Informatics

# Über den Bedarf neuer Rollen: Verwenden von Design Fictions zur Entwicklung neuer Use Cases für Pflegeroboter

DIPLOMARBEIT

zur Erlangung des akademischen Grades

**Diplom-Ingenieurin**

im Rahmen des Studiums

**Media and Human-Centered Computing**

eingereicht von


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Wien, 13. Juni 2023

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# On the Need of New Roles: Using Design Fictions to Develop Novel Use Cases for Care Robots

## DIPLOMA THESIS

submitted in partial fulfillment of the requirements for the degree of

**Diplom-Ingenieurin**

in

**Media and Human-Centered Computing**

by

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to the Faculty of Informatics

at the TU Wien

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Vienna, 13th June, 2023

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# Erklärung zur Verfassung der Arbeit

Katharina Brunnmayr, BSc

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Wien, 13. Juni 2023

Katharina Brunnmayr

# Danksagung

Diese Diplomarbeit wäre ohne die Betreuung und Feedback von Astrid Weiss und Anna Dobrosovestnova nicht möglich gewesen. Vielen Dank für die geduldige Unterstützung, die vielen inspirierenden Gespräche und zahlreichen Möglichkeiten Neues zu lernen.

Ich möchte mich ebenfalls beim Team des Projekts Caring Robots für die zahlreiche Inspirationen und den regen Wissensaustausch bedanken. Diese Diplomarbeit wurde teils durch den FWF #ConnectingMinds Zuschuss des Projekts Caring Robots  Robotic Care (CM 100-N) finanziert.

Außerdem möchte ich mich bei Jürgen Öhlinger und dem Technischen Museum Wien bedanken, dass ich einen meiner Spiel-Prototypen im Zuge der Langen Nacht der Museen 2022 im Museum testspielen durfte.

# Acknowledgements

This thesis would have been impossible without the supervision and feedback from Astrid Weiss and Anna Dobrosovestnova. Thank you for your patient support, all the inspiring conversations, and many opportunities to learn something new.

I also want to thank the Caring Robots team members for all the inspiration and knowledge provided. This work was partly funded by a FWF #ConnectingMinds grant to the project Caring Robots  Robotic Care (CM 100-N).

I also want to thank Jürgen Öhlinger and the Vienna Museum of Science and Technology for the opportunity to play the trial run at the museum event "Lange Nacht der Museen" in 2022.

# Kurzfassung

Die Vorstellung, die wir auch heute noch von Robotern haben, wird noch immer großteils von Medien und Science Fiction geprägt. Allerdings besteht eine Lücke zwischen den Vorstellungen von Robotern und dem aktuellen Stand von Robotertechnologien. Ein Beispiel von existieren Robotern, über die die allgemeine Öffentlichkeit noch wenig weiß, sind Pflegeroboter. In dieser Diplomarbeit werden drei spielerische, low-fidelity Prototypen vorgestellt, die dabei helfen sollen diese Lücke zu überbrücken.

Der erste Prototyp ist ein kurzweiliges Karten- und Brettspiel, das die Diskrepanz zwischen überzogenen Vorstellungen von Robotern durch konsumierte Medien und aktuellen Robotertechnologien verringern soll. Der Spielprototyp wurde entwickelt, um auf spielerische Weise das Thema Pflegerobotik an Menschen mit geringen Vorkenntnissen zu vermitteln, und um zu erkunden wie diese Menschen Pflegeroboter in ihrem Alltag potentiell wahrnehmen würden. Der erste Spielprototyp wurde bei der Langen Nacht der Museen im Technischen Museum Wien mit 35 Personen testgespielt und hat sich als hilfreiches Instrument erwiesen, um das Thema Pflegerobotik anzusprechend und auf spielerische Weise zu vermitteln. Mithilfe des Spielprototyps wurden zahlreiche Gespräche und Diskusionen angestoßen und mehr Bewusstsein zum Thema Robotik in der Pflege geschaffen.

Der zweite Prototyp ist von Rollenspielen inspiriert. Ein integraler Bestandteil des Spiels ist das Erstellen eines fiktionalen Spiel-Charakters mithilfe eines Charakterblattes. Mithilfe des Spiel-Charakters werden verschiedene Alltagsszenarien erkundet und die Spielenden erstellen durch immersives Geschichtenerzählen Design Fictions von potentiellen zukünftigen (Pflege-)Technologien. Ziel des zweiten Prototyps ist zukünftige Pflegetechnologien zu erkunden, die sich nahtlos in den Alltag des gespielten Charakters integrieren lassen, und dabei auf Fachwissen von Expert_innen zurückzugreifen. Der Prototyp wurde mit vier Expert_innen aus den Bereichen Mensch-Roboter-Interaktion oder Pflegetechnologien testgespielt. Die Spielrunden wurden aufgezeichnet, transkribiert, und aus den Transkripten wurden Mindmaps erstellt, die sich auf die Technologienutzung des Charakters, aktuell vorhandene, und zukünftige Technologien fokusieren. Die Mindmap für zukünftige Technologien dient als Grundlage für die Erstellung eines Design-Fiction-Kartendecks, das vier fiktionale Pflegeroboter vorstellt und insgesamt aus 14 Karten besteht.

Der dritte Prototyp ist als Design Game konzipiert und bringt das Spielbrett aus dem ersten Prototypen und das Design-Fiction-Kartendeck aus dem zweiten Prototypen

zusammen. Das Design-Fiction-Kartendeck wird mit leeren Karten erweitert und so können Spielende, wenn sie eine leere Karte ziehen, eine neue Design Fiction für eine Robotertechnologien zum Kartendeck hinzufügen. So kann das Kartendeck über mehrere Spielsitzungen weiterentwickelt und als Inspirationsanstoß für weitere zukünftige Robotertechnologien verwendet werden. Ziel ist es neue Anwendungsbereiche für Pflegerobotik zu finden und bestehende innovative Ideen zu diskutieren und zu verfeinern.

In dieser Arbeit werden drei Spiel-Prototypen vorgestellt, die verschiedene Ziele verfolgen. Der erste Prototyp soll auf spielerische Weise einen Dialog und Diskussionen anregen, um mehr Bewusstsein zum Thema Pflegerobotik zu schaffen und gleichzeitig den aktuellen Stand der Forschung vermitteln. Der zweite und der dritte Prototyp zielen darauf ab innovative Ideen und neue Anwendungsbereiche für Pflegerobotik zu erkunden. Die Spiel-Prototypen sind ein Versuch, die Vorstellungen der Menschen von Robotern von gängigen Anwendungsfällen loszulösen und stattdessen zu erkunden welche zukünftigen Robotertechnologien im Alltag oder in der Pflege wünschenswert wären. So können potentielle neue Erkenntnisse gesammelt werden, was es bedeutet, einen Pflegeroboter in unser Zuhause zu bringen und welche Art von Aufgaben dieser verrichten sollte.

# Abstract

As people's expectations regarding robots are still mostly shaped by the media and Science Fiction, there exists a gap between imaginaries of robots and state-of-the-art of robotic technologies. Care robots are one example of existing robots that the general public has little awareness of. In this thesis, three playful low-fidelity prototypes are introduced.

The first prototype is an engaging card- and board game designed to address the disparity between unrealistic expectations surrounding robots' capabilities and the current state of research. Its primary objective is to explore how laypeople perceive existing care robots within their everyday lives. This first prototype was test played with 35 participants during a museum event, proving itself as a highly effective tool to educate people about care robots in an engaging and playful manner. It successfully facilitated conversations and discussions, raising awareness and promoting dialogue on the topic.

The second prototype draws inspiration from role-playing games, incorporating the creation of a character as an integral part of the gameplay. The character embarks on a journey through different daily life scenarios, allowing players to explore design fictions of technologies through immersive storytelling. The goal of the second prototype is to harness the expertise of professionals and envision potential future care technologies that seamlessly integrate into the daily life of the character being played. The prototype underwent test play with four experts with expertise in human-robot interaction or care technologies. From the transcribed play sessions, mind maps were generated, specifically focusing on technologies explored during gameplay. These mind maps served as the foundation for the creation of a design fiction card deck. The design fiction card deck comprises 14 cards, each introducing one of four fictional care robots.

The third prototype combines two elements: the game board from the first prototype and the design fiction card deck from the second prototype, resulting in a design game. This design game serves as a platform that integrates both components, allowing for an interactive and engaging experience. By incorporating blank cards into the card deck, the gameplay is expanded to include the introduction of new ideas for robot technologies. This addition aims to elicit the generation of further concepts for future robot technologies during gameplay and facilitate the evolution of the card deck through multiple play sessions. The objective is to encourage a continuous flow of innovative ideas and refine the card deck over time.

The three low-fidelity prototypes introduced in this thesis attempt to ground the discussion (first prototype) and use participants' imagination in a purposeful way to explore potential novel use cases for care robots (second and third prototypes) in a playful setting. Exploring future technologies, like care robots, through games and play is also an attempt to get people's imaginations of robots unstuck from common use cases. Through games, it is possible to open up the space of possibilities and imagine desirable future technologies. This might lead to novel use cases for robots and re-imagining what kind of care work we want robots to perform in the future. Thus, utilizing playful approaches might lead to novel insights into what it means to bring a care robot into our homes and also what kind of tasks we want a robot to take care of.

# Contents

CHAPTER 1

# Introduction

People's imagination was, and still is, a driving force for developing future technologies. Robots are among the most popular technologies we often encounter in various science fiction media. From humanoid robots like Data (Star Trek) or C-3PO (Star Wars) to less human-shaped robots like R2D2 (Star Wars) or WALL-E (WALL-E). There is a wide range of depictions of robots which influenced people's imagination and expectations for decades. The impact of fictional robots on people's expectations regarding existing robots is not always positive or helpful [33]. One of the most influential portrayals is from the movie Terminator: the Cyborg, played by Arnold Schwarzenegger, which often comes up when the topic of potential futures, including robots, is discussed. This dystopian view of the future results in negative reactions towards existing robots, like the fear of being controlled, killed, or replaced by a robot.

The fear of being replaced surfaces when robots (or other novel technologies) are applied to new contexts. One example would be robots developed for or applied in care contexts. Care workers working in care facilities or in mobile care are not familiar with robots, and in studies, the fear of being replaced was mentioned [28]. In care contexts, robots are still a new technology, and most care workers do not know much about robots. Further, the broader public does not know much about robots applied in care contexts. People tend to base their expectations mostly on the media they consume [33]. So, there is a knowledge gap regarding existing robots and current research involving robots that needs to be addressed.

Robots currently applied in care contexts are not capable of providing the care a care worker is capable of. When robots are applied to care contexts, they are mostly used to assist and complement human workers with their tasks [36, 29]. The promise of robots solving the problem of missing care personnel is so far just that: a promise.

But fictional robots and the imaginaries we have of robots also have an impact on current research in human-robot interaction (HRI). HRI researchers seem to be stuck with the same ideas what a robot can (and cannot) do resulting in re-inventing and re-implementing the same kind of robots performing the same kind of tasks. Being stuck is part of the process of developing something new, and there are many other limitations at work, for instance, financial limitations, technical feasibility, time limitations, missing human resources, skills, etc. Most of these limitations are resolvable given enough money or time.

However, the "being stuck" situation covers (at least) two aspects. One aspect are imaginaries of robots being stuck in a person's head, mainly coming from fictional robots leading to an over-expectation regarding a robot's abilities and skills. And the second aspect is the person's imagination being stuck regarding ideas of what a robot can (and cannot) do.

So, one question we should ask when it comes to imagining robots is: How to get a person's imagination (of robots) unstuck? This rather broad question is hard to answer. Thus, breaking it down towards a more concrete question focusing on the first introduced aspect of being stuck leads to the following research question: *How can the gap between (over-)expectations of care robots and current research in HRI be narrowed down playfully?* (RQ1)

Utilizing the concept of Design Fiction, which is closely related to Science Fiction, might also provide an angle to getting unstuck. Introducing a playful approach to uncouple a person's imagination from existing technologies and use cases towards potential future technologies might also be a suitable tool. So, the second research question this thesis tries to answer is: *Are Design Fictions a useful approach to redirect HRI researchers and spark new ideas regarding future care robots? What kind of ideas are sparked by this method?* (RQ2)

In this thesis, three methods are introduced to approach the question of how to get a person's imagination unstuck. The first method aims at getting people's imagination of fictional robots unstuck by introducing existing robots used in care contexts through a card- and board game and using the game as an ice-breaker to open up conversations about the topics of robots and care. The second method aims at getting the expert's imagination unstuck by drawing on aspects of role-playing games and narrative design fictions. By creating a fictional character and exploring multiple days in the present time and ten years in the future. The 10-year time jump intends to open up the imagination and explore a future world, including future care technologies through narration resulting in design fictions of novel robot use cases created. The third prototype introduces a design game based on the first prototype's board game and utilizes the design fiction card deck resulting from the second prototype. The design game aims at providing a game prototype for exploring and creating more design fictions and novel use cases for care robots through gameplay.

CHAPTER 2

# Related Work

The Literature Review draws from different areas of research: First, a short history of robots used in care contexts is given. Followed up by exploring the role of science fiction and popular media as shaping factors of robot imaginaries. In the next part, I will address the concept of Design Fiction and how design fictions can help with exploring futures and future technologies. In the last section, I will address playful approaches to human-computer interaction (HCI) and HRI.

The concept of Design Fiction was the starting point of the literature research[1]. Starting with familiarizing myself with the concept(s) of Design Fiction [11, 70] and diegetic prototypes [39]. The search engine scholar.google.com was primarily used. Search terms were: "design fiction", "design fictions", "speculative fiction", "science fiction", "diegetic prototype", etc., and I also looked up references in the literature I read. The book "Shaping Things" by Bruce Sterling [70] is often referenced as starting point of Design Fiction, and Sterling is often mentioned as the person who coined the term Design Fiction.

The next iteration of the literature research was expanded after the thesis topic was decided to be robots in care contexts. Using scholar.google.com and terms like "robot health care", "care robot", "assistive robot", etc. Because the environment a robot is applied is a highly relevant aspect, the focus was shifted towards robots applied in domestic environments and interacting with people at home.

The third part of the literature research focused on playful research approaches.

A first selection round was conducted by reading the abstracts of the papers found via the search engine. The second round included a quick review after reading the papers' abstract, conclusion, and method section. At this stage, some papers were removed. When the paper seemed to fit the search criteria, the whole paper was read and sorted

[1]At that point in time, the thesis topic was not decided yet.

into one of three categories: “yes”, “maybe”, or “no”. In total 86 papers were sorted into categories, 28 “yes” papers, 45 “maybe” papers, and 13 “no” papers. Papers included in the “yes” section were summarized in 1-2 paragraphs and collected in an Overleaf document. During the first full read of the paper, some interesting aspects were already marked. The summaries were used to sort the papers into subsections and provided a starting point for the write-up. During the write-up “maybe” papers were included as well when they fitted the section.

## 2.1 About Care Robots

In the context of this thesis, the term “care robot” is used for robots developed specifically for care interactions (like the robot seal Paro used in dementia care [29]) and robots developed for non-care contexts, which are applied for care interactions (like the robot Pepper [29, 22]). So, in this thesis, care interaction is the defining aspect that makes a robot a care robot. A care interaction is an interaction the robot performs to support a care-receiving person with a daily life task, maintain mental or physical health, or entertain the person to keep them active and socially connected.

### 2.1.1 A Short History of Early (Care) Robots

As there is no collective source regarding the history of care robots, I will give a brief overview and early examples of robots from different application areas that were brought into care contexts.

The first robots were used in industrial contexts to assist in automobile production and can be dated back to 1958 [31]. One of the first surgical applications was performed by a robot arm originally developed for industrial uses. The robot arm was used to perform a stereotactic brain biopsy - removing brain tissue - with an accuracy of 0.05mm in 1985, and the introduced prototype resulted in the development of the Neuromate robot. Another early example is Robodoc, an integrated surgical system for hip replacement surgery introduced in 1992 [31]. In 1995 the Zeus robot was introduced as another surgical robot [32]. Industrial robots do bring advantages like high precision [31] and the possibility of teleoperating them [21], thus, using them in surgeries is reasonable.

Some of the robots used in care contexts have their origin in service contexts. For instance, personal service robots applied in a domestic home to assist and support a person in managing their daily chores can also be labeled as care robots, as defined in this thesis. Following this approach, vacuum cleaning robots are also included in the care context. The first prototypes for a commercially available floor cleaning robot date back around 1991 and were developed by Hitachi and Sanyo [53]. Since then, vacuum robots have become increasingly popular and are one of the robot technologies integrated into daily life and the homes of the broader public.

Some service robots and service functionalities have been applied to care robots and care contexts. For instance, service robots have also been used for patient monitoring.

An early example is the robot Carebot which could measure patients' vital signs [32]. Other service-oriented functionalities of robots that can be applied in care contexts are, for instance, different kinds of reminders. So far reminder functionalities for medication [21, 73], staying hydrated [2, 73], or appointments [73].

Tasks like manipulating the environment can also be understood as service functionalities. Robots have been used for tasks like fetching, packaging, and providing medication to patients [21], finding and bringing items [26], opening doors [73], and receiving parcels [2].

In hospital facilities, service robots have been applied for different routine tasks like cleaning, disinfecting areas [32] or logistics like delivery of goods [32, 72].

