a measure of trust: the 7-point Likert-type Source Credibility Scale [95], consisting of eight bipolar items. We also measured likeability of the robot using five items on a 7-point Likert-type scale, which was developed by McCroskey & McCain [96].

Robot extraversion was measured using two different scales. Personality was measured using 13 adjectives developed by Wiggins [97], consisting of both introvert (6) and extrovert (7) items, measured using a 7-point Likert-type scale. Because of the participant population, a Dutch translation of the items was provided to aid participants. Participants were given the same items used to measure their own personality [93], to evaluate the robot's personality (e.g. "The robot is the life of the party"). These ten items were also measured on a 7-point Likert-type scale. The items used to measure robot personality can be found in Table 1.

Intelligence of the robot was measured by a subset of the Godspeed questionnaire [98]. These five items were measured on a 7-point Likert-type scale. At the conclusion of the questionnaire, participants were provided with the six RIASEC occupational categories, as well as two or three example jobs associated with that particular category, based upon [84]. Participants were asked to indicate on a 7-point Likert-type scale how well they believed the robot would perform in that type of job.

6.3.4 Experiment procedure

After entering the experiment room, the participant was informed of the overall experiment procedure, followed by the purpose of the study. After having filled in the consent form, the participant was introduced to the robot, and asked to sit and watch the robot.

The duration of the task was between two and three minutes, depending on the condition. During the experiment, the robot would first tell either that it cleans the floor around these three paintings or that it provides information about the artworks in this room. The experiment concluded with the robot asking the participant which of the three paintings was the participants' favourite. Having given the answer to the robot, the experimenter informed the participant that the experiment was over.

After completing the post-experiment questionnaire, the participant was given a lollypop (non-students) or a lollypop and course credit (students) as reward for participating in the experiment. The total length of the experiment was about 15 minutes, including completing the questionnaire.

6.3.5 Data Analysis

After checking internal consistency and normality of the items that make up the set of measures, 57 items were included in the final set of measures.

Because of the high internal consistency of both robot personality measures we ran a principal component analysis (PCA) on the 23 robot personality items in order to create a combined internally consistent measure of robot personality. The Kaiser-Meyer-Olkin (KMO = .557) measure verified the sample was, although just, suited for analysis. Bartlett's test of sphericity (X^2 (253) = 501.7, p <0.01) indicated that correlations between items were sufficiently large for PCA. 17 items were found to explain 27.38 % of the variance. These items, marked with (**) in Table 1 were combined into one robot personality measure, with α = 0.877.

TABLE I. FINAL SET OF MEASURES

Robot personality (Wiggins), α = 0.827
Cheerful (opgewekt) **
Enthusiastic (enthousiast) **
Extroverted (extravert) **
Unrevealing (verhullend)
Vivacious (levendig, pittig) **
Inward (naar binnen gekeerd) **
Outgoing (uitbundig) **
Undemonstrative (gereserveerd)
Jovial (joviaal) **
Bashful (verlegen, schuchter) **
Introverted (introvert) **
Perky (brutaal, eigenwijs)
Shy (verlegen) **
Robot personality (IPIP), α= 0.804
The robot is the life of the party**
The robot is quiet around strangers*, **
The robot feels comfortable around people
The robot doesn't like the draw attention tohim/herself*, **
The robot starts conversations**
The robot has little to say*
The robot talks to a lot of different people at parties**
The robot doesn't talk a lot*, **
The robot doesn't mind being the center of attention
The robot keeps in the background*, **

* Item reversed prior to analysis
** Item combined into "robot personality" measure (α = 0.877)

6.4 Results

A manipulation check confirmed that people perceived the extrovert robot (M = 4.92, SD=.70) as more extrovert than the introvert robot (M = 4.40, SD=.85) (t(43) = -2.230, p <0.05). However, no statistically significant interaction effects were found between the robots behaviours and the task contexts for perceived intelligence, interpersonal attraction, or social credibility. Instead, a main effect for social credibility was found. Both robots were trusted, but, the introverted robot was rated significantly less credible (M=4.70, SD=.66) than the extroverted robot (M=5.29, SD=.64) (F(1, 41) = 8.95, p <.05).Second, an interesting non-significant (*F(1,25) = 8.10, p = 0.31*) trend was found related to the debate on the similarity-attraction versus complementary-attraction rule. In the tour guide condition, extraverted people trusted the extraverted robot (M=5.75) more than the introverted robot (M=4.75). The introverted participants rated the introverted (M=5.28, SD=.34) slightly higher than the extraverted robot (M=5.25, SD=.89), which could be interpreted as a similarity-attraction effect (Figure 6).