Another example of robots often applied in care contexts is social robots. Share and Pender [64] point out that over the past years, there has been a trend of applying information technologies to the care field. Their report focuses on social robots and AI technologies used to support daily life activities. Further, some social robots are applied for entertainment purposes [22, 29, 73] or as a companion to lessen a person's loneliness and anxiety [29]. Follmann et al. [27] found that robots used for communication in a hospital or nursing home can reduce the loneliness of older people. The robot also becomes part of the community and is used for entertainment, e.g., playing music. 70 participants participated in the study. Also, in dementia care, the application of the robot seal Paro was effective in managing dementia-related mood and behavior problems like anxiety [42].

Robots have also been applied as tools to improve social interaction skills. One early example is the spherical ball robot Roball which was developed in the 90s as an interactive toy to aid autistic children with social interactions through play [21]. Followed in 2005 by the robot Keepon, which was one of the first social robots aiming at improving autistic children's interpersonal communication skills through play [32].

In 2013 the robot Socially Assistive Robot (SAR) was developed with the aim of helping with social interactions and motivating people to perform physical exercises [23]. In 2014 the robot Pepper was introduced, aiming at social interaction, entertainment, and physical exercises as well [32].

Predecessors of entertainment robots can be found a long way back in history in the form of water or steam-powered statues or puppets [16]. Entertainment is a broad field, and there are many different approaches and possibilities to entertain a person or a group of people. For instance, singing together is a popular activity programmed into social robots like Palro [73] and Pepper [32]. Another popular approach to entertainment is playing games. The robot Hobbit provides the game Nine of Men over its touch display [26]. Also, guessing quizzes [29, 2] are popularly offered by different robots. Some of these games aim to maintain mental health by keeping people mentally active and training their memory. Some interactions and games are developed specifically for people with dementia [2]. There are also many playful approaches introduced combining exercises and entertainment to keep people engaged, physically active, and entertained at the same time, where robots play a mediating role [2, 29].

Pet robots are a subcategory of social robots. One of the first examples of a robotic pet is the robot dog Sparko. Sparko would have been part of the Paris International Radio Exhibition in 1929, but it was destroyed due to an accident with a car before the exhibition opened. Sparko could perform 25 movements, follow a light, and respond to commands in a microphone. [16]

As existing animals often inspire pet robots, they are designed in the shape of popular pets or come with some of these characteristics. Some current examples are the robot dog Aibo developed by Sony and the robot cat Joy .

One of the most successful care robots is the robot seal Paro. Although Paro might be mistaken for a pet robot, it was specifically developed as a tool in dementia therapy.

As already pointed out at the beginning of this section, the historical roots of robots nowadays used in care contexts lie in other application fields. In some areas, predecessors of robots date back to the pre-industrial era when automatons were built for entertainment purposes.

### 2.1.2 Categorizing Robots

There is already some literature to give an overview regarding robots used in different care contexts. For instance, in 2013, Bedaf et al. [9] conducted a literature review to assess robots supporting the independent living of older people. They categorized the robots into activity domains: mobility, self-care, interpersonal interaction & relationships, and other activities. In total, 107 robots were categorized.

Another study categorizing robots was conducted by Andtfolk et al. [2]. They only included studies with humanoid robots (e.g., Kompaï, Humanoid, HOBBIT, Care-O-Bot, Nao, MARIO, Ryan, PALRO, iRobi, and Pepper) taking care of older people in their review. A focus was on how older persons experience human-robot interaction. In total, the review includes 12 studies divided into four categories: (1) Supports everyday life, (2) Provides interaction, (3) Facilitates cognitive training, and (4) Facilitates physical training.

In their review, Ghafurian et al. [29] focused on assistive robots developed for and evaluated with people with dementia. In total, 18 different robots were discussed in the review, and the most frequently used robot in the included studies was the robot seal Paro. The authors point out that most of the robots have been studied regarding their use in therapeutic contexts, and only a few studies focused on other contexts like supporting activities of daily living, companionship, and health guidance. Overall, most of the studies reported that assistive robots have a positive impact on care givers and people with dementia by reducing agitation, anxiety, depression, and other symptoms of dementia.

In their paper, Vincze et al. [73] argue that there is a discrepancy between service robots' abilities and older persons' needs. They introduce the Three Layer Model of User Needs: (1) personal needs - stay longer at home, (2) physical needs - health, (3) basic human needs - safety. And thus, it introduces a human-centered approach to categorizing robots and care interactions.

Categories regarding (care) robots are often blurry and fluid, so trying to sort robots and their application contexts in strict categories like care, entertainment, health, monitoring, etc., is of no avail as there are a lot of context cross-overs.

### 2.1.3 Challenges within the HRI Research Field

As the field of human-robot interaction is still relatively young, there are many challenges of technical and social nature. Conducting expert interviews, Johannson-Pajala et al. [36] identified three "grand challenges" when introducing care robots into the Swedish health care system: (1) individual and group use, (2) systematic and societal challenges, and (3) preconditional challenges. Each section is divided into multiple themes, resulting in 14 themes covering a wide range of issues, including challenges of ethical, governmental, economic, infrastructural, knowledge, safety, privacy, and integrity aspects.

In 2012, Bedaf et al. [9] wrote a review including a total of 107 robots, but back then, the majority of the robots (95 robots) were still in the development phase, only six robots were commercially available, and the remaining six robots still in the concept phase. Developing a robot often is a long-lasting project and takes years to finish. Thus, the resulting robots are also often expensive and not suitable for commercial use.

Another challenge is the complexity of the tasks a robot should perform, as people often underestimate this aspect. For instance, navigating indoors in a flat is a non-trivial challenge that involves multiple technologies, as described by the example of Hobbit [26]. Also, grasping and manipulating objects is a challenging task for a robot and involves object recognition, moving the robot's arm, and grasping the object with the right pressure and at the right position. Scopelliti et al. [62] found a distortion regarding the capabilities of robots when it comes to object manipulation. Participants expected object manipulation through a robot to be much easier to implement than it actually was (e.g., cleaning windows, dusting, using a washing machine, etc.). In 2013, Bedaf et al. [9] concluded that it would take quite some time until a robot could support people with activities due to the complexity of the tasks.

Share and Pender [64] point out the lack of education regarding social robotics in general and emphasize the importance of knowledge and a critical view on emerging technologies so practitioners are able to shape these technologies instead of being determined by them. The authors suggest reading and discussing studies and different media like films, books, and short stories. They also suggest creating media and learning materials focusing on social robotics and robots as an approach to educating and learning. Also, Kerruish [38] emphasizes the importance of exposing social practitioners and students to the topics of social robots to develop critical awareness and proficiency in ethical issues. Also, Share and Pender [64] introduce a list with 23 suggestions of potential pedagogic tactics, including tasks like reading and discussing academic literature about robots, watching and discussing science fiction media, engaging with media of existing robots, interviewing robot professionals and users of care robots, but also writing and designing fictional and non-fictional materials to engage with the topic. In regard to care robots, the 11th and 12th points of the list are highly relevant: “11.Studying and breaking down caring behaviours with a view to programming robots [64, p. 57]” and “12.Auditing caring behaviour with a view to identifying what could (not) be conducted by a robot [64, p. 57]”. Regarding Design Fiction, the 17th point is relevant: “17.Writing fictional Human Robot Interaction [HRI] scenarios (Nourbakhsh 2013) [64, p. 58]”.[2] In their study, Scopelliti et al. [62] found that people with lower educational backgrounds reported a significantly more negative emotional reaction toward robots and technologies.

So, learning about care robots and how to interact with them is an essential aspect of introducing robot technologies both for care workers and care receivers, but also for experts from all research fields involved in the development of such robots.

When it comes to interacting with robots, interfaces play an important role. In a study conducted by Frennert et al. [28], care staff and students already had experience with care technologies and mentioned complicated interfaces were one reason why these technologies were not used anymore. Thus, providing intuitive and usable interfaces is another challenge when it comes to care robots.

Care workers often mention their fear of being replaced by a robot and that robots would threaten the quality of care provided [28]. This fear is often based on the care workers’ imagination of fictional robots from popular media, thus, where robots are often depicted as human-like and capable of performing complex tasks [33]. Interacting with existing robots and gaining knowledge regarding real robots and their skills do lead to less fear of being replaced as a more realistic picture of robots’ skills is gained [33, 68, 32]. The fear of robots is also a question of technology literacy, or more precisely, the lack of technology literacy, as pointed out by Sorenson et al. [68]. Literacy is a skill that can be learned, and the learning approaches should be accessible and with a low threshold for everyone. In technology contexts, the thresholds are often high, and especially in the context of robots, the robot imaginaries are a threshold that needs to be remediated.

Another challenge is the fear of the loss of human-human connections and replacing human interactions with robot interactions. In [29], negative impacts were pointed out, for instance, concerns regarding reduced social contact and neglect by relatives as a consequence of using social robots in care contexts. Also, Sparrow and Sparrow [69] argue that care robots are unethical because they deceive people into believing in relationships and emotions, although these are only simulated. They point out ethical issues of applying robots in the care sector as a replacement for human-human interaction

[2]Nourbakhsh is the author of the book ’Robot Futures’. In the book, fictional scenarios of robots are introduced in a story format. These scenarios are used as starting points for discussions of various topics regarding robots.

and social relationships. They argue to use robots to assist care workers rather than as a replacement for them.

Regarding building human-robot relationships, Kerruish [38] addressed the importance of human-to-robot empathy in caring contexts. She points out that human labor is essential for building relationships between humans and robots.

The more negatively perceived robots from popular media a participant recognized, the more they feared robots as a threat to humanity [33].

The financial aspect of robot technology has multiple facets. The currently happening demographic shift is often mentioned in the scientific community as one (of the main?) reasons to invest in robot technologies and make care more cost-efficient. For instance, there is the promise of reducing costs by introducing robot technologies in care contexts and replacing workers [69].

As robot technologies are often expensive and, in many cases, are not commercially available, the question arises of who will be able to afford the developed technologies. Currently, care technologies and care robots are mostly applied in care institutions in the scope of research projects. Thus, only a small group of people have access to these expensive technologies. Therefore, shaping these technologies on the patient side happens mostly through people who can afford to stay at a care institution. So even today, access to current care technologies is already limited by the financial background of care receivers or their family. Also, the question of time and financial resources on the institutional and care worker side is also a limitation.

The framing of an aging society as a problem to be solved through applying new technologies is an issue in itself. More specifically, covering the rising need for care workers and care facilities is often presented as a problem to be solved by introducing robot technologies.[3] Burema [15] points out that older adults in HRI research are seen as "frail by default, independent by effort; silent and technologically illiterate; burdensome; and problematic for society [15, p. 455]." The solution to the problem of the aging society is often seen in technology - for instance, care robots - and thus, the acceptance of older adults regarding robots is inevitable. So, older bodies are understood as "fixable" with technologies. Burema argues that this reduces older adults to care receivers and shifts the discourse and responsibility onto the individual.

In my opinion, one of the biggest challenges when it comes to care robots and their application is ethical issues. Although the robot seal Paro is one of the successful examples of a therapy robot used in dementia care, there are unresolved ethical issues. Kerruish [38] points out that using Paro (or any other robot) ethically as a therapy tool is only possible if human labor intermediates between the care recipient and the robot. Building an empathetic relationship with a robot might lead to other ethical issues, for instance, the question of what happens to the relationship and everyone involved when the therapy robot is withdrawn after the end of a study.

[3]The approach to solving social issues with or through technology is another topic for a thesis. Thus, I will not go into depth here as it is not the scope of this thesis.

Many other ethical aspects need to be considered. For instance, is a robot allowed to refuse a patient's command? This question is discussed by Bedaf et al. [8] in their study involving a Care-O-Bot 3. They conducted a study with older people, informal carers, and professional carers discussing a scenario involving an older person and a care robot refusing a command. One scenario involved a Care-O-Bot 3 refusing to bring a glass of water because the person commanding should be more active and get the glass themself. Dehydration might lead to severe health issues, especially in older people. Also, lower activity might lead to a loss of mobility and, further, independence. So, the question of how much help should be provided to stay healthy vs. how much help is too much and might lead to losing abilities and independence is highly ethical and most certainly will have a complex answer.

The acceptance of robots is another current challenge. As acceptance is crucial for the successful application of a (robot) technology, it is also one of the big challenges to be overcome. For instance, Rantanen et al. [54] conducted a study with 200 home care workers using a questionnaire to explore their attitudes regarding care robots. They found that the home care worker's acceptance of the robot was closely related to how useful the robot was perceived. Care workers reacted positively towards robots as reminders for older people, as guides for physical exercises, and increased safety. Other aspects influencing care workers' attitudes were connected to their colleagues' and supervisors' expectations of the robot. Another positive aspect regarding acceptance was how easy learning to handle the robot was perceived by care workers. Also, Scopelliti et al. [62] found that older people experience more mistrust regarding technology than the other two groups. They also found that women had a stronger diffidence towards technology than men participating in the study.

In [28, 36] the authors pointed out that using the word “robot” in study settings might lead to biases and negative reactions and attitudes in participants when it comes to robot technologies. To avoid this kind of bias, the word “robot” was not used when talking to the participants. Instead, more neutrally perceived words like “technology” were used.

Horstmann and Krämer [33] might give an answer to the question of the origin of the biases attached to the word “robot”. They explored the influence of popular media on the perception of robots and found that participants are biased regarding the skills and abilities of robots. This leads to an over-expectation of existing robots' skills and abilities because the fictional robots are often displayed with highly developed skills.

### 2.1.4 About the Shaping Aspects of Fictional Robots

*Parts of this section were also used in the paper [14].*

From existing research in Human-Robot Interaction (HRI), we know that expectations people have about robots are still predominantly shaped by media and Science Fiction [33, 13]. This opens up a gap between the imaginaries of robots that people have and state-of-the-art robotics. It also influences how people interact with robots because of the expectations and assumptions people have developed. For instance, Bruckenberger et al.

[13] found that participants had high expectations mainly shaped by the perception of fictional robots that lead to over-expectations regarding real robots. They conclude that the “good” and “bad” representations of fictional robots lead to “weird”, double-minded feelings and expectations regarding real robots, even when the participants are not aware of the shaping factor media has on them. Horstmann and Krämer [33] explored the influence of robots in media on expectations regarding social robots and also found that people’s experiences with fictional robots lead to higher expectations regarding the real (existing) robot skills and abilities. Thus, it is crucial to be aware of the influence of fictional representations of robots regarding real robots. Further, Mubin et al. [48] explored how robots from sci-fi where referred to in the research landscape. They found, that papers with philosophical focus mentioned more dystopian scenarios than papers with technology focus which focused on utopian scenarios and technology application of robots.

In popular media, human-like robots are often depicted as having human-like skills and abilities. Although, as fiction, it seems a desirable goal to give robots abilities and independence, this does not necessarily translate to real robots. For instance, Bruckenberger et al. [13] found that participants expected the robot to have human-like skills to support people but should not have an independent personality. Making robots independent and giving them emotions is tapping into a quite deep philosophical discussion, and the possibility of human-like robots is a theme often explored in Science Fiction movies. These depictions often result in humans’ fear of a future scenario of robots emerging as superior [13, 33]. However, studies have shown that interacting with existing robots does lead to a more realistic view of what robots are capable of and does reduce the fear of a robot take-over [33].

The lack of experience and interaction with state-of-the-art robotics in daily life contexts might explain the influence of fictional robots on people. Bruckenberger et al. [13] conducted an online survey with 58 participants, and 91.4% of the participants knew fictional robots, while 24.1% knew real robots from media, and 20.7% knew robots from work contexts. In 2019, Horstmann and Krämer [33] also conducted an online survey with 433 participants and qualitative interviews with 13 participants. In the interviews, they found that only a few participants actually interacted with a social robot before, but nine participants mentioned science fiction movies during the interview, and science fiction scenarios were mentioned multiple times by the participants. Thus, the shaping influence of media was one aspect the researchers followed up on in the online survey. In this survey, 18.9% of the participants stated that they had contact with industrial robots, 61.2% had contact with a household robot like a vacuum cleaner or lawn mower, while 10.6% had contact with a social robot, and 7.4% with a different kind of robot. With the exception of household robots, the possibility of interacting with a robot in real life is still not common for the broader population. Regarding the fictional robots, the researchers included 25 robots from 16 science fiction movies. Participants remembered, on average, 9.27 (SD = 6.12) of the 25 fictional robots and knew 7.06 (SD = 4.05) of the 16 presented movies and series. The online survey participants stated they neither very often nor very rarely watch science fiction movies.

However, people still base their expectations on some sources, and it is highly likely that the consumption of mass media (e.g., science fiction movies, reports, but also documentaries about robots) is the main shaping factor regarding robots for the broader population.

Overall, the application of care robots outside of study setups is still more an exception than reality. Care robots as supportive technologies have still not merged towards commercialized products. The question of how an emerging technology (e.g., robots) becomes a domestic product was discussed by Auger [4] in his thesis. He draws from the theory of domestication and speculative design and describes three possible journeys of emerging technologies: "1. Technology *does not* make the transition from laboratory to domestic life. [4, p. 5]" This means the technology stays in its laboratory research habitat and does not arrive in domestic homes. For instance, the robot exists as a means of research and only fulfills imaginaries of being a promise or a warning regarding potential technological futures. The second option: "2. Technology *does* make the transition from laboratory to domestic life. [4, p. 6]", e.g., the robot successfully shifts from one habitat (laboratory) to another (domestic home). The third option makes up the core of Auger's thesis: "3. How technology *could* make the transition from laboratory to domestic life. [4, p. 6]" For the "could" option, Auger explores through three speculative designs more plausible depictions of future (robot) technologies. He presents three speculative designs exploring robots: First, he explores a robotic alternative present by raising questions regarding speculative designs existing in everyday life. Followed by a robotic speculative future by introducing speculative storytelling through vignettes written in collaboration with a poet. And finally, he introduces a speculative design course with first-year master students with the aim of exploring aspects of living with robots. Through the speculative design approaches, Auger points out the issue of robot imaginaries reproducing stereotypes regarding future robot technologies. Auger also addresses the question of what a preferable robot future might look like.