In the cleaning condition, however, introverted participants trusted the extravert robot (M=4.96, SD=.08) over the introvert robot (M=4.63, SD=.76). The extroverted participants rated the introverted robot (M=5.13, SD=1.06) slightly higher than the extroverted (M=5.08, SD=.67), which could indicate a complementary-attraction effect (Figure 7).

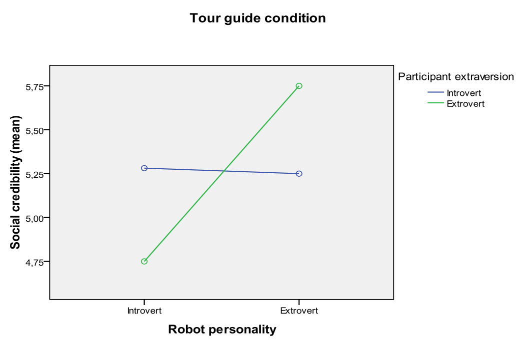

Figure 6. Social credibility in the tour guide condition

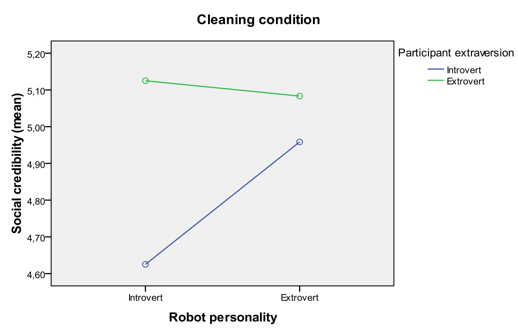

Figure 7. Social credibility in the cleaning condition

TABLE II. ANSWERS AND MATCHES

	Introvert robot	Extrovert robot
	Correct answers to Robot's Favorite Painting	
Cleaning condition	1 (9.1%)	11 (78.6%)
Tour guide condition	5 (50.0%)	6 (60.0%)
	Match between robot and participant's favorite	
Cleaning condition	9 (81.8%)	3 (21.4%)
Tour guide condition	6 (60.0%)	6 (60.0%)

In each condition, the robot would tell which painting was his favourite. In the extrovert conditions this was more prominent than in the introvert conditions. While filling in the questionnaire participants were asked to recall which painting was the robot's favourite. Table 2 shows the number of correct answers for each condition.

At the end of the interaction, each participant was asked which painting was his/her favourite. The robot already had told the participant which painting it liked the most; a match could be seen as compliance with the robot (see Table 2). A Kruskal-Wallis test revealed that matches were significantly affected by the task of the robot ($H(3) = 7.42$, $p < 0.05$). Specifically, participants in the tour guide condition (M=28.00) matched their choice more often than participants in the cleaning condition (M=19.00), $U = 150.0$, $z = -2.719$, $p < 0.05$.

In the post-experiment questionnaire, participants were asked which kind of RIASEC job type they thought the robot they just saw could do. Participants believed the extrovert robot was more suited (M= 2.63, SD=1.74) for an artistic job than the introvert robot (M=1.67, SD=1.20) ($t(43) = -2.174$, $p < 0.05$). For other occupational themes only small, non-significant effects were found.

6.5 Discussion & Conclusion

We did not find sufficient evidence for the matching hypothesis, nor evidence for either the similarity-attraction or complementary-attraction rule. In contrast, the data suggests that attraction rules for robot personalities and behaviours depend on the task-context. We expected that people would hold such stereotype expectations of robots in particular jobs and that they would prefer an introverted robot as cleaner and an extraverted robot as museum guide. However, the trend we found may indicate that for some task contexts the similarity attraction rule holds while for others the matching hypothesis does and still for others the complementary attraction rule may apply.

This suggests that people's preferences for robot's personalities may be much more complex than initially found. Rather than preferring a robot with a personality similar to the own, we may want this for a robot that does a chore we like to do but not for chores we dislike.