## 2.2 About Design Fiction

Lindley and Coulton [43] give a short overview of the ten years since the term Design Fiction was coined. Moving from talking *about* design fiction toward strengthening applications *of* design fiction.

More on the theoretical and historical side, Kirby [39] introduces the term *diegetic prototype* and explains its role in popular films and its influence on the audience and future development of technologies.

So far, only a few design fictions are focusing on robot technologies. For instance, Cox et al. [20] explore the impact of artificial intelligence and robots on higher education through eight literature-based design fictions. These design fictions involve different technologies (e.g., tutoring systems, learning assistants, text and data mining, smart campus) and address different issues. Another example where robots are briefly mentioned is by Rapp [56], who argues for using design fictions as a tool for students to reflect on technology matters.

### 2.2.1 Science Fiction Media as Inspiration for Design Fiction

Speculating about the future and future technologies is an inherent part of creating and designing new technologies. The popular question “What if ..?” is often the initial inspirational spark to explore something new and exciting for creators and researchers alike.

Jordan and Silva [37] emphasize that Science Fiction movies and series are an untapped opportunity for HCI and Speculative Design research. They argue that Science Fiction media can be used as a means for design fictions to stimulate creativity, conversation, and discussion about future technologies and their broader implications. Also, design fictions can be used to initiate a more critical perspective by speculating on potential future scenarios of technology use.

Furthermore, Fiesler [24] points out multiple examples of how science fiction media can be used in the educational context to ignite discussion of ethics and policy-making regarding technologies. Fiesler uses speculation as a design tool to imagine how futures could be and how they could be better when technologies are developed with critical speculation as part of the design process. For instance, episodes of the Science Fiction series Black Mirror[4] can be used as a starting point for discussion of future technologies and current technologies.

Another example of Design Fiction inspired by popular media is by Sturdee et al. [71]. They based their design fiction, a so-called Voight-Kampff Machine, on the sci-fi film Blade Runner. This machine can detect empathy and is used as a major component in future communication. In the paper various artifacts are introduced: a digital prototype of the Voight-Kampff Machine as an iPhone add-on and a storyboard describing technology-enhanced dating with the iPhone add-on. They explore design fictions as a world-building tool and use the introduced fictional prototypes to focus on specific aspects to discuss *about* the world which makes these technologies possible. Thus, the design fictions are used as focus points for discussing the broader contexts that made them possible.

Design fictions are also used in other fields. For instance, Rapp [56] conducted multiple university courses with philosophy students and introduced design fictions as reflective tools for the students discussing theoretical assumptions of technology, ethics, morality, long-term impacts of technology, and agency.

Books were also used as inspiration for design fictions and a means for discussion. For instance, Noortman et al. [51] based their design fictions on Margaret Atwood’s books

[4]Black Mirror is an episodic television series. Each episode is a unique future scenario featuring a potential future technology and how using the technology reshaped society and people’s lives. The explored futures are often dark and dystopian, showing worst-case scenarios regarding technologies.

*The Handmaid's Tale* and *The Testament*. They use fictional characters from the books to create archetypes, and then they put these archetypes in newly created *pastiche scenarios* inspired by the COVID-19 pandemic. Using pop culture as a starting point for design fictions might be a good approach for an audience of pop culture. However, there is also a knowledge gap that needs to be considered when someone is unfamiliar with the material used.

Another example of a book-inspired design fiction approach is by Wong et al. [74], who based various design fictions on the book *The Circle*. By building on already existing narratives and technologies in the text, they extended the design fictions and their future appliances with different purposes. The focus of the discussion is on privacy and security, as most of the technologies are sensors used for tracking.

Writing as a narrative approach to explore design fictions and the future worlds was used by Ambe et al. [1]. They conducted a writing workshop with older writers. They successfully engaged the participants to explore their life and future with technologies through design fictions. Creating these *co-design fictions* in a participatory approach prioritizing the "importance of prioritizing participants' creative freedom, negotiation of the topic, and seeking inspiring prompts [1, p. 13]" enabled the participants to explore moral and social dilemmas, and reveal their relationships and convictions with technologies, rather than focusing on dystopian or utopian futures.

### 2.2.2 Design Fictions Focusing on Health Care

Design fictions have been used to discuss various health care scenarios, for instance, a "home for life" smart home for elderly people [60]. This design fiction is aimed at people with dementia, and the focus is on taking care of and supporting people with dementia. Although, again, from the point of view of caregivers. Also, Noortman et al. [52] developed and conducted a study using a design fiction probe addressing dementia care via using smart home technologies. The probe included a welcoming letter, a control panel, an information brochure, and a resident file of the person the participants cared for. The fictional narrative included a scenario where Annie, the care-receiving person with dementia, lives in a smart home, and the participants care for her remotely. Direct contact with Annie was not possible, so the participants were in a passive role of observing Annie via the data collected via the smart home. This approach was intentional, as Nortman et al. wanted to put the care-receiving person into an active role instead of the (common) passive role. Although, the caregiving person reacted to reports generated by Annie by adjusting the smart home regarding medication, identification, nutrition, communication, and location. So, the caregiver is reacting to data sent to them and still taking an active role in taking care. Another design fiction example is used to discuss Intimate Futures from a feminist and critical point of view regarding personal digital assistants by creating design fictions about a smart toilet "U" helping with women's health and menstrual cycles, and a personal assistant "AYA" that verbally pushes back when sexually harassed [67]. By combining participatory design and design fictions Nägele et al. [49] achieved to "personally ground, inspire and reveal values and imaginaries of vulnerable individuals who rely on medical technologies for their health and wellbeing [49, p. 1]". They created a design fiction storyboard describing the interaction with a smart toilet and how technology can be used to prevent or deal with emergencies. They 3D-printed design fiction artifacts as well, and thus, manifested a fictional design in a physical shape.

### 2.2.3 Design Fiction as Fictional Prototypes

An interesting approach to building digital representations of design fictions is provided by Ringfort-Felner et al. [57]. They created a design fiction named Kiro. Kiro is a social voice assistant applied in cars. By building a website, a fictional prototype, and conducting a focus group, they collected online data created via online posts for their study. They aimed to discuss what kind of relationship(s) we could have with machines in the future.

By creating low-fidelity prototypes, Blythe et al. [12] introduced a non-solution design approach through two "magic machine" workshops. The approach focused on creating un-useless, partial and silly artifacts - not solution-oriented artifacts. The materials used were simple: cardboard, paper, pencils, tape, etc., for creating low-fi artifacts and sketches. In the first workshop, they imagined an older self of themselves, and they responded to their older selves individually. The second workshop was conducted with elderly participants to explore the participants' visions of smart city technologies.

Also, Design Fiction has been used in HCI contexts in the form of fictional abstracts, reviews, and research papers. Lindley and Coulton [44] explored design fictions by introducing fictional abstracts and fictional reviews of a fictional game named *Game of Drones*. They argue that fictional research papers can contribute to HCI research. Further, Linehan et al. [45] introduce a workshop targeted at HCI experts to explore fictional research papers through design fiction. Blythe introduces another example citeblythe2014researchThroughDesignFiction who created imaginary abstracts to explore the potential value of design fictions without building prototypes.

Overall, the shape of design fiction can range from exploring world-building based on science fiction media or fictional narration to low-fidelity and high-fidelity prototyping or creating (non-)functional representations like websites or physical representations like folders or blueprints. The form is not as important as the possibility to open up discussion and imagination of what could be.

## 2.3 Game and Playful Approaches in HCI & HRI

*Parts of this section were also used in the paper [14].*

The role of game and play in designing and using technologies has been widely recognized and studied in the HCI community. On the one hand, simple games have been used as eliciting tools for collecting qualitative and quantitative data. For example, Rapp

[55] used the game World of Warcraft to collect data about user behavior and habits. In another study, Mayer and Zach [47] used imaginary characters and simple games to explore the needs of people with dementia.

Using a game helps to immerse the players in a potential scenario and characters via role-play [18]. For instance, Koey et al. [41] explored a narrative approach to human-robot interaction in a smart home. They introduce *principles of engaging prototyping* and explore immersion as a narrative aspect.

Playful approaches and participatory design play well together, for instance, when the aim is to "eliminate the functional knowledge designers usually bring to their work" [30, p. 152], using game elements as thinking tools for engaging participants and "entering the realm of the imaginary" [34, p. 12], or using a game as dialogue tool to change perspectives and emphasize empathy [40]. These three aspects of design games connect well with design fictions in a playful approach to initiate novel ideas.

Using games is also a popular approach in educational contexts. These games are often labeled as "serious" games because they are used for learning and developing skills. Noemí and Máximo [50] introduce successful digital games with different learning goals, for instance, simple games to learn numbers and vocabulary, but also more complex video games to learn skills like teamwork, sustainability, innovation, information management capacities, and creativity. They also point out the importance of tutoring the players to facilitate the learning process and guide the players through the games.

In higher education, digital and non-digital game-based approaches are also used to educate students regarding HCI concepts. As an example of a digital game, Santana-Mancilla et al. [59] let students learn HCI concepts by designing and evaluating video games. As a non-digital example, Silveira [66] assigned graduate and undergraduate students the task of creating board games to educate them about important HCI concepts and skills like teamwork, communication, time management, and problem-solving.

Card-based approaches introduce a playful element and have already been used as a tool in HCI for various contexts. For instance, Schwaninger et al. [61] used elicitation cards as an interview guide to explore user needs with a focus on trust in the context of assistive technologies. Ballard et al. [6] developed a card game for industry product teams to explore ethical issues with the AI technologies they were developing. They aimed for value-sensitive design in industrial contexts using a playful approach.

In HRI, game and play have also been addressed, though to a lesser extent. There have been different approaches to playing games with robots, but only a few approaches use a playful approach or a game to teach about robots.

Many studies in HRI focused on gameplay *with* robots in different contexts, for instance, to develop an affective-aware social robot to provide adequate emotional interactions [7], or a card-playing social robot for older people to explore trust and reduce social isolation [19]. These studies use robots or high-fidelity prototypes, thus, need extensive resources and preparation.

Robots as motivation for learning have already been around for quite some time. For instance, Janssen et al. [35] introduced a robot game to motivate children to learn arithmetic based on the concept of "learning by playing". In educational contexts, robots have been quite popular, especially in school settings for younger children [3, 10]. Robots are used as tutors, teachers, learning peers, or as learning tool. In their review, Atman et al. [3] claim that there was a massive rise in research regarding learning with robots and robotic learning in the past five years. Robots were mainly applied and used for language learning, whereas educational robotics was focused on teaching programming skills and concepts, e.g., computational thinking. Belpaeme et al. [10] reviewed social robots in education contexts regarding the efficacy of cognitive and affective outcomes, the impact of the robots' embodiment, and their interaction roles in the learning processes. Social robots were used mostly as tutors and teachers, but also as learning peers or in a mixed role of tutor and teacher. They found a positive effect on the students' learning outcomes when the robot was physically present, although they do not know which aspect of presence promotes better learning outcomes.

Another playful approach to learning programming is the robot game environment developed by Shim et al. [65]. They introduce a programming environment, an educational robot that performs the programmed commands, and a game board the robot moves on and aims at teaching programming concepts to elementary school students.

Shahid et al. [63] explored cultural differences between Dutch and Pakistani children playing a game with a robot, alone, or with a friend. They found that children had more fun playing with a robot than playing alone but had the most fun when playing with a friend. Also, the Pakistani children appreciated the interaction more than the Dutch children, which also points to a cultural difference.

Fischbach et al. [25] developed a tabletop role-playing game with a social robot in the role of the game master. The robot plays different characters the players meet during their adventure playing the board game *Quest: Zeit der Helden*. Another example of a tabletop game is by Collins and Šabanović [18], who developed a co-designing game to explore a robot companion to support people with depression to cope with daily life challenges.

Yang et al. [75] presented a prototype of a competitive robot for fencing, introducing the idea of a competitive opponent for physical training.

For instance, Chernova et al. [17] collected quantitative data via an online game where two players played together and recreated the game in a physical setting with a robot as a counterpart to explore HRI aspects.

Most the examples above often involve some kind of physical present robot or robotic prototype the participants play with or against.

CHAPTER 3

# Methods

This thesis attempts to answer the following research questions:

RQ1: "How can the gap between (over-)expectations of care robots and current research in HRI be narrowed down playfully?"

RQ2: "Are design fictions a useful approach to redirect HRI researchers and spark new ideas regarding future care robots? What kind of ideas are sparked by this method?"

To find an answer to RQ1 in the first study a low-fidelity prototype was developed that introduces lay people to robots used in care contexts. The prototype was tested at the Vienna Museum of Technology and Science at the "Lange Nacht der Museen" event 2022. The trial run included 20 play rounds and 35 participants.

To answer RQ2 in study 2, another low-fidelity game prototype was developed. It includes a character sheet that aims to create a relatable and non-stereotypical character to be played while exploring a potential future world and future care technologies through narration. Study 2 was conducted with four experts with expertise in HRI or care technologies. The conducted play sessions took between 60 and 140 minutes.

The third prototype introduced in this thesis is a design game prototype bringing together the game board from the first study and the design fiction card deck from the second study. The third prototype attempts to create a design game for creating design fictions of future care technologies through gameplay. The prototype was test played with two participants in one play session. As the third prototype was only test played, it is currently not possible to draw from it to answer any research questions.

## 3.1 First Prototype: Developing a Board- and Card Game to Elicit Conversations about Care Robots

*Parts of this section were also used in the paper [14].*

The initial idea for the game prototype was sparked by the offered opportunity by my supervisor to partake in the museum event “Lange Nacht der Museen” 2022 at the Vienna Museum of Science and Technology. At that moment, the topic of the thesis was already concertized to be robots in care contexts.

Some requirements for the prototype were: it should be portable and easy to set up at the location. Thus, a low-fidelity prototype seemed a good fit for the occasion. Another benefit of a low-fidelity prototype is that the materials are cheap and can be adapted and changed without much effort. The materials used for the game board of the prototype were: paper, tape, (color) pencils, an eraser, and felt pens. The cards were created digitally with the program Gimp and printed on printer paper, cut out, and put into card sleeves so they are robust enough for the trial runs and could be disinfected if needed. The game board was drawn and lettered by hand with pencils and felt pens. The corners were color-coded, starting with a bright green for the “Yes, sure” corner, a lighter green for the “Yes, but ..” corner, orange for the “No, except ..” corner, and red for the “No” corner.

### 3.1.1 Creating the Cards for the Game Prototype

As a first step to creating the cards, literature research regarding the current state-of-the-art of care robots was conducted to provide an overview of currently used robots. A list of tasks/interactions with different robots mentioned in the papers was created based on the literature research. The initial list included 51 tasks/interactions and 40 different robots.

The card deck was created to provide an overview of care interactions provided by robots, including providing physical and mental health, entertainment, and support of daily activities. The robots should be able to function mostly autonomously and in a home environment. Thus, teleoperated robots were excluded from the selection for the card deck. From the initial list, nine robots were included in the card deck: Bestic Arm (1 card), Care-O-Bot 3 (2 cards), Cody (1 card), Hobbit (5 cards), Mobiserv (4 cards), Nao (5 cards), Palro (4 cards), Paro (1 card), and Pepper (4 cards). The different number of cards resulted from the tasks/interactions chosen to be included in the card deck. Also, some robots are developed for specific tasks and interactions (e.g., the Bestic Arm robot helps a person with eating a meal, and the seal robot Paro is used a lot in dementia care), and thus, are only included with one card in the deck. The robot Cody was included because it was the only robot on the list to provide personal hygiene via a sponge bath.

The cards were created digitally with the program Gimp, printed, cut out, and put into game card sleeves. Every card shows the picture and name of the robot and a speaking bubble suggesting an interaction to the player (see Figure 3.1). In total, 27 cards were created for the card deck. The texts suggesting specific interactions to the players are based on interactions described in papers by Ghafurian et al. [29], Dino et al. [22], Vincze et al. [73], Fischinger et al. [26], and Kerruish [38]. The card deck is attached in the Appendix 7.


Figure 3.1: A card from the card deck of the first prototype showing the robot Pepper suggesting to do your daily fitness exercises.

The game board is the size of DIN A3 paper. There are 24 fields, representing 24 hours of a day, and an additional start field (see Figure 3.2). Some fields are marked blue for time-specific interaction cards like eating or taking medication. So, when the player lands on one of the blue fields, they pick a card from the blue stack in the middle of the game board. The game board is attached in the Appendix 7.