Future research needs to investigate whether this indeed is correct. If so, this will have a major impact on adapting robot behaviours to users' personality. Household robots would need to adapt their behaviours differently from museum guide robot, robots that pick up trays in hospitals, office robots and so on.

Participants in the tour guide conditions complied more with the art preference of the robot, in contrast with the cleaning condition. Perhaps participants found the tour guide robot more as an authority on art compared with a cleaning robot and they were more likely to comply with the guide's taste. For the cleaning robot there was significantly less compliance. This could indicate that role expectations indeed influence people's behaviours leading to more or less compliance in particular task settings.

The current study was a first exploration of the complexity of task context in identifying effective robot personalities and behaviours. The limitations of the current study need to be addressed in future research. One of the limitations could be the manipulations. Participants in the cleaning condition had to physically remove an obstacle out of the way in order for the robot to continue cleaning. In case of the tour guide, no physical action of the participant was requested. Perhaps this led the cleaning robot to be perceived as more extraverted compared with the tour guide. Also, participants were not selected based on their personality. From our entire sample 45% of the participants did not have a strong extraverted or introverted personality and were therefore excluded from the personality matching part of our study. This limits the statistical power of the found results. For a future study, selection based on personality could be helpful.

Moreover, in future research we need to focus on the perception of robots by the elderly who are our target population. Therefore, we need to research robot roles that are particularly relevant for elderly people living independently in their own homes. In the following section we describe an experimental design that complies with these needs.

7 Motivating Robot in a Physical Task: Next Experiments

This section explains our next experiments that will be looking at a robot playing a game with an elderly person. In one condition the robot will merely be the interaction partner that the person plays with. In the other condition the robot will also take the role of a motivator trying to increase the participants' intrinsic motivation in the task.

7.1 Problem Statement of Main Experiment

In view of the evidence found in the literature on elderly needs and the contextual analysis described above, elderly´s motivational factors, such as loss of affection (e.g. affection provided by relatives), are relevant determinants of their independence [8]. Hence, interventions aimed at tackling these factors are highly important. We believe that such interventions or techniques can translate to human robot interaction in that when robot behaviours are congruent with these techniques they can increase feelings of control of elderly.

Whereas many HRI studies focus on people´s perceptions and preferences towards robots and the interaction with them [52], [60], [61], few studies have investigated the effects that robots can have on psychological aspects, such as motivation [56]. Even though Fasola and Mataric [56] implemented certain techniques to increase people´s intrinsic motivation in a robot [20], [21], they did not isolate the effect that these motivational techniques could have alone. In addition, their study did not measure the impact of the robot on the participants´ motivation.

Next to these psychological aspects, elderly frequently tend to experience problems in mobility that affect their daily life [6], [7]. However, these problems can be alleviated through physical therapy programs [99], and experiments with robots and virtual agents show that they could be employed as an aid in this context, for example by motivating them to do more exercise or walk [56], [57].

Embedding activities in games has been shown to be particularly motivating. IJsselsteijn et al. describe several motivations to play games [100]. First, games can provide relaxation or entertainment. Second, games bring opportunities to reduce social distance (for example, Bingo) or to share topics of conversation (for example, Trivia). Third, games can be played as exercises to improve one´s mental abilities. Finally, physical exercise can be performed as well in some games (e.g. Wii) [100]. Certain robots have the ability to participate in games with humans. For instance, Ng-Thow-Hing et al. [101] presented a scenario where an ASIMO robot had the ability to play the Memory Game (see description in Procedure).

We want to exploit the positive effects of games in our experiment that aims to ascertain whether a robot can indeed influence elderly´s motivation, and in particular their intrinsic motivation. The concrete question is whether the robot could achieve this by incorporating four behaviours that have been found to promote intrinsic motivation in the interaction with the user while playing a game together: praise, indirect competition, optimal challenge, and offer of choice [56]. In addition, the experiment will involve physical activity as well since mobility was identified as a problematic area not only in the literature above, but also by ACCOMPANY [7]. This leads us to formulate the following hypothesis:

Hypothesis: If an interacting robot implements the abovementioned behaviours (praise, indirect competition, optimal challenge and offer of choice), then the intrinsic motivation of the user to perform a physical task will increase during the interaction.

The results of this experiment will provide valuable insight to understand how elderly users can be motivated to perform a task that involves physical activity. This information will be crucial for robots that act as coaches.