### 3.1.2 Playing the Game

The player rolls a die and advances the pawn that represents them on the fields of the board. Every turn, the player also draws a card with an interaction suggested by the robot depicted on the card and decides on which stack on the game board the card is to be placed: (1) accept the interaction unconditionally, (2) accept the interaction including a condition, (3) refuse and change the interaction significantly, or (4) refuse the interaction completely. When the participant provides no explanation for the decision made, the research prompts one with a question(s). The game ends after playing through one day of interacting with care robots, but there is the possibility to play until no cards are left.

The game prototype was tested with two participants, and their feedback was positive.


Figure 3.2: Game board of the prototype. The cards are drawn from the two stacks in the middle and placed on the corner stacks depending on how the player decides.

The first participant noted that the fast play rounds fit the museum event context well. They also suggested adding context cards to add a complexity level to the game and influence the gameplay (e.g., having a good day or having a bad day). The second participant noted that the game prototype was fun to play. The test run worked well to open up a dialogue and later discussion about the topics of care robots and care. As both participants did not point out any major flaw, the game prototype was deemed ready for the trial run at the museum event.

### 3.1.3 Playing the Game Prototype at Lange Nacht der Museen 2022 at the Vienna Museum for Science and Technology

The event Lange Nacht der Museen is a yearly museum event where all participating museums can be visited with one ticket. The event starts in the evening and finishes around 1 o'clock in the night. A lot of museum visitors use the event to visit multiple museums. Thus, one requirement for the game prototype was a short duration for a play session. We aimed for the game to last between 5 to 10 minutes for a play session. Also, the game prototype should be portable and easy to set up.

Besides the game prototype materials, the setup included 1 table, 3 chairs, and a suitable place at the museum for potentially interested visitors passing-by. I was placed between the Science Corner[1] with the Caring Robots[2] exhibition and the techLAB (the maker space at the museum). Setting up the game prototype took about 5 minutes.

### 3.1.4 Data Collection

In a duration of about 6 hours, 20 game sessions with 35 participants were played. Demographic data were not collected from the participants in a structured way. However, the participant sometimes mentioned occupation or age while playing the game or discussing care technologies after finishing the game session.

Each play round was documented by taking pictures of the cards the participants placed on the four stacks on the game board. The placement of the cards onto one of the four stacks was transferred into an Excel sheet for quantitative analysis.

After each play round, handwritten notes were taken to document the likes and dislikes of the participants regarding the robots and suggested interactions, and any other relevant insights from the conversations had with the participants. As the play sessions and the note-taking were done by one person only, the first round of notes turned out fragmented and missing some aspects participants talked about. Thus, a second round of notes was taken by going through the card deck and taking notes for each card. The second round of note-taking helped to capture card-specific aspects participants mentioned during the game that were missed out in the first round of note-taking. The handwritten notes were digitized, read multiple times, and key insights were summarized.

## 3.2 Second Prototype: Creating a design fiction card deck

The initial idea for the second game prototype was to develop a low-fidelity prototype to create design fictions about future care technologies.

The players are invited to imagine a world 5 to 10 years in the future and technologies have moved forward to open up the space of (technological) possibilities. Then they would start playing the game, play through multiple days of this fictional future and create design fictions of care technologies to use in daily life. The idea was to create a design fiction card deck that could be played with the original game prototype.

While adapting the initial game prototype, two significant shifts happened regarding the game prototype. The first shift happened after the first adaptation did not work out

[1]The Science Corner at the Vienna Museum for Science and Technology is a space provided by the museum to present current research from different research groups and projects at TU Wien. The exhibition changes every three months, and a different project/group is presented.

[2]The Caring Robots//Robotic Care project is a transdisciplinary research cooperation by TU Wien, University of Salzburg, Caritas Wien, and Technisches Museum Wien. The project aims to re-imagine robotic technology in care contexts "by developing technology that is useful, safe, meaningful, and wanted, through a design process that involves caregivers, people in care, care organizations, and other stakeholders [58]". The idea for the game prototype was sparked by the opportunity to partake in the museum event and resulted in this master thesis.

(details described below), and the game board was changed towards a simpler design, only including the fields for the 24 hours of a day.

### 3.2.1 First Iteration (failed): Adapting the First Game Prototype

Disclaimer at the beginning: The first iteration of adapting the first game prototype was discarded for two reasons. First, it was a non-participatory approach to creating robot technologies for a design fiction card deck. Second, the developed cards and gameplay was not thought through and often resulted in card combination that did not make sense at all. Nevertheless, for reasons of completeness of documenting the development process, the failed attempt is also described here.

The first adaptation of the game was reusing the initial design of the game board and only adapting the labels on the board. The cards used in the first adaptation were created from scratch. There were four different kinds of cards: object cards (including all important objects someone would use in daily life), context cards (including different contexts like places at home or places the player would like to go to), attribute cards (these cards should bring a surprising element to the gameplay by suggesting a feature the care technology should have like "smart", 'ìnvisible", "small", and so on), and person cards (including different people as part of the game, for instance, care workers, relatives, and so on).

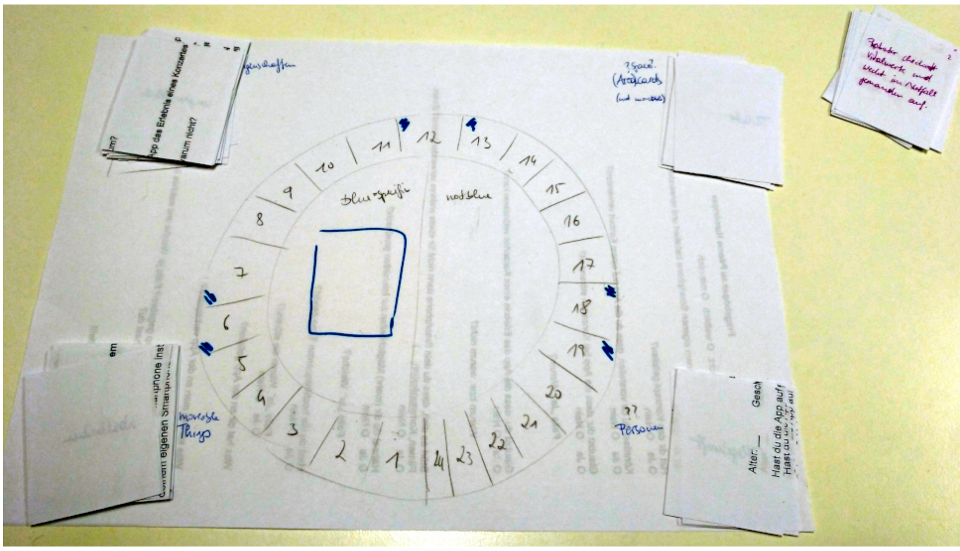


Figure 3.3: Failed attempt of adapting the game board by renaming the categories in the corners and creating fictional cards by playing through a day.

The gameplay idea was similar to the original game: the player rolls a die and moves a pawn forward on the game board. The field they land on is the hour of the day. Then they draw a card from each stack and connect the time of the day, the context card (giving them a place), the object card (giving them an object to include), the person card (including another party that could be helpful or affected), and the attribute card (giving a feature the potential technology has) they try to imagine something new.

The fictional cards created via this approach focused on the robot's functionalities. Following functionalities were created during the gameplay (see also Fig. 3.4):

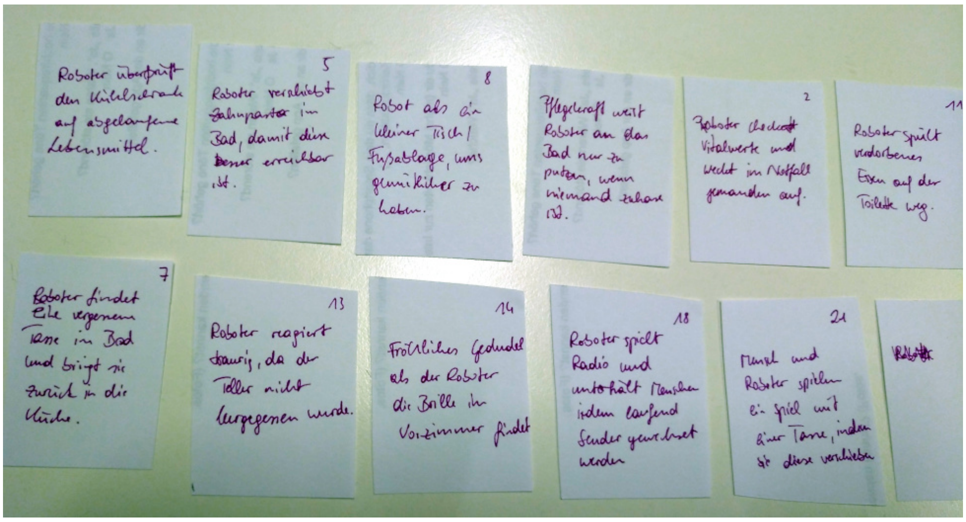



Figure 3.4: Failed attempt of creating fictional cards for a design fiction card deck.

- Checking for vital values during the night and notifying someone in case of an emergency.
- Robot rearranges the toothpaste in the bathroom so it is easier to reach for a person.
- Robot finds a cup in the bathroom and carries it back to the kitchen.
- Robot is used as a small table or a footrest to provide a comfortable environment.
- Robot flushes spoiled food in the toilet.
- Robot reacts sadly when the meal is only partly eaten.
- Playing happy music when the robot finds the lost glasses in the hallway.
- Robot plays some radio and switches between radio stations for entertainment.
- Person and robot play a game of moving a cup around.
- Robot checks the fridge for spoiled food.
- A care worker instructs the robot to clean the bathroom when no one is home.

The first adaptation had multiple flaws: The approach was rather complex with so many different card types. Also, creating attribute, object, and context cards turned out quite tricky. The context and object cards were hard to create beforehand, as peoples' living situations and daily routines are quite different. The cards should represent a person's daily interactions, but by limiting the game to objects and contexts/places, the human was cut out of the gameplay. Missing the human-centered aspect was the biggest flaw of the first adaptation.

Also, the attribute cards turned out to be quite biased by introducing negative co-notated features, for instance, "bad", "sad", and "nonsensical", and due to the flawed and techno-centric approach, it was not reasonable to create a more neutral kind of set.

Another issue with this approach was that the combinations of cards were often not working out because the combinations did not make sense. Also, it was not really fun to play the developed game, thus, the first adaptation of the game prototype was discarded.

### 3.2.2 Second Iteration: Adapting the First Game Prototype

Learning from the failed first adaptation of the first game prototype, a more human-centered approach was aimed. Also, the game board of the second adaptation was simplified. For the human-centered aspects, personas were considered, but although personas might be a suitable tool, they bring the issues of over-simplification and introducing biases resulting in reproducing stereotypes [46]. So, instead of using a pre-created persona, it seemed like a good fit to have the character creation as a part of the gameplay. Further, to counteract biases the participants might have, most characteristics are decided by the random element of rolling a 20-sided dice.

Introducing a playable character was inspired by the character sheets often used in role-playing games (RPGs). In RPGs, a playable character with strengths, weaknesses, and other characteristics is created before starting a new adventure. Building on the idea of creating a character at the beginning of the play round, the characteristics introduced on the character sheet were chosen to fit the purpose of the second study.

The character sheet created for the second study is still a simplification to capture specific aspects like health status and living situation. Some gaps were intentionally left for the participants to fill in details and flesh out their characters themselves. By including the character creation process as part of the gameplay, I wanted to immerse the player into the character's life and also the different future world they were living in.

The character sheet is divided into the following sections: general attributes including name, age, gender, migration background, educational level, occupation, and employment. The other sections covered the Living Situation and the Health of the character, whereas the health section was divided into Sports, Chronic Illness(es), Pain Intensity, and Restrictions in Daily Life. The focus on disabilities was intentional, as the character sheet aimed to create a character highly likely to use care technologies in their daily life.

The attributes added for each section to the sheet were mostly based on statistics from Statistic Austria [5]. The answer sheet was created by mapping the statistical values to a 20-sided dice. To fill in the character sheet, the player rolls a 20-sided die, and the researcher gives the matching values from the answer sheet. The player has some freedom in choosing attributes (e.g., occupation, hobbies, imagining the character's home) of the character they create. Creating the character is a part of the game experience, and the researcher should invite the player to imagine the character, their living situation, their family, and other shaping aspects to give the created character a background.

I want to point out that this does not mean that the characters in the gameplay are reduced to represent their disabilities. The character sheet aims to create a character that the participants could imagine as alive. So, it is much more about the process of creating the character step-by-step and making sense of how specific attributes shape the participant's imagination of the character they created.

Although each section has multiple attributes, there is always the issue that some attributes or aspects might be missing. So, there was also left blank space for the participants to take notes if they liked to do that. Also, during the character creation process, the participants were invited to include any missing aspect they thought might be important.

The character sheet and the answer sheet are attached in the Appendix 7.

The character sheet was tested with one person in two different modes. **First mode: A fictional character was created** by rolling a 20-sided die multiple times and filling in the sheet with the values provided by the researcher. When the sheet was filled in, the researcher asked the test person to introduce the character they created and fill in the gaps if needed. **Second mode: A fictional character based on the test person was created.** The character's age was evaluated by rolling the 20-sided die and adding the number when it was ten or higher. All other attributes were filled out by rolling the 20-sided die or voluntarily adding personal information. The test person stated the character sheet was fun to create, and the resulting characters were a kind of an "alter ego" to the person. Leaving gaps to fill in, like the character's hobbies and details on the living situation (How does the flat/house look? Where is it located? Who is living with the created character?) made the persona more realistic and tangible.

The game board was reduced and only contains the 24 fields representing 24 hours of a day. The initial idea of playing through a day was kept to give the game a time-structured sequence and anchor the player in the daily life of the character they are playing.

Finally, context cards should give impulses regarding the character's mental and physical condition and the space the character is situated in. The researcher can create new context cards ad hoc if they wish to explore additional contexts. The context cards were a suggestion from one of the test persons for the first game prototype. As context cards would add an additional layer of complexity to the gameplay, the suggestion was not included in the first game prototype but came in handy for the second iteration of the second game prototype.

### 3.2.3 Playing the Game Prototype

For the play session of the second prototype, the aim was to include experts' perspectives in creating a design fiction card deck. So, participants with expertise in human-robot interaction or care technologies were contacted for the study. In total, four game sessions with 4 participants were conducted, and the duration of the sessions ranged between 60 and 140 minutes. A consent form informing the participants about the aim of the study, requirements, and audio recording of the game sessions was handed over to the participant at the beginning of the play session.

The game prototype included different activities. The overall aim of the second prototype was to immerse the participants into role-playing a character they created by filling in a character sheet by rolling a 20-sided die and letting them play through one or multiple days of their character's life.

The gameplay followed the following structure:

1. Create a character using the character sheet.
2. Create a typical day in the character's life using the simplified game board and putting sticky notes at specific times their character does something.
3. Optional step: Ask the player how they feel about knowing their character. If the character's day is still vague to the player, follow up with playing through a normal day in the character's life.
4. Make a time jump ten years into the future and adapt the character sheet. There are two options for how to do that: (1) let the player adapt the character sheet as they wish, or (2) let them roll the die again to adapt the attributes on the character sheet.
5. With the adapted character, start playing through one or multiple days of the character's life ten years in the future. It is crucial to nudge the players towards technologies the character might have adapted into their daily life without influencing the players too much by introducing ideas yourself.
6. To give more context, one play round of playing through a "sick day" 10 years in the future was added to the gameplay. This should give the players more incentive to explore care technologies.

After the game session, interview questions were asked regarding the materials and methods used to create the character, follow-up by questions regarding the developed technologies during the gameplay. Questions about potential technologies from an expert perspective and what a positive- and negative co-notated future regarding technologies might look like were added as well.

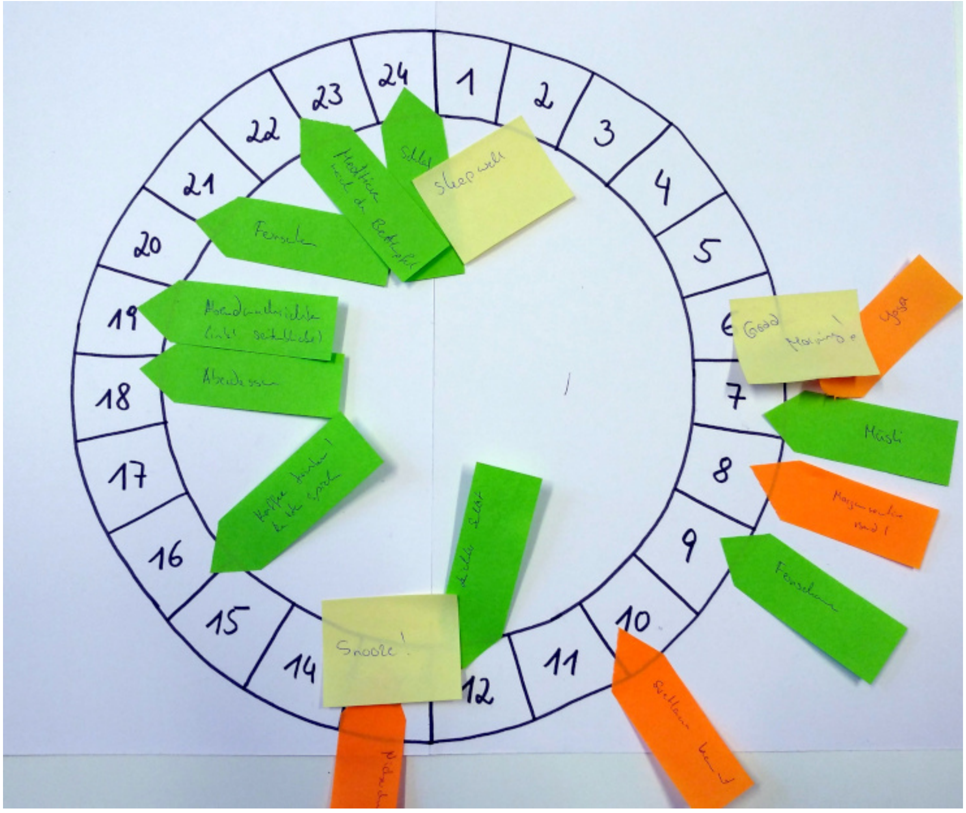



Figure 3.5: A typical day one of the participants created for their character using the game board and post-its.

### 3.2.4 Data Collection and Evaluation

Four game sessions were conducted with participants with expertise in HRI or care technologies. The collected data included an audio recording of the play session, a picture of the filled-in character sheet, and pictures of the game board with the daily routine created by the players. The recording was transcribed word-by-word by hand without using any transcription tools. The transcripts were printed out and coded by hand. From the codes related to technologies, mind maps were created for each game session, introducing the structure of "existing technology", "using technology" and "potential/future technology" from the codes and including all the ideas mentioned in the game sessions. Next, the mind maps from the game sessions were merged, keeping the three categories. In the merged mind maps, all ideas featuring robots were marked bold. The first 11 cards of the fictional deck were created by picking 11 ideas introducing care interactions from the bold-marked entries in the "potential/future technology" mind map. Also, the author created three cards inspired by the game sessions and added these to the design fiction card deck. The card deck features four fictional robots and 14 interaction cards. The design fiction card deck is attached in the Appendix 7.

## 3.3 Third Prototype: Creating a Design Game Prototype

The initial idea of the third prototype was sparked by the idea of connecting the game board created for the first prototype and the design fiction card deck developed based on findings from the second prototype.

The gameplay for the third prototype is similar to the gameplay of the first prototype: players play through a day and interact with different fictional care robots. The third prototype aims to explore future robot technologies in care contexts through the design fiction card deck, while also opening up the gameplay and allowing players to add new design fictions of future care robots technologies and interactions to the card deck.

Before starting a play session, blank cards are added to the card deck to give the players an opportunity to add new design fictions to the card deck. For the test play session, 14 blank cards were added. If a player draws a blank card, they can add a new interaction with a fictional robot to the card deck. The idea is to evolve the design fiction card deck from play session to play session by collecting new design fictions from different players.

The gameplay must also be prepared beforehand so the game does not start with a blank card. So, the person conducting the play session has to place 2-3 non-blank cards at the top of the card deck without drawing attention from the participants. So, the participants start with drawing cards already introducing design fictions of care robots to them and discreetly nudging them towards care robotics.

### 3.3.1 Test-playing the Design Game Prototype

One test-play session with two participants was conducted. The test-play assessed if the gameplay works as intended and where the prototype needs adjustments.

Before starting the test-play session, the participants decided whether to play with one pawn or two pawns. The participants played with a pawn for each player as they had different daily schedules.

As I wanted to know if the design fiction card deck would spark more design fictions regarding robot technology, I did not specifically brief the participants to explore robot technology. As mentioned by [36, 28], the word robot might negatively bias the gameplay or lead to the typical robot use cases.

During the test-play session, the participants explored technologies they use daily for work or leisure, like Zoom for work meetings, Social Media platforms for news or entertainment, and streaming services like Netflix. Other technologies included smartphones, podcasts, and audio books (this might be sparked by one of the cards from the design fiction card deck). However, the participants did not add design fictions featuring interactions with (care) robots to the card deck. During the gameplay, one of the participants mentioned "I think we play it [the game] wrong" because they felt the cards from the design fiction card deck did not match the cards/ideas they added.

The test-play session made it clear that adaptations regarding the gameplay are needed. Although the third prototype already nudged the players toward exploring technologies, it did not nudge them to explore robot technologies. Adding more directions for the participants as part of the gameplay should improve the design game prototype to fulfill its purpose better.

Due to limited time resources, conducting a study with the improved design game prototype will not be part of this thesis.

### 3.3.2 Recommendations and Adaptations for Playing the Design Game Prototype

Based on the test-play session, I recommend to make following three adaptations to the gameplay:

Fist adaptation: As the design fiction card deck was not enough to nudge the players towards exploring more design fictions featuring care robots, adding a scenario seems reasonable. More specifically, adding a scenario that nudges the player towards developing future robot technologies. So, introducing a time jump scenario similar to the gameplay explored with the second prototype might be a feasible approach to improve the design game prototype.

Second adaptation: Each play session should be played with two or more participants. This is based on two aspects: Firstly, during the play sessions of the first game prototype, there was a strong dynamic between participants when two people joined a play session, mostly in the form of a playful back and forth or asking questions like "Oh, you really would do that?". So, inviting two participants to a play session might bring similar benefits. Secondly, designing alone and on the spot is challenging and most likely not as constructive as coming up with an idea with a partner.

# CHAPTER 4

# Findings

## 4.1 Study 1: Developing a Board- and Card Game to Elicit Conversations about Care Robots

*Parts of this section were also used in the paper [14].*

The trial run of the first study was conducted at the Vienna Museum of Technology and Science during the event of the "Lange Nacht der Museen" in 2022. In total, 20 rounds were played over a duration of 6 hours. In total, 35 participants joined the game sessions at the museum event.

### 4.1.1 Methodological Insights

Inviting participants to play a game worked well in the museum context with many visitors passing by. Most people reacted interested and were willing, some even excited, to play a game. Only a few passersby declined the invitation.

In general, the game worked well as a conversation starter regarding the topics of care and care robots. There was a smooth transition from playing the game to discussing a topic most participants were not familiar with. Thus, the game worked well as an ice-breaker for informal conversations about care technologies. Multiple participants said that they had not thought about care and care robots until engaging in the game.

Two participants stated their fascination with the game prototype and that this kind of work was possible as part of a master's thesis in Computer Science. One participant saw the potential of adapting the prototype to educate people about biochemistry (biochemistry was their field of studying).

Although there is no limit on the number of players who could join the game, the setup for the trial run was intended for 1 or 2 players to join the game to keep the setup simple.

Thus, five rounds were played with one participant, and 15 rounds were played with two participants. When two participants joined the game, there also developed discussion between the participants regarding their decisions. The game sessions had a different dynamic because the participants knew each other quite well and expressed surprise impulsively or even teased each other while playing the game.

The person conducting the game sessions has the important task of introducing the game to the players and guiding the players through the game, introducing the game board and the gameplay. The role of the person guiding through the gameplay can be compared to the role of a "game master", a term lent from role-playing games (RPGs). The term describes the person knowing more about the game than all other players and guiding the players through the game. The role of the game master comes with some preparation beforehand so they can guide the players and provide information when needed. Thus, the game master should be familiar with the robots and what kind of sensors and functionalities the robots have so they can answer questions regarding the robots' functionalities. Also, the game master should be familiar with the interactions introduced by the cards. As mentioned in Section 4.1.2 some cards caused more questions and controversies than others. The most important part of the game master's role is not to interfere or influence the player(s) with their decisions regarding the cards drawn. If the player(s) are uncertain how to decide, the game master should help them by asking them to share their thoughts and if they tend more towards accepting or refusing the interaction, so the player(s) can conclude themselves. It is also an option not to place the card at all or at a later point. Sometimes it helps the participants to give more information regarding the card's background or help them imagine the interaction by introducing a scenario.

When playing the game, some participants intuitively constructed some person(a) to play the game with. On the one hand, some participants played the game with their current health and age condition in mind (some being young and healthy, some already taking medication regularly). On the other hand, some participants imagined themselves as requiring care or imagined an older version of themselves. These imaginations happened without the game master introducing the idea of creating a persona. Sometimes the participants imagined different versions of themselves when they drew a card e.g., when they did not need help with something now but potentially would need help when being older or disabled (e.g., picking up objects or memory training). The implicit assumption of being old or that (older) age is connected with needing care was voiced multiple times by participants explicitly and implicitly.

### 4.1.2 Game Content Related Insights

Among all robots, only the robotic seal Paro was recognized by one participant during the game. After finishing the game, another participant recognized the robot Pepper and continued the conversation about the robots they had already encountered. They saw Pepper at a museum in Italy, where the robot greeted museum visitors passing-by.

Most participants reacted with surprise when they learned that the robots used in the game existed and that the suggested interactions were based on research. Most participants anticipated that the robots and the interactions were purely fictional and designed for the game.

The robots were perceived differently by the participants. For instance, when the Paro card was drawn, multiple participants noted that they found the robot cute because of its design and because it looked like a stuffed toy. The robot Cody irritated some participants because of its crude design: as the picture on the card had no shell, the robot looked 'unfinished' to the participants. Also, the task the robot suggested was a sponge bath, and some participants asked how this would work because the robot did not have any sponges attached to the arm, and they could not imagine how the robot would perform the task. The robot Pepper surprised participants with its emotion recognition feature.

Another finding was that the time of the day was an important aspect for participants when deciding how to react to the suggested interaction. Some participants decided against an interaction when it was too late in the evening, during the night, or too early in the morning. However, they would have interacted with the robot during the daytime. For instance, drinking water was refused by some participants because they did not want to get up at night to go to the toilet. During the day, some participants decided against video chatting with another person because they did not want to disturb someone else.

Also, when interactions were introduced twice a day, it made a difference what kind of interaction was suggested. When participants were prompted to drink water twice, most of them agreed to do so because they believed drinking water was a healthy thing to do. When participants were prompted to exercise twice a day, most of them refused to do so. Although both interaction cards were part of the Health and Reminder categories, it seems like the suggested activities were valued differently by the participants.

Some participants said they liked the idea of having a robot at home that helps and supports them with daily activities. If an interaction was perceived as useful or helpful, e.g., to maintain health, the participants were more likely to accept it.

The text on the cards and the game board was in German, but this was not an issue for participants not fluent in German or too young to read the texts themselves. Translating the texts to English or reading the texts aloud worked well for participants to lessen language and skill barriers. They still enjoyed playing the game and shared their thoughts on the robots and care interactions.

Some cards in the card deck caused controversies, intense discussion, and confusion among participants. The following 3 cards are specific in this aspect:

- The Bestic Arm card suggesting the interaction "Let's eat together!". Participants reacted positively without taking into account that the Bestic Arm robot spoon-fed them. Pointing out this detail made participants think more deeply about the suggested interaction and what it entails, e.g., that there might not be a human involved when a robot performs the task. Some participants said they would prefer to be fed by a person, but if no one was available to help them, they would also use a robot. One participant said they would only use the robot when a human was near to intervene if something went wrong. The participant's initial decision regarding the Bestic Arm card did not change and remained positive because eating was a vital aspect of staying alive and healthy.

- The Cody card suggesting the interaction "It's time for your daily sponge bath." This card caused much controversy for different reasons: Participants wondered how the robot could perform the task of giving a sponge bath because they did not think the robot could perform it. The picture of the robot Cody used gave them the impression the robot was too crude (not having sponges anywhere and the robot having no shell). One participant pointed out that the skin might be harmed by giving a bath with a sponge and rubbing too hard, especially if the bath is given to an older person. Also, when someone's skin is hurt, it might worsen the wound. Another participant was amazed by the suggested interaction and thought of it as a comforting and relaxing interaction if performed by a robot.

- The Care-O-Bot 3 card suggesting the interaction "I'll bring the newspaper only if you stop shouting at me." This card caused much confusion when participants drew it. One reason was that some participants wondered why they would be rude to a robot in general and, more specifically, shouting at a robot because of a newspaper. This card also often revealed that the robots on the cards exist and that the cards are based on research studies.

### 4.1.3 Quantitative Insights

The pictures of the cards the participants placed on the game board were used for quantitative analysis. The four decision options the participants had were: (1) accept the interaction unconditionally ("yes, sure"), (2) accept the interaction including a condition ("yes, but"), (3) refuse and change the interaction significantly ("no, except..."), or (4) refuse the interaction completely ("no").

Summing up the participants' tendencies to interact or refuse to interact with the robots into two simplified categories: (1) Positive (adding the stacks "yes, sure" and "yes, but...") and (2) Negative (adding the stacks "no, except..." and "no"). According to these two simplified categories, the participants were most willing to interact with the robots in the following order: Bestic Arm (88.9%), Cody (87.5%), Hobbit (76.2%), Mobiserv (75.9%), Paro (71.4%), Care-O-Bot 3 (66.7%), Pepper (65.4%), Nao (63.2%), Palro (48.3%). The low number of cards likely had an impact on the placing of the robots. The Bestic Arm robot is intended to help people eat in a hypothetical situation where they can no longer use a spoon. Thus, this interaction card was seen as vital for maintaining health. The robot Cody was also perceived as vital regarding personal hygiene. The low interaction

| | Reminder | Health | Entertainment |
|---|---|---|---|
| Yes, sure | 35 (55.6%) | 58 (51.8%) | 38 (39.6%) |
| Yes, but | 14 (22.2%) | 23 (20.5%) | 18 (18.8%) |
| No, except... | 4 (6.4%) | 11 (9.8%) | 14 (14.6%) |
| No | 10 (15.9%) | 20 (17.9%) | 26 (27.1%) |
| | | | |
| Positive | 49 (77.8%) | 81 (72.3%) | 56 (58.3%) |
| Negative | 14 (22.2%) | 31 (27.7%) | 40 (41.7%) |

Table 4.1: Summed up interactions and percentages for the categories Reminder, Health, and Entertainment.



rate with the robot Palro is likely connected to the entertainment focus of the interaction cards used for the robot.

As the data were not sufficient to analyze each card individually, the cards were put into three categories: Health (including interaction cards aiming at physical and mental health), Reminder (including interaction cards working as reminders for tasks), and Entertainment (including interaction cards aiming at entertaining the person interacting with the robot)(see Table 4.1). Some cards were part of two categories. For instance, all cards regarding drinking water or exercising could be sorted into the categories of Health and Reminder.

Overall, the participants' tendency to interact was highest when the card was in the Reminder category (77.8% interaction rate), as most participants considered reminders useful. Also, health-related interactions were seen as important and useful (72.3% interaction rate). Compared to the categories Reminder and Health, the Entertainment category was not so well received (58.3% interaction rate). The personal preferences of the participants might be an explanation for the low interaction rate. For instance, some participants did not like the suggested entertainment activities like singing, dancing, or listening to music with a robot.

## 4.2 Study 2: Creating a Design Fiction Card Deck

In the second study, a participatory approach is introduced that aims at immersing the study participant into the life of a fictional character they create. The participants are playing through multiple days in the life of the fictional character, exploring the role of (care) technology. By jumping ten years into the future, the approach aims at creating narrative design fictions of potential (care) technologies.

### 4.2.1 Methodological Insights

This section presents insights from the character sheet, the simplified game board, and the play sessions of the second study. Improvements to the developed methods will also be suggested.

The character sheet worked well in creating a character in a collaborative and immersive way. The participants liked the random element of rolling a die to create the character. However, repetitively rolling the die for the attributes was also pointed out as a point of improvement. Participants noted that creating the character step by step by filling in the character sheet was helpful to immerse them into the character's situation. Especially imagining their living situation shaped the created characters.

Participants had multiple improvements for the character sheet: Removing the repetitive way of rolling the die for single attributes and instead rolling the die once and mapping all the attributes of a section to the 20-sided die. One participant wished for more attributes regarding the personality of the created character, e.g., if they are more on the social side, patient, or easy to anger. One aspect that some participants mentioned did not translate so well was bringing the character's disabilities into the gameplay. One participant said that the disabilities were mostly in the background and should be more explicitly tied into the gameplay. One participant was concerned that they might create a character they could not play because they lacked knowledge about how disabilities might come into play in the character's daily life.

The game board was intentionally designed simplistically with only 24 fields representing 24 hours of the day to give the participants a time structure to create a typical day for their character. By using the game board to create a typical day, a lot of details were added to the character. After playing through the character sheet and creating a typical day, the participants had quite a detailed idea of their character's schedule, activities, and also struggles in daily life. Some participants noted that the character came alive to them.

The players' immersion in the gameplay and, specifically, the character they created was an important factor. While playing the game, three out of four participants used the first person "I" to play their character most of the time. They expressed emotions, likes, and dislikes while playing, and also added further details regarding family and activities, and also adapted behavior and hobbies when the ten-year time jump and worsening health made things (more) difficult or no longer feasible for them. The coherence of the character and the living situation was important to the players. Thus, they revised their narration if some aspects did not fit the character. Sometimes they dropped out of character when they were unsure if an aspect fitted the character. For example, participants said "I am not sure if she would like to use something like that [technology]." or "I am not sure if going swimming is something he would do.", switching perspective from I (for the character) to he/she for the character when dropping out of perspective.

Immersing the participants into playing a character and developing a routine leads to the main limitation of the method. If a technology did not fit the character, it would not be introduced during the gameplay, even if it existed in the imaginary world they created. Two aspects that additionally contributed to limiting exploring future or potential technologies were the technological affinity of the character and also how wealthy the character was.

When creating a character using a (limiting) method like a character sheet with predefined sections and selected attributes, there is always the issue of recreating and introducing stereotypes and biases. This should also be seen as a limitation of the method introduced.