7.2 Procedure

Physical version of the Memory game

Memory is a card game for two or more players with a number of pairs of the same cards. Cards are on the table face down and each of the players in turn may turn around two cards. If the two cards show the same picture the players becomes owner of the pair that is removed from the table. If the two cards are different, they are turned face down again. All players always see the cards that are turned by the other. The winner is the player that ends the game with more cards.

In order to promote physical activity, we propose a physical version of the Memory game. In this version, the cards are hidden underneath certain objects that stand on the floor. It is not relevant what these objects precisely are, but for the sake of clarity we will choose cubes with different weights as an example.. During this version of the Memory, game, the participant must lift the cubes in order to check the corresponding cards that lie underneath.. This way, not only social and cognitive aspects are promoted, as in the standard version of the Memory game, but also physical activity. The weight and amount of cubes (or any other arbitrarily chosen objects) are set after a pilot experiment.

Scenario

The experimenter visits the home of the participant, who will participate alone in the experiment, bringing the equipment for the experiment. This is preferred to lab conditions because ACCOMPANY focuses on HRI at elderly´s homes. After the introduction, a consent form is administered to the participant and the instructions for the experiment are explained, ensuring confidentiality and informing the participant that he/she is free to leave the experiment at any moment. Next, the experimenter sets up the experiment in a spacious room (e.g. the living room). In particular, the physical version of the Memory game is displayed. The experimenter sets up the video camera and starts recording.

Before the start of the game, the participant is asked to freely interact with the robot (i.e. encouraged to introduce himself to the robot and to have a basic conversation). This phase aims to let the participant familiarise with the robot in order to minimise the novelty effect [102] and lasts 5 minutes.

Next, the participant alone plays the game against the robot for 20 minutes. Meanwhile, the experimenter is present in the scene and controls the behaviours and utterances of the robot from his/her laptop. The experimenter knows what figure to find under each cube, as facilitated by a scheme he/she uses while "playing" against the participant. After these 20 minutes, the experimenter declares that the experiment has officially finished and the participant can either continue playing or do something else. If the participant continues playing, this time is recorded as free-choice measure (see Section 7.3). Once the participant stops playing, he/she is asked to fill in the questionnaires. After this, the participant is briefly interviewed for 5 minutes approximately. Interviews will also be video recorded. Thereafter, the experimenter thanks the participant and leaves the house.

Behaviour of the robot:

The robot will display certain behaviours in all interactions with the participant, which will be constant for all the experimental conditions. These behaviours will be aimed at improving the social bond between robot and participant and include [56]:

- Varying the content of the utterances. The utterances will be produced by the experimenter, who controls the robot.
- Pronouncing the name of the participant during the interactions.
- Politeness in the utterances.

Given that the robot will not possess enough dexterity to pick up und turn the cubes by itself, it will indicate by voice and point with an arm which card it wants to be flipped (cube lifted in this case) and kindly ask the participant to show him the card (even though the experimenter already knows what figure to find under each bucket). Being remotely controlled by the experimenter, the robot may offer help to the participant in some occasions by pointing at two or three cards from which one would be the right card to check [101].

Manipulations:

The experiment will be based on a between-subjects design with two conditions. Eight participants will be randomly assigned to each condition.

<u>Experimental condition</u>: the robot implements the four sets of behaviours enumerated in the Problem Statement: praise, indirect competition, optimal challenge and offer of choice. This is how each set of behaviours is implemented:

- Praise: whenever the participant performs well, the robots praises him/her by uttering sentences such as “well done!” or “you are doing great!”
- Indirect competition: the robot compares the performance of the participant to an ideal, for example another previous participant (who can be fictitious). It gives feedback on high achievements.
- Optimal challenge and offer of choice: the robot asks the participant whether he/she wants help at choosing among the cards. If help is requested, three cards are suggested as candidates to turn up. If more help is requested, the number of candidate cards is reduced to two. The level of challenge will be also determined by how well the robot plays. In this case, the robot will play worse or better to adapt itself to the participant’s level (i.e. the robot will choose more or less wrong cards on purpose).

<u>Control condition</u>: the robot does not implement the behaviours that are specific for the experimental condition.

As mentioned above, in the control condition the robot is merely a partner that plays a game with a person. In the experimental condition the role also includes motivational aspects.