Figure 4.1: Part 1 of the mind map "potential/future technologies" including all technologies as nodes and ordered into categories. The boldly marked entries are robot technologies.

### 4.2.2 Coding and Themes

The second study aimed to find potential future technologies in the form of narrative design fictions through gameplay. As the game sessions quite broadly explored the characters' daily lives and routines, many details were included that were not really related to technology use. The first round of coding was conducted without a specific focus by reading through and marking sections with a pencil. After the first round of coding, a second round was conducted with a focus on any already existing technology (e.g., smartphones, TVs, kitchen devices) the character used in their daily life but also on future technologies introduced by the players. The three codes "existing technology", "using technology", and "potential/future technology" were used in the second round.


Figure 4.2: Part 2 of the mind map "potential/future technologies" including all technologies as nodes and ordered into categories. The boldly marked entries are robot technologies.

From the codes "existing technology", "using technology" and "potential/future technology" mind maps were created for each game using the online tool Miro. The mind maps highlight technologies introduced during the gameplay as separate entries. The mind maps from the game sessions were merged together, resulting in a collection of all entries structured by the three codes. All entries featuring robots or robotic technologies were marked in bold. The bold entries of the mind map served as the basis for the first 11 cards of the design fiction card deck. The author created three additional cards inspired by the gameplay sessions and world-building of the participants.

The mind maps "existing technologies" and "using technologies" are attached in the Appendix 7.

During the coding, other aspects formed into themes as well. Although not relevant for creating the design fiction card deck, dropping them without mentioning them would be a loss. The codes covered other aspects of daily life as well, like relationships, activities, family, and emotions the player expressed through the character. A short overview:

**Family as helpers and supporters** were mentioned by all participants during the game session. The characters' living situations varied from living alone in an apartment to living with a partner or family in a house. All of them were still independent but relied


Figure 4.3: Part 3 of the mind map “potential/future technologies” including all technologies as nodes and ordered into categories. The boldly marked entries are robot technologies.

on their family and partners regarding daily life activities, especially when sick. Help ranged from bringing food when cooking was not possible to maintaining and explaining technologies and tools, as well as visiting and spending time together.

The topic **climate change** also came up in two play sessions. One participant mentioned it directly as one of the main issues that need to be resolved; otherwise, technological development and care technologies would be void. One participant mentioned the impacts of climate change more indirectly during the gameplay when describing the dried-up garden and how the terrace was no longer usable during the day.

**Affordability of the technology** was one of the main limitations mentioned by all participants during the play session or later during the interview part. Two participants explicitly noted that technology’s affordability (or non-affordability) is one of their main concerns for the future. The scenario that only the wealthy could afford the (care) technologies to survive was mentioned as a negative co-notated future.

Another interesting aspect was **what kind of technology was deemed a new technology by the created character**. For one participant, a microwave was a novel technology introduced in the daily life of the character they played. Another player mentioned that their character was not an early adopter, thus, would not use (care) technologies even if they already existed ten years in the future. This aspect especially points out the major limitation of the method: By creating a character and immersing the participant in their daily routines, the exploration of novel technologies is limited by

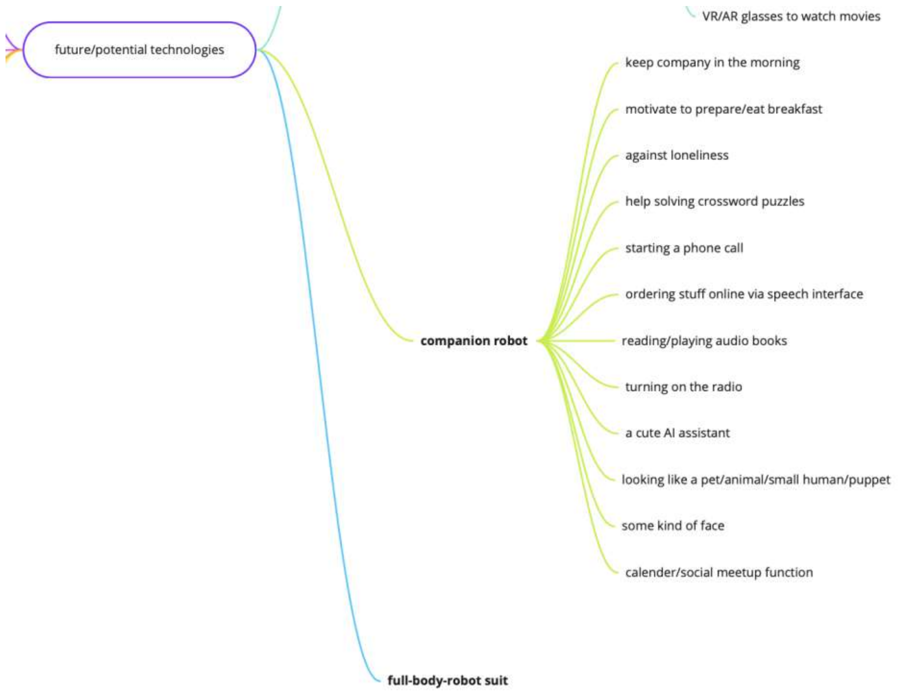



Figure 4.4: Part 4 of the mind map "potential/future technologies" including all technologies as nodes and ordered into categories. The boldly marked entries are robot technologies.

the technological affinity of the character imagined. All **participants made an effort to create a coherent narrative story and character**; this showed by participants adding corrections and revising ideas during the gameplay while exploring the daily life of their character. However, this aspect could be overcome in the interview part by asking the participants if they, as a researcher, could imagine a technology that might help their character.

### 4.2.3 Creating the Design Fiction Card Deck

The design fiction card deck is based on the technology ideas related to robots the players introduced in the gameplay or in the discussion after the game sessions. In one of the game sessions, a social robot was introduced, and this idea was translated directly into the fictional robot Companio. The fictional robots BuildBot and MultiBot are based on multiple ideas introduced in the game sessions. The fictional robot Keyohe is based on inspirations the author drew from the game sessions addressing technological gaps they found. For each fictional robot, 3 or 4 interaction cards were created based on the entries from the mind map. In total, the design fiction card deck has 14 cards. Each robot was named, and the author created a picture to put on the cards. The pictures were drawn on an iPad with an iPencil using the Apple Notes app.

The design fiction card deck includes the following robots:

**Companio** is a stationary social robot put on the table or a shelf. The primary mode of interaction is via verbal commands, and its purpose is to keep someone company and converse with them, as well as motivate people to do activities like meeting friends or cooking.

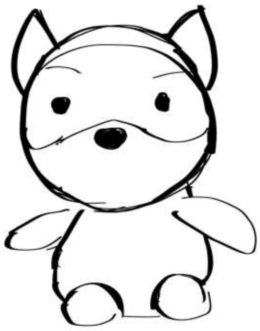


Figure 4.5: Sketch of the fictional robot Companio. It shows a small animal-like robot.

**BuildBot** is a do-it-yourself robot building kit. The robot is disassembled in a package but is functional enough to remind the person building the robot at what stage the building process is. Building the robot is also intended as a social activity, including other parties, like family members or friends. Also, programming the robot is part of the experience.


Figure 4.6: Sketch of the fictional robot BuildBot. It shows a box with a do-it-yourself building kit for a robot.

**MultiBot** is a household robot that helps with multiple activities like making and serving tea, collecting and cleaning dishes, or helping with gardening work like planting and watering flowers. It can move indoors and outdoors and assists a person with repetitive activities and chores.

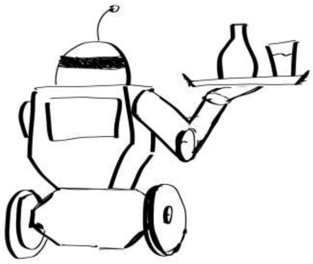


Figure 4.7: Sketch of the fictional robot Multibot serving some drinks on a tray.

**Keyohe** is a robot with the aim of keeping a person healthy. It has a built-in temperature sensor and cooling unit that can be turned on when it gets too hot. It detects sleep issues and functions as a personal fitness trainer. Keyohe is an acronym created by using the first two letters of the robot's aim: **ke**ep **yo**u **he**althy.

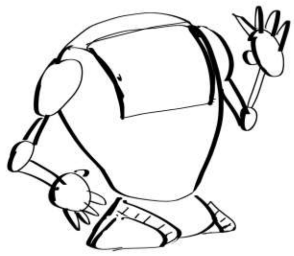


Figure 4.8: Sketch of the fictional robot Keyohe. It has two arms to show movements.

The design fiction card deck can be found in the Appendix 7.

CHAPTER 5

# Discussion

This thesis aims to answer the following research questions: "How can the gap between (over-)expectations of care robots and current research in HRI be narrowed down playfully?" (RQ1) And: "Are Design Fictions a useful approach to redirect HRI researchers and spark new ideas regarding future care robots? What kind of ideas are sparked by this method?" (RQ2)

In the first study, participants were invited to play a low-fidelity game prototype at a museum event at the Vienna Museum of Technology and Science. Inviting potential participants to play a game turned out as a good hook to elicit conversations and discussions about the topic robots in care contexts. Similarly, the first study revealed that laypeople in Austria are barely familiar with existing robots used in care contexts as they assumed that the robots on the cards were all fictional. This finding is surprising, assuming the participants were most likely more interested in technology as they were visiting the Vienna Museum of Science and Technology. The most popular interactions were cards introducing different kinds of reminders, while the least popular were the cards introducing entertainment activities like dancing, singing, or playing games.

In response to RQ1, the findings from the first study confirm the presumed knowledge gap regarding robots in care contexts in two ways: Firstly, out of the 35 participants, only two participants recognized one of the showcased robots on the cards (Paro and Pepper). Secondly, after the play session, most participants expressed surprise upon discovering that all robots depicted on the cards were real and used in research studies. Prior to that revelation, most participants assumed the robots depicted and interactions suggested on the cards were purely fictional.

The first prototype also proved to be an effective ice-breaker and catalyst for conversations. During the play session, the conversations were anchored through the suggested care interactions on the cards. When participants decided where to place the cards on the game board, the evolving conversation was grounded through the card. After the play session, some participants said they have so far never engaged with or thought about the topics care or robots in care contexts. Therefore, the first game prototype also worked as an impulse to think about the future of care and what kind of roles robots might play. Consequently, the first game prototype is a suitable tool to narrow the gap between the over-expectations of care robots and educate people in a playful way about existing robots and the interactions they can perform.

The primary limitation of the first study stemmed from the documentation method employed, wherein hand-written notes taken after the play sessions were frequently hastily recorded between play sessions. Although the second round of notes aimed to capture more details, still a lot of information was omitted. It is advisable to address this limitation by either having a second person dedicated to note-taking or exploring alternative recording methods. Moreover, it is worth noting that the combination of focusing on gameplay, engaging in conversation with the participants, and simultaneously taking care of documentation induced a considerable level of stress. Furthermore, it is important to acknowledge the presence of potential biases in the sample, as the test players recruited at the museum event were mostly young and also most likely interested in technology. Consequently, this sampling approach raises the likelihood of a biased representation towards a specific target group, potentially limiting the generalizability of the findings to a broader population.

In response to RQ2, I draw on insights from the second study, which specifically targeted participants with expertise in HRI or care technologies. The second game prototype aimed at immersing the participants into the gameplay but also drawing on the experts' knowledge through the gameplay. One finding from the second study is that the character sheet worked well to immerse participants in the gameplay and enable them to explore the lives of their created characters. Similarly, the narrative approach proved well-suited to create design fictions of future technologies including (care) robots. The narrated design fictions were condensed to fit the limited space available on the cards, resulting in the design fiction card deck. The design fiction card deck consists of 14 cards, and introduces four fictional robots.

The design fiction card deck introduces some novel use cases for robot technologies. One notable example is the fictional robot BuildBot, a fictional do-it-yourself building kit for a robot that individuals can assemble at home. It aims at guiding the person assembling it with step-by-step instructions and reminders of where they stopped their building session. Additionally, BuildBot suggests the interaction of exploring pair programming as a social activity to (re-)connect with other people. Using a robot building kit as the mediating tool for social interactions and learning how to program is a novel use case in care contexts. Another novel use case is presented through the fictional robot Keyohe which also functions as a temperature sensor and a mobile cooling unit. As temperatures rise globally, dealing with heat in care settings becomes an important health aspect.

Some of the introduced interactions might not be surprising or novel. For instance, the fictional robot Multibot suggests preparing and serving tea or cleaning up the dishes left on the table. However, these suggested use cases showcase that participants see potential in supporting people with domestic tasks and daily life activities. Moreover, the fictional robot Keyohe functions as a reminder for daily exercises. This is an interaction already covered by current robot technologies, for instance, Pepper [22], Hobbit [26], or Nao [29], thus, not a novel use case. However, Keyohe goes a step further and individualizes the fitness exercises and adapts the training sessions towards the interacting person's needs, a feature yet to be realized with current robot technologies.

Certain suggested interactions may prompt questions regarding their applicability in care contexts. For example, Multibot suggests the interaction of planting flowers and vegetables together or collecting and taking out the trash. While these interactions may initially seem unconventional for care settings, they can be viewed as reminders and means of supporting individuals with activities that may become more challenging for them over time or due to personal circumstances. In care contexts, maintaining physical activity among older individuals is often emphasized as an important health aspect and preventive measure. Therefore, despite their initial appearance, these interactions contribute to the overall well-being and health of individuals in care settings.

The fictional robot Companio, which can be understood as a social robot or a robot companion for a person, suggests different interactions, for instance, playing an audiobook or asking how well a person slept, asking to offer inspiration for cooking, or suggesting to meet up with friends for coffee and cake. These interactions might seem trivial as the interaction was condensed from a narrated scenario to a simple sentence to put on the card. During the play sessions, the narrated scenarios were primarily focused on addressing the specific needs of the created characters and aiming to improve the character's living situation, mood, and maintain social connections. Reducing loneliness is one aspect that is already explored by current research [27], as well as using therapy robots such as Paro to manage dementia-related mood changes [42] or to reduce anxiety [29, 42]. Similarly, robots have been used for entertainment purposes like playing games [26, 29, 2] or singing [73, 32], so playing an audiobook might be an interesting addition to entertainment activities. Companio's function to suggest meeting up with other people connects with the reminder functionalities of multiple robots, which have already been implemented for various purposes, e.g., drinking water [26, 73]. Although, Companio's reminder function for meetings hides a more complex and nuanced application including a shared calendar in which people note when they have time, a wish-who-to-meet-soon-list, and an algorithm suggesting date and time when to meet up or join a meeting.

Regarding the second study, the approach to utilizing a role-playing game and fictional characters proved suitable for exploring health, care, and technology aspects in a playful setting. Exploring future technologies through narration brought some difficulties. For instance, guiding the player through the gameplay session is tricky in regard to not introducing biases or affecting the participants regarding the technologies they imagine for their characters. Also, when there is not enough or unclear guidance, the focus on care technologies might get lost. Thus, it is challenging to find a balance between letting the participant explore their character's life and nudging toward potential future (care) technologies. Conducting a play session, the conductor of the study should be aware of their influence on the gameplay and the power dynamic between them and the participant. The narrative approach of the second game prototype is a suitable tool to explore future(s) and find novel use cases for technologies when conducted with care and awareness of power dynamics and influences.

The second game prototype connects to other creative approaches in creating design fictions, for instance, by Ambe et al. [1], who explored future technology and imaginations of future life in a writing workshop with older women. Other formats like storyboards [49], narrative writing [60, 1], prototyping design fiction probes including control panels, a brochure, and documents [52] have also provided valuable insights through playful and creative approaches. However, for some participants narrating fictional scenarios might be more accessible to explore technologies than other creative approaches like drawing storyboards or writing short stories, as participants might assume they need creativity and skills for drawing or writing to participate.

The narrative and character-based approach utilized in the second study, while being beneficial in many aspects, also presented a notable limitation concerning the exploration of future technologies. If a particular technology did not align with the lifestyle of the created character, the players were unlikely to introduce it even if it existed within the imagined world they co-created. Consequently, to discover more technology-centered novel use cases, an alternative approach that avoids relying solely on a character as a focal point may be worth considering.

The third prototype, the introduced design game prototype, might be a suitable approach to move a step away from using a fictional character as an anchor for the technologies imagined and introduced. The design fiction card deck might nudge the participants more towards exploring the technical aspects of future care robots as there is no explicit character to design technologies for. Drawing from experiences from the trial run of the first game prototype, some participants will most likely use themselves as a focal point or someone they care for, e.g., a relative, but it most likely will be a weaker influence than the created character used in the second game prototype. Playing the third game prototype, participants have the opportunity to add desired (or non-desired) interactions with robots to the card deck. As the focus is coming up with ideas of interactions with fictional robots for themselves, there is still a human-centered aspect to the approach. However, there is likely more focus on the future care technology. So far, the third prototype was test played and is in the process of refinement. The test play session provided vital feedback on the game setup and the importance of adding a narrative game scenario, including a jump into the future and the possibility of having robots as supportive technology. By adding the scenario, I hope to nudge towards eliciting more design fictions featuring novel use cases for care robots from the participants playing the prototype.