Pilot experiment

Before the experiment, a pilot experiment will be carried out with two extra participants in order to ascertain the adequate initial difficulty of the game, i.e. the total number of cards and corresponding number of cubes. The weight to be lifted with each cube will be also tested here.

7.3 Measures

Intrinsic motivation:

- Self-report measure: Situational *Motivation Scale (SIMS)* [20]. This is a test that comprises 16 Likert scale items (1 to 7). It measures intrinsic motivation, identified regulation, external regulation and amotivation.
- Behavioural measure: *free-choice measure*. The experimenter says that the experiment has finished and must leave the participant alone, who now has the opportunity to either continue working on the experimental task, by own initiative, or to do something else, such as reading a magazine, etc. [103].

Ethnographic techniques:

Qualitative data are obtained from the interaction of the participant with the robot in the participant's home. Participant observations and interviews are combined as ethnographic techniques [104].

- Participant Observations: these will be complemented with video recordings.
- Interview: in a semi-structured interview (approximately 5 minutes) the participant is asked to relate his/her impressions about the experience. The experimenter asks in an open-ended question what aspects of the whole experience contributed the most to the enjoyment of the participant. The experimenter also asks what would make the experience more enjoyable and whether the participant would play this game if he/she had the robot at home.

Performance in the game:

The performance in the game is measured quantitatively as the number of successfully coupled cards during the game and the time it took to find the matches.

7.4 Participants

16 participants above the age of 65 will participate in the experiment. This ensures a number of 8 participants in each of the two conditions of the between subjects' design experiment (robot with motivational behaviours, robot without motivational behaviours). The participants will live independently, either alone or in couples. The participants will be asked in advance if undertaking the physical activity that the experiment involves could be harmful for them, and only participants that would not undergo any physical risk would be accepted.

7.5 Data Analysis

Quantitative data:

Time in seconds from the free-choice measure will be averaged across participants of each condition and a T-test will determine if there are significant differences between the two conditions.

Data from the SIMS scale will be analysed analogously, in this case averaging the punctuations from the test that refer to intrinsic motivation.

ANOVA will be employed to find differences in game performance (number of cards correctly coupled) between the participants.

Qualitative data:

Video recordings and interviews are transcribed. Key aspects are extracted from these transcriptions, which are analysed following the Affinity Diagram method [64].

7.6 Future Experiments

We believe that intrinsic motivation of participants can be manipulated even within short periods of time, for example during a one-session experiment. There are other motivational constructs that may have a greater relevance for elderly´s independent living, such as coping and self-efficacy. However, psychological interventions that relate to these concepts usually last weeks or even months and comprise multiple sessions [105–107].

Same as we proposed a first experiment where we translate psychological evidence to robot behaviour, we will design multiple session-experiments that will endeavour to improve deeper psychological aspects of participants, such as coping and self-efficacy. Interventions might be sought as well for other problems of psychological origin identified in the contextual analysis, such as feelings of loneliness. An adequate mapping will be sought between specific therapeutic techniques performed by humans and robot behaviours.

The Memory game offers the possibility of being extended in various ways, for example several people could play the game instead of only one against the robot, or cards could be substituted by pictures of acquaintances of the participant, motivating him/her to talk about them. In this last case, one hypothesis could be that playing with pictures would have more positive effects on participants (e.g. higher intrinsic motivation) than playing with regular cards.

8 Conclusion

The document has presented first research conducted in the EU FP7 project ACCOMPANY into how assistive robots can support elderly in living independently. Necessary requirements to enable people to live happily at home up to a high age are a sufficient degree of physical, social and cognitive health. We started to investigate how robots can support all factors by taking different roles. The basis of our research is a thorough literature review. From the review we concluded that the main reasons why people move into elderly care facilities are issues related to physiological decline (deteriorating eyesight and hearing), social decline (lack of company, affection) and psychological decline (distress, cognitive impairments). We also found that research on functional rehabilitation robots often concerns people with disabilities, which elderly may or may not have. Other than that most studies focusing on the elderly population employed pet like robots. Some of these studies did indeed find psychological effects but disregarded the other factors.

We are specifically interested in robotic assistive technology that allows people to live independently. Thus, all factors are important for us. Therefore, we conducted in-depth interviews to identify needs of elderly people and to infer roles that future robots could play in their lives. The affinity diagram method was employed to analyse the data. A great variance was found in the behaviours, emotions and attitudes of the participants, which were described in detail. As a result of the study, robot roles are proposed that might help fulfil the needs of independent aged persons. Since loneliness, a low appreciation of one´s abilities and depressive mood appear to be very problematic issues in the lives of the participants, evidence is sought that indicates the important role of self-efficacy and related constructs in causing or preventing disability. Studies are reported which suggest that elderly people´s motivation can be influenced, that their self-efficacy can be trained and that robots might be able to participate in interventions that promote elderly´s welfare, such as physical activity programs.

Our evaluation efforts aim to determine how such positive effects can be achieved. A first study is reported that researched the influence of task context and robot role on perceived social robot personality. From the findings of this study we conclude that people’s attitudes toward a robot’s personality depends on its role. Therefore it is important to compare user responses to robot behaviours in a variety of contexts and robot roles.

Such context and corresponding roles have been identified based on this document resulting in the design of user studies focussing concretely on robot roles for interaction with elderly. These studies are based on a memory game scenario that can be adapted to improve physical, social and cognitive health of elderly and to enable them to live independently in their own homes. The first study will investigate whether behaviours that are known to improve people´s intrinsic motivation, such as praising the user upon completion of an exercise, providing reassurance in case of failing, showing humour or calling the participant by name, increase the participants’ motivation in a physical task. This study will be a first step towards developing an assistive robot, able to support independent living of elderly in their own homes.

9 Appendix

Protocol and questions for the interview

Introduction

The interviewer introduces himself according to the nature of relationship between interviewer and interviewee. For instance, if interviewer and interviewee are acquainted with each other, interviewer will start with *hello, it´s very nice to see you again, how are you?* If interviewee did never meet interviewer, interviewer will explain his profession. The fact that robotic applications will be developed as part of the interviewer´s project will be omitted unless interviewee explicitly asks about it.

Interviewer thanks the interviewee for the participation. If there are other people in the scene, these are mentioned and thanked: *and thank you also to you* (3rd person in the scene) *for your help. It is alright that you are here while we conduct the interview.*

The purpose of the interview is explained. *I am conducting interviews that will contribute to my research. In particular, I am investigating daily life aspects in older people (that is, people aged 65 years old or older) that live independently at home. This is why you are a good candidate for my interviews.*

It is common practice to audio or video record interviews. If you do not mind, I would like to video record this interview. This will allow me to go back in time to review your comments so that I do not become distracted by taking notes.

Video camera and audio recorder are prepared and start recording at this early stage, since interviewees may start to provide valuable information even before the first questions.

All the information derived from this interview will be treated confidentially. It is also very common when interviewing people to offer a consent form. Consent form is administered and further explained if required.

There are no right or wrong answers. It is important for my research to receive honest opinions. If you do not have an opinion about a topic or *prefer to omit an answer, you are not obliged to answer. You are allowed to leave at any time or to interrupt the interview. Please let me know whenever you have a question.*

Interviewer prepares his material: copy of this protocol with interview questions and copy of template "Generic Activity". Some activities that are explored during the interview will have their particular specific questions. Other activities (for example, those that the interviewer had not foreseen, such as specific hobbies) will be explored by using generic questions. These questions focus on the activity and its circumstances, roles involved in the activity and breakdowns that occur in those activities and roles, along with solutions.

Questions Interview

Open questions are asked first. Specific questions are asked if detailed information has not been provided.

Questions that could cause embarrassment or resistance are preceded by a version of the following cue:

It may be a little embarrassing/personal for you, but I need this information. Remember all data is treated confidentially.

A) Questions about general situation in life

The purpose of these questions is to make the interviewee start talking about anything they want. The intention is to find priorities in interviewee and to start to create a rapport (very easy, open-ended questions). Finish after 5 min.

If interviewee and interviewer had never met before:

How are you? Tell me something about your current life so that I get to know you a little bit.

Tell me a little about your family.

If they do not start talking or do not understand, go directly to next questions as example.

Where do you come from originally?

What did you do for a living?

If interviewee and interviewer had met before:

How are you doing recently? How is everything going? And your family?

Personal Information

Some questions here could offer certain resistance: age, income level and education level. This is the reason why rapport creating questions have been asked previously.

Before we continue with the interview, let us complete some personal data.

Name:

Age:

(Old) Profession:

Education level:

Basic studies High school Professional training University

How would you consider your income (given that you are retired)?