CHAPTER 6

# Conclusion and Future Work

The depiction of robots in popular media is one of the major shaping and interfering factors when it comes to research involving robots. Regarding application contexts, like robots in care contexts, where robots are novel applications, people's expectations are still shaped by robot imaginaries resulting in over-expectations and dissonance with state-of-the-art robot capabilities. Thus, it is necessary to bridge the gap between the imaginaries of robots and existing technologies and ground the conversations and discussions. However, it is also necessary to open up new spaces of possibility when it comes to robot use cases in care contexts. In HCI, game and playful approaches are already widely recognized and studied, while in HRI, low-fidelity game-based approaches are still scarcely used. The three game prototypes introduced in this thesis showcase how low-fidelity game prototyping can be utilized for HRI research. Thus, using game prototypes as eliciting and informing devices holds potential for HRI research to diversify and deepen research on different perspectives on care robots, as well as provide data that can be insightful for future use cases.

This thesis introduces three low-fidelity game prototypes to bridge the gap and explore novel use cases of care robots. The first prototype is a card- and board game prototype to introduce state-of-the-art robots and care interactions to the participants. The first game prototype was test played at a museum event, and passing-by visitors were randomly recruited for play sessions. In total, 20 play sessions with 35 participants were conducted. Insights were generated from the collected qualitative and quantitative data. The first game prototype worked well as an ice-breaker and conversation starter regarding the topics concerning care and care robots, with which most participants were not familiar or did not think about until engaging in the game. Only the robots Paro and Pepper were recognized by participants, and most participants reacted surprised when learning that the introduced robots existed and were not purely fictional. Thus, the first prototype confirmed the assumed knowledge gap between robot imaginaries and existing robots. Overall, participants preferred the reminder functionality of interactions

(77.8% interaction rate) over health-related interactions (72.3% interaction rate) and entertainment interactions (58.3% interaction rate).

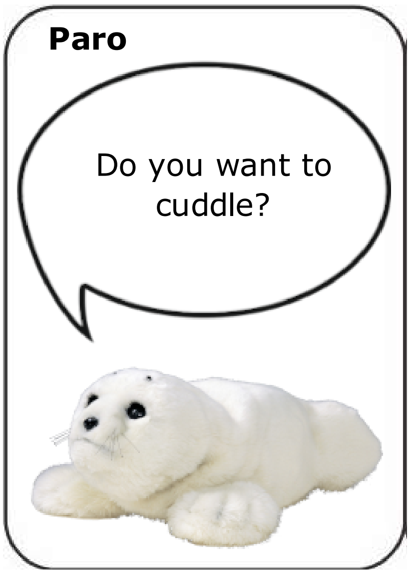
The second game prototype was inspired by role-playing games and aims at eliciting design fictions of future (care) technologies by immersing the participants into the daily life of a fictional character. The participants playing the second game prototype had expertise in HRI or with care technologies bringing in experts' perspectives. The second prototype worked well to immerse the participants into the gameplay and explore future technologies. Through the gameplay, various future technologies were explored to improve the characters' daily life chores and health issues. Although, the character-centered approach also limited the exploration of technologies the character would (and could) bring into their life. The resulting design fiction card deck includes novel and refined use cases to support individuals with daily life activities and introduces novel care robot use cases. So, the second prototype's playful approach helped the participants to overcome common robot imaginaries and create novel use cases for robot technologies.

The third prototype is a design game combining the game board from the first prototype and design fictions in the form of a card deck from the second prototype. By adding blank cards to the design fiction card deck, the participants playing the design game prototype can add new ideas and evolve the design fiction card deck further with each play session. So far, the third prototype was test played with two participants. The third prototype worked in aspects of eliciting technologies the participants used in their daily lives, but the focus of the gameplay was on current technologies. Thus, the test play session highlighted the need for further adaptations, like, introducing a fictional scenario and a time jump at the start of the play session to set a focus on future robot technologies. By moving the game setting ten years into the future, I hope to open up the participant's imagination regarding potential future care technologies, specifically for care robots.

Further, creating fictional robots and discovering novel use cases for care robots might be the first step toward designing and creating physical robot prototypes. Assessing and discussing the use cases introduced in this thesis with (1) target groups of the technologies and (2) people with expertise in creating robot prototypes might be reasonable next steps on the adventure of creating new care robots and care technologies.

CHAPTER 7

# Appendix


Paro
Do you want to cuddle?


Bestic Arm
Let's eat!


Care-O-bot 3
I’ll bring the newspaper only if you stop shouting at me.


Care-O-bot 3
My sensors registered a potential fall. Do you need help?


Cody
It is time for your daily sponge bath.


Hobbit
It is time for your exercises. Please follow the instructions.

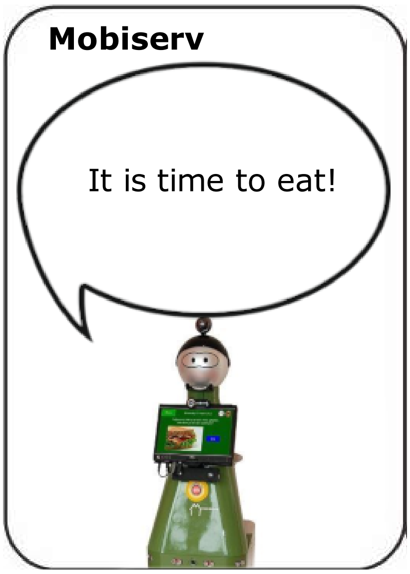

Hobbit
Do you want to play nine men’s morris with me?


Hobbit
It is time for your medication. You should also drink some water.


Hobbit
Please point at the object to pick up.


Hobbit
Do you want to drink some water?

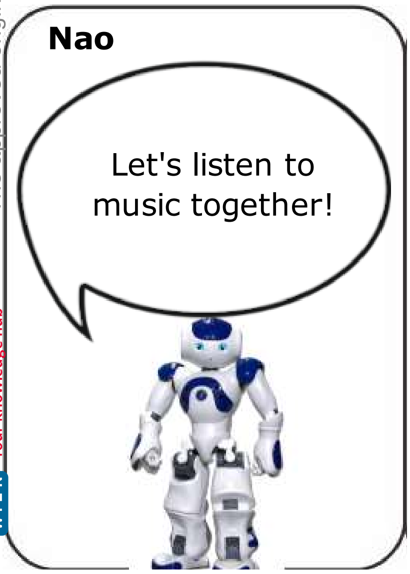

Mobiserv
Don’t forget your doctor’s appointment!


Mobiserv
It is time to eat!

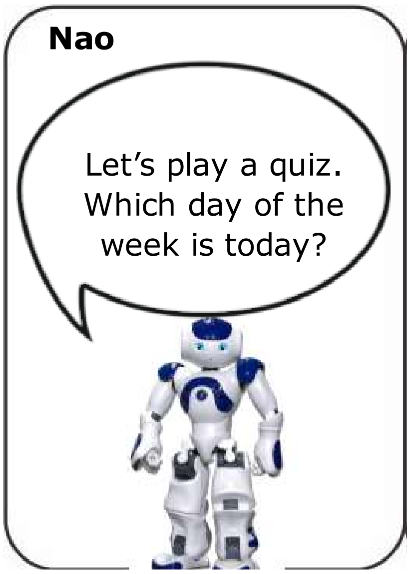

Mobiserv
It is time for your medication.

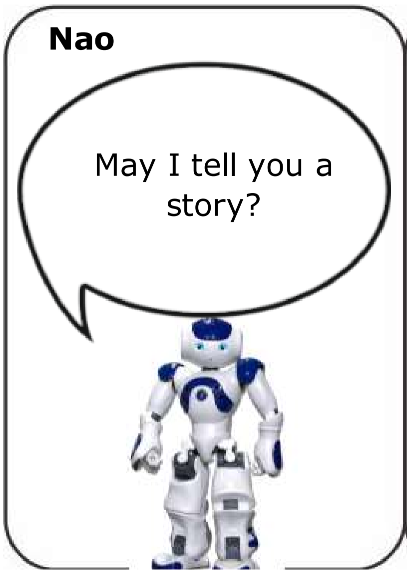

Mobiserv
Do you want to video call someone?


Nao
It’s time for your exercises!

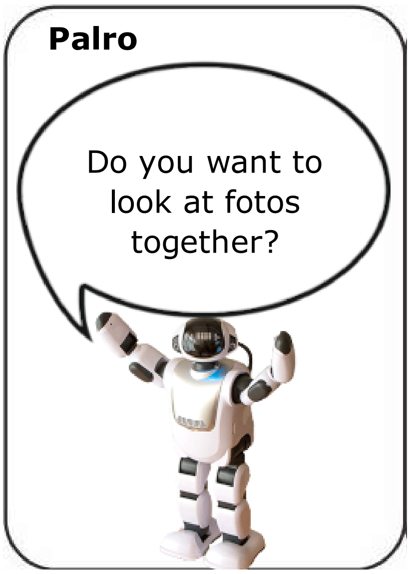

Nao
Let's listen to music together!


Nao
Let’s practice numbers and counting together!


Nao
Let’s play a quiz. Which day of the week is today?

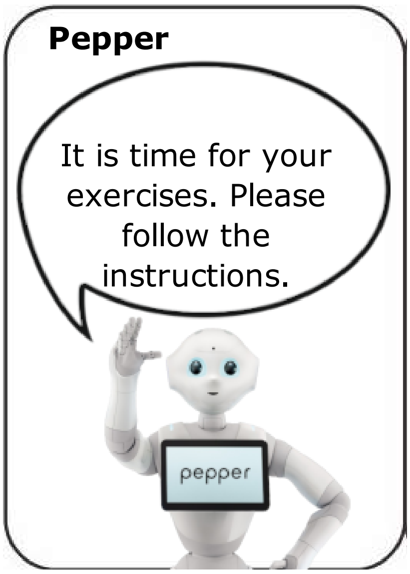

Nao
May I tell you a story?


Palro
Let’s dance!


Palro
Do you want to look at fotos together?

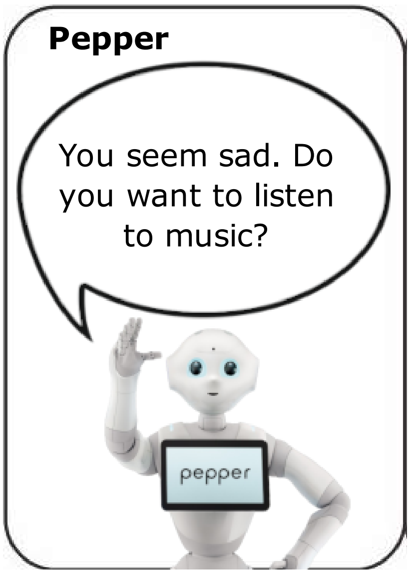

Palro
Let’s play together!


Palro
Let’s sing together!


Pepper
It is time for your exercises. Please follow the instructions.
pepper


Pepper
Do you want to create a playlist together?
pepper


Pepper
Do you want to play a music quiz?
pepper


Pepper
You seem sad. Do you want to listen to music?
pepper

Bestic Arm

Lass uns essen!

**Care-O-bot 3**

Meine Sensoren haben einen potentiellen Sturz festgestellt. Benötigst du Hilfe?

**Care-O-bot 3**

Ich kann dir die aktuelle Zeitung erst dann bringen, wenn du mich nicht mehr anschreist.

Cody

Es ist Zeit für dein tägliches Schwammbad.

**Hobbit**

Bitte zeige auf den Gegenstand, den ich aufheben soll.

**Hobbit**

Es ist Zeit für deine Fitnessübungen. Bitte folge den Anweisungen.

**Hobbit**

Es ist Zeit für deine Medikamente. Trinke auch ein bisschen Wasser dazu.

**Hobbit**

Möchtest du Mühle mit mir spielen?

**Hobbit**

Möchtest du etwas Wasser trinken?


Mobiserv
Vergiss nicht deinen Arzttermin!


Mobiserv
Es ist Essenszeit!


Mobiserv
Es ist Zeit für deine Medikamente.


Mobiserv
Möchtest du mit jemandem videotelefonieren?


Nao
Es ist Zeit für deine Fitnessübungen!


Nao
Lass uns gemeinsam Musik hören.


Nao
Lass uns ein Quiz spielen. Welchen Wochentag haben wir heute?


Nao
Lass uns gemeinsam Zahlen und Zählen üben!


Nao
Soll ich dir eine Geschichte erzählen?


Palro
Möchtest du gemeinsam Fotos anschauen?


Palro
Lass uns gemeinsam singen!


Palro
Lass uns gemeinsam ein Spiel spielen.


Palro
Lass uns gemeinsam tanzen!

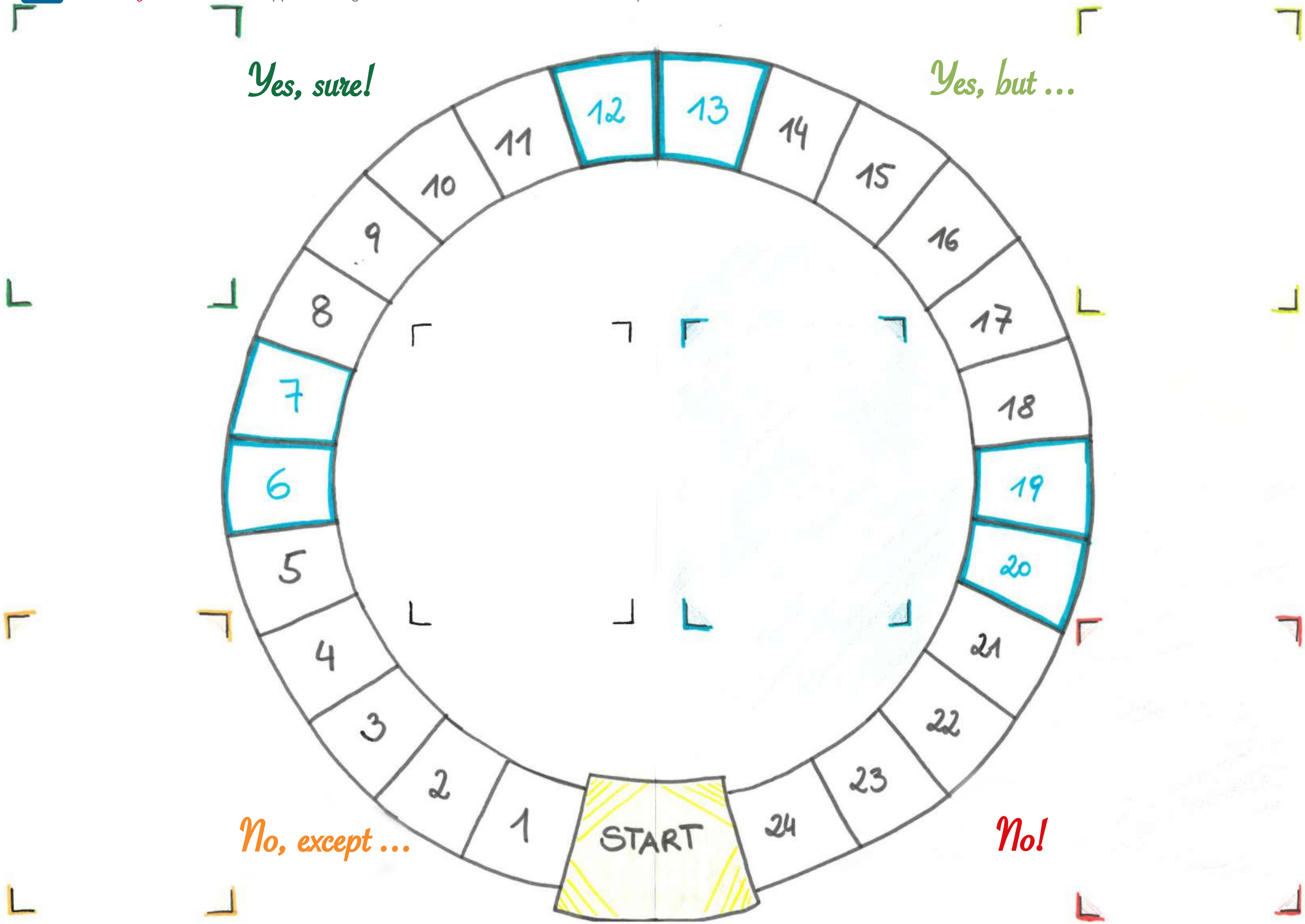

Paro
Möchtest du mit mir kuscheln?