Low Low-Intermediate Intermediate Intermediate-High High

B) Physical and Cognitive Abilities. Basic care.

Since the emphasis of the interview is placed on activities, roles and breakdowns, this section will be covered fast and focusing on how interviewee overcomes functional deficits, for example by use of assistive technology and own adaptations. There will be a great overlap between this and the section Daily Activities. This section precedes subsequent sections about routines and activities since these are better understood if the participants´ deficits have been described in advance.

Health:

How would you describe your health in general terms?

Do you have any disability?

Which?

Do you receive care?

Questions from Generic Activity

How often?

Have you lost weight recently?

Do you take medicines?

For what?

If problems are identified in the following questions, ask from the following questions:

- *What are the worst situations when you…?/When is it more problematic?*
- *What things help you at…?/What do you to improve it?*
- *Who helps you at…?*

1.

Mobility:

How is walking for you?

Specifications if they do not report much

How is it at home?

How is it outdoors?

How is it when you walk long distances?

How often do you walk?

How is your balance?

Did you have falls?

How is your use of hands and arms?

Only as examples if interviewee does not report much:

How is lifting objects for you?

How is carrying objects for you?

How is reaching for objects for you?

How is your eyesight?

How is reading and writing?

How is your hearing?

Cognitive:

How would you describe your mental abilities?

What do you think about your memory?

Ask for examples.

C) Daily activities (not focused on social and leisure).

Daily activities and the corresponding physical and cognitive functions are described in order following the schedule of a typical day.

Tell me a bit more about (activity). If specific questions for an activity had not been answered spontaneously before, these are asked. The order of activities corresponds to the order given by the interviewee. If one of the activities of this list makes sense to be carried out before the activity suggested, interviewer asks *do you not do (activity from list) before (activity proposed by interviewee)?* If an activity is proposed which is not on the list, improvised specific questions and questions from “Generic activity” are asked to learn more about the activity.

Try to re-enact in your mind the things you did yesterday. Could you describe, with detail, the activities that you performed?

Wake up

- *At what time did you wake up?*
- *Who or what made you wake up?*
- *(Who was there?)*
- *Was it easy or difficult to get up?*

If interviewee reports difficulty:

- *Why was it difficult to get up?*
- *What movements did you do to get up?*

2.

- *Was it alright or could it be better?*
- *What did you do exactly right after waking up?*

Toileting/bathing

- *What order of activities did you follow in the bathroom?*
- *What objects did you use?*
- *In general, what is the most annoying or boring activity in the bathroom?*

Dressing

- *What did you put on?*
- *What order did you follow?*
- *Is dressing easy or difficult for you?*

3.

Eating (breakfast/snack)

- *Did you enjoy it while having breakfast/snack? Why?*
- *What did you eat for breakfast/snack?*
- *Please, explain how you prepared your breakfast/snack.*
- *(What tools and materials did you use?)*
- *Who was there?* If someone was there: *what was he/she doing?*
- *What activities did you perform while preparing your breakfast/snack?*
- *Would you prefer to have your breakfast/snack in a different way?*

Cooking

- *Who cooked?*
- *What did you cook?*
- *What tools and materials were used?* (Avoid a thorough list of tools and ingredients)
- *Who was there?* If someone was there: *what was he/she doing?*
- *What activities did you perform while cooking?*
- *Is cooking enjoyable or boring?*
- *If you could improve something, what would it be?*

Eating (lunch or dinner)

- *Did you enjoy it while having lunch/dinner? Why?*
- *What did you eat for lunch/dinner?*
- *Did you prepare something to drink? Go* to Prepare drinks
- *Who was there?* If someone was there: *what was he/she doing?*
- *What activities did you perform while preparing your lunch?*
- *What activities did you perform while having your lunch?*
- *Would you prefer to have your lunch in a different way?*

Until that moment, had you completed all the activities you had planned for that time of the day?

Prepare drinks

- *What do you usually drink?*
- *Who prepares it?*
- *How was it prepared?*
- *(What materials and tools are used?)*
- *Is it boring or entertaining?*

Sleeping (nap)

- *Did you take a nap?*
- *When?*

- *How long?*
- *Who was there?*
- *What are the conditions you need when taking a nap?*
- *What happens if you do not take the nap?*

Sleeping (at night)

- *How did you sleep last night? If bad: why?*
- *How do you sleep usually?*
- If bad: *why?*
- If bad: *what happens when you sleep bad?*
- *What do you need to sleep well?*
- *Who is there?*
- *What things would you change to sleep better?*

So far we have discussed your routines on a typical day. Do you have days when you do different things?

If nothing comes to mind, examples are offered: villa, Sundays, holidays.

Repeat same process as before.

Housework:

Since many of these activities are not performed every day, when asking about them we will not refer to yesterday, but we will employ terms as “usually” or “generally”. Questions from Generic task are used and specific questions are added.

Let us talk a little about housework tasks.

General cleaning

- *What can you tell me about how your house is cleaned?*

Cleaning:

4. Vacuuming/sweeping

   Mopping

   Dust

Windows

Kitchen

Dishes

Bedroom

Bathroom

Tidying house

Garbage management/taking out garbage

Examples: separate/recycle, take out garbage.

Laundry (washing and drying)

Make bed

Ironing

Making and repairing clothes

Maintaining dwelling and furnishings

Maintaining domestic appliances and other machines

Example: *What do you do when a domestic appliance breaks?*

(When applicable) Maintaining assistive devices

Maintaining vehicles

(When applicable)Taking care of plants and gardening:

Examples: *water plants, garden, manure, cut lawn.*

(When applicable) Taking care of animals:

Examples: *feed pets, walk the dog.*

Get mail, newspaper.

Shopping and acquiring goods and services

Examples: *buy groceries and other home products, unpacking them, storing them.*

<u>Administrative issues</u>

Ask from Generic Activities

Tell me a little about your administration activities.

Bank

Pension

Insurance

Use of technology:

Ask also from Generic Activity.

When do you use (machine from list 1)?

How often do you use (machine from list 1)?

List 1:

Telephone

Watching TV

Music

Computer, Internet, emails

D) Social life and recreation

Social life and communication:

(Family partly covered)

What are the persons that are around you most often?

If answer is unclear, suggest from List 2.

List 2:

Partner

Parents

Siblings

Other relatives

Friends

Informal and formal associations

Neighbors

Acquaintances

For each of those suggested persons, ask:

What do you usually do when accompanied by (this person)?

Is it boring or entertaining when (person) is around you?

If you would like to see a change in those activities, what would it be?

Would you spend more time with (person) at the expense of not doing other things?

How do you obtain information about the people you know? If necessary, mention persons from List 2.

Do you take care of any person?

Tell me a little about it.

Recreation:

For each question, ask also from Generic Activity.

Do you perform religious activities?

How do you find entertainment?

Tell me more about your hobbies.

Do you practice any sport?

If not mentioned: *do you stroll regularly?*

E) Psychological factors.

Do you feel safe at home or do you feel unsecure?

If not: *why?*

How could your feeling of safety improve?

What things do you do to feel safer at home?

Give examples if nothing comes to mind: *reinforced door, lights when gone or night.*

Are you confident or worried about having an accident at home?

About having a fire?

About having accidents with electricity?

About slipping and falling?

How do you prevent these things from happening?

What would you change about your house (as building)?

What do you like most about living in your house (as building)?

<u>Psychological issues:</u>

What do you do when you are nervous or worried?

What helps you to feel better?

What persons help you when you have problems?

What do the people close to you think about the fact that you live independently at home?

Do you feel comfortable or uncomfortable at home?

Why?

Would you like to have less or more company?

How?

Do you feel good received or abandoned?

F. Finish

What are the things that make you happiest in your life?

Give me an example of a recent happy moment.

Interviewer tells interviewee that the interview is finished and asks if there are additional comments or questions.

Interviewee is thanked again.

Interviewing material is collected.

Interviewer leaves the house.

Generic activity

When applicable, ask from the following questions:

Activity

Tell me a little about (activity) or how do you (perform activity)

When/under what circumstances does (person) (perform activity)?

What do you do in the mean time?

Role/Agent/Persons

Who does it?

Who is present?/Are you alone when you do it?

What objects are used?

Breakdowns and solutions

Do you find it boring or entertaining?/Do you find it easy or difficult?/

Is it pleasant or unpleasant?/Do you like it or dislike it?

Why?

If something goes wrong or is disliked:

Why (is that bad)?

Who/what helps you (to make it better)?

If you could change/improve something, what would it be?

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