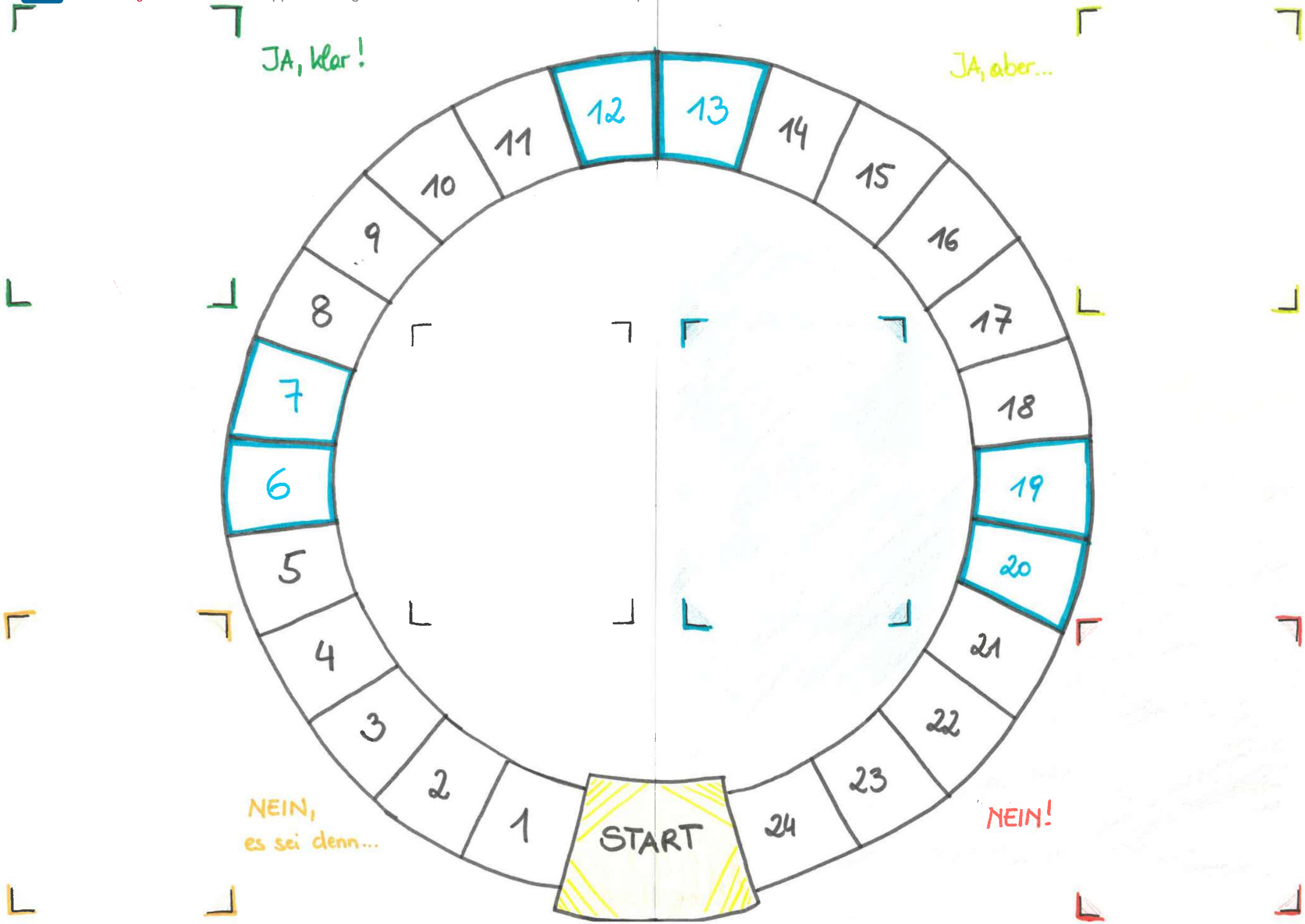

Pepper
Es ist Zeit für deine Fitnessübungen. Bitte folge den Anweisungen.
pepper


Pepper
Möchtest du mit mir ein Musikquiz spielen?
pepper


Pepper
Möchtest du gemeinsam eine neue Musik-Playliste erstellen?
pepper


Pepper
Du siehst traurig aus. Möchtest du Musik hören?
pepper


Yes, sure!
Yes, but ...
No, except ...
No!
START
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24


JA, klar!
JA, aber...
NEIN, es sei denn...
NEIN!
START
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24

| Name | Age | Gender | Migration background |
|---|---|---|---|
| ______________ | ______ | ____ | ____________ |

Education Level
______________

Occupation
______________

Employed
☐ Yes ☐ No

## Living Situation

Living with
- ☐ Partner(s)
- ☐ Child(ren)
- ☐ Non-Related Person(s)
- ☐ Alone

Living in a
- ☐ House
- ☐ Apartment
- ☐ Rented

Notes:

## Health

Sports
- ☐ Cardio training
- ☐ Strength training

Notes:

Chronic Illness (es)
- ☐ Back pain
- ☐ Allergies
- ☐ Blood pressure
- ☐ Neck pain
- ☐ Arthritis
- ☐ Head aches
- ☐ Depression
- ☐ Diabetes
- ☐ Asthma
- ☐ ______________

Notes:

Pain Intensity
- ☐ No pain
- ☐ Light pain
- ☐ Moderate pain
- ☐ Strong pain
- ☐ Very strong pain
- ☐ Once a month
- ☐ 2-3 times a month
- ☐ Weekly
- ☐ 2-3 times a week
- ☐ Daily

Notes:

Restrictions in Daily Life
- ☐ Vision
- ☐ Hearing
- ☐ Walking
- ☐ Walking stairs
- ☐ Getting up
- ☐ Sitting down
- ☐ Memory and concentration
- ☐ Eating
- ☐ Cooking
- ☐ Household/Cleaning
- ☐ Dressing
- ☐ Personal hygiene
- ☐ ______________

Notes:

# Answer sheet for creating a fictional Character

All data used in this sheet is from Statistik Austria.
https://www.statistik.at/statistiken/bevoelkerung-und-soziales/gesundheit
The data for single person households is from Statista.

All values are rolled with a 20-sided die.

## Age

(start by 15 years)
Roll a die, multiply number with 4 and add +11

## Gender

1 to 10 female
11 non binary
12 to 20 male

## Migration background

| | Bevölkerung in Privathaushalten | Mit Migrationshintergrund | |
|---|---|---|---|
| Österreich | 8 807 300 | 2 240 300 | |

1 to 15 no
16 to 20 yes

## Educational Level

| Jahr | Pflichtschule | Lehre | Mittlere und höhere Schule | Hochschule und Akademie |
|---|---|---|---|---|
| 2020 | 17.5% | 33.0% | 30.4% | 19.2% |

| | |
|---|---|
| Statutory education (17.5%) | 1 to 3 |
| Apprenticeship (33.0%) | 4 to 10 |
| Secondary school (30.4%) | 11 to 16 |
| Tertiary school (19.2%) | 17 to 20 |

## Occupation

Player may choose the occupation

## Employed

| | |
|---|---|
| 15 to 24 years: 50.2% | 1 to 10 yes; 11 to 20 no |
| 25 to 54 years: 83.8% | 1 to 16 yes; 17 to 20 no |
| 55 to 64 years: 53.4% | 1 to 11 yes; 12 to 20 no |

## Living with

Familien nach Familienformen 1985-2021 (Tabelle)

| Familienform | 2021 | % | |
|---|---|---|---|
| **Familien ohne Kinder im Haushalt** | 1078500 | 15,62545 | 1 to 3 |
| **Familien mit Kindern im Haushalt** | 1389100 | 20,12546 | 4 to 7 |
| **Paare ohne Kinder im Haushalt** | 1078500 | 15,62545 | 8 to 10 |
| **Paare mit Kindern im Haushalt** | 1119400 | 16,21801 | 11 to 13 |
| **Lebensgemeinschaften ohne Kinder im Haushalt** | 249800 | 3,619135 | 14 |
| **Lebensgemeinschaften mit Kindern im Haushalt** | 191300 | 2,771580 | 15 |
| **Mütter in Ein-Eltern-Familien** | 223600 | 3,239546 | 16 |
| **Väter in Ein-Eltern-Familien** | 46000 | 0,666454 | |
| **Statista Einpersonenhaushalte 2021** | 1526000 | 22,10889 | 17 to 20 |
| | 6902200 | | |
| | 69022 | | |

# Living in a

House 1 to 10
Apartment 11 to 20
Rented (42.9% are renting) 1 to 9 yes; 10 to 20 no

# Sports

23.6% doing cardio or strength training)

Körperliche Aktivität 2019 gemäß den WHO-Empfehlungen nach

| Geschlecht | Alter | Ausdaueraktivität | | Muskelkräftigungsaktivität | |
|---|---|---|---|---|---|
| | | | Yes | | Yes |
| **Non binary** | 18 29 Jahre | 54 | 1 to 11 | 40,2 | 1 to 8 |
| **Non binary** | 30 44 Jahre | 44,9 | 1 to 9 | 29,3 | 1 to 6 |
| **Non binary** | 45 59 Jahre | 44,1 | 1 to 9 | 26,5 | 1 to 5 |
| **Non binary** | 60 64 Jahre | 44,6 | 1 to 9 | 28,2 | 1 to 6 |
| | | | | | |
| **Männer** | 18 29 Jahre | 56,2 | 1 to 11 | 45,2 | 1 to 9 |
| **Männer** | 30 44 Jahre | 47,9 | 1 to 10 | 32,2 | 1 to 6 |
| **Männer** | 45 59 Jahre | 44,4 | 1 to 9 | 27,2 | 1 to 5 |
| **Männer** | 60 64 Jahre | 43,5 | 1 to 9 | 26,8 | 1 to 5 |
| | | | | | |
| **Frauen** | 18 29 Jahre | 51,6 | 1 to 10 | 34,9 | 1 to 7 |
| **Frauen** | 30 44 Jahre | 41,9 | 1 to 8 | 26,4 | 1 to 6 |

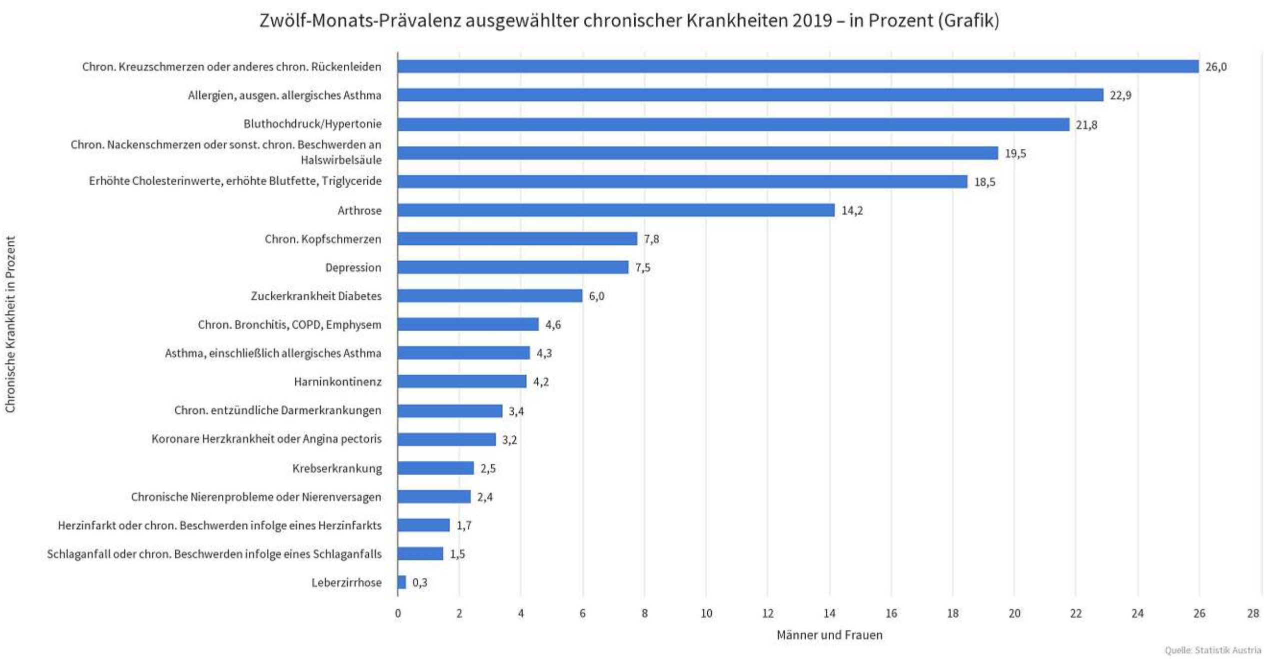
| | | | | | |
|---|---|---|---|---|---|
| **Frauen** | 45  59 Jahre | 43,8 | 1 to 9 | 25,9 | 1 to 5 |
| **Frauen** | 60  64 Jahre | 45,6 | 1 to 9 | 29,5 | 1 to 6 |

## Chronic Illness(es)

(38.3% of population from 15+ years have a chronic illness)

1 to 8 yes
9 to 20 no

Roll the die, and if „yes“ the player can choose options:




## Pain Intensity

Stärke der körperlichen Schmerzen 2019 nach Geschlecht und Alter – in Prozent (Tabelle)

| Geschlecht | Alter | no | light | moderate | strong | Very strong |
|---|---|---|---|---|---|---|
| | | | | | | |
| **Non binary** | 15  29 Jahre | 1 to 11 | 12 to 17 | 18 to 19 | 20 | 20 |
| **Non binary** | 30  44 Jahre | 1 to 10 | 11 to 16 | 17 to 18 | 19 | 20 |
| **Non binary** | 45  59 Jahre | 1 to 8 | 15 to 17 | 15 to 17 | 18 to 19 | 20 |
| **Non binary** | 60  74 Jahre | 1 to 8 | 15 to 17 | 15 to 17 | 18 to 19 | 20 |
| **Non binary** | 75 Jahre und mehr | 1 to 5 | 6 to 10 | 11 to 16 | 17 to 19 | 20 |
| | | | | | | |
| **Männer** | 15  29 Jahre | 1 to 12 | 13 to 17 | 18 to 19 | 20 | 20 |
| **Männer** | 30  44 Jahre | 1 to 11 | 12 to 16 | 17 to 18 | 19 | 20 |
| **Männer** | 45  59 Jahre | 1 to 8 | 9 to 14 | 15 to 17 | 18 to 19 | 20 |

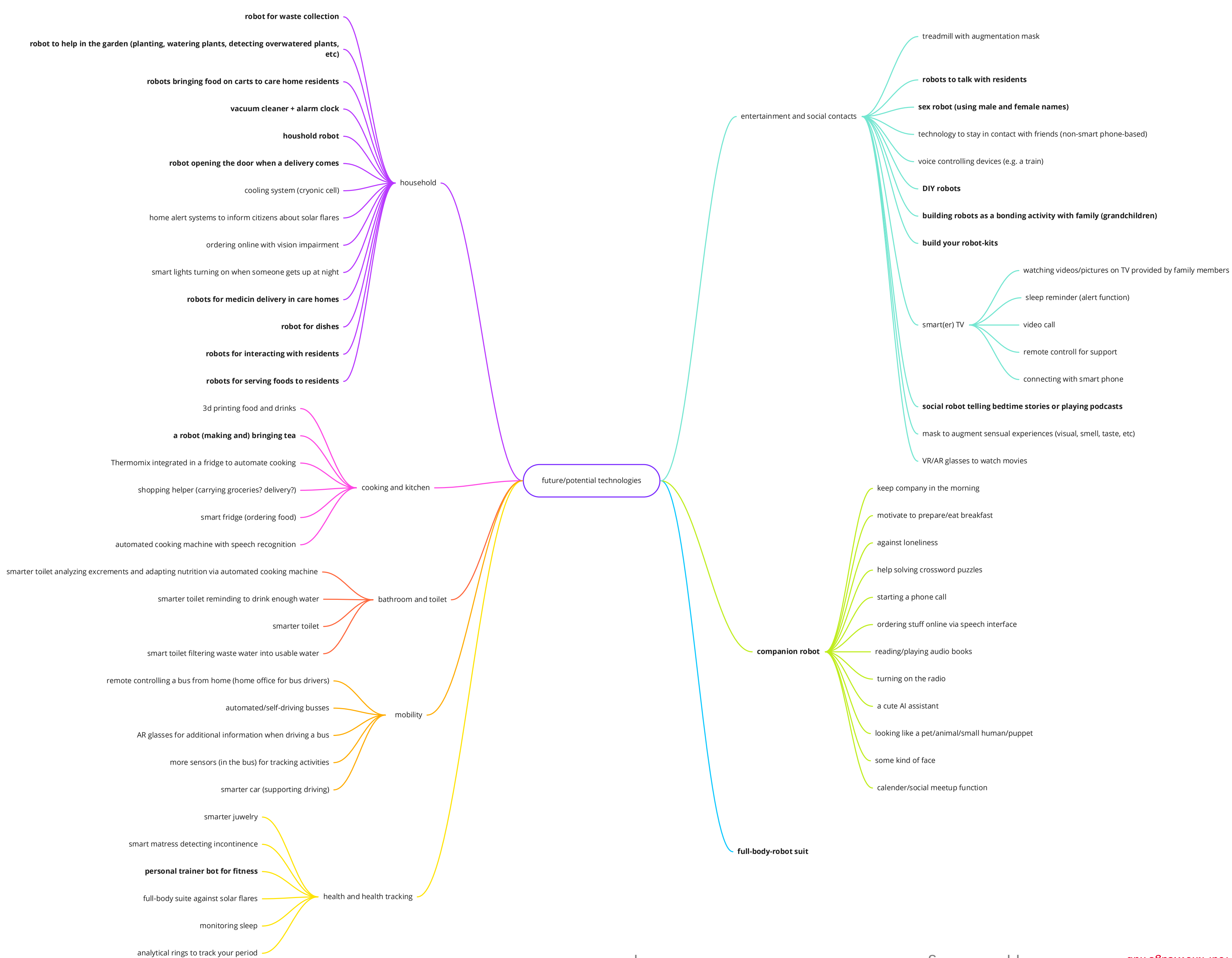
| | | | | | | |
|---|---|---|---|---|---|---|
| **Männer** | 60  74 Jahre | 1 to 8 | 9 to 14 | 15 to 17 | 18 to 19 | 20 |
| **Männer** | 75 Jahre und mehr | 1 to 6 | 7 to 11 | 12 to 16 | 17 to 19 | 20 |
| | | | | | | |
| **Frauen** | 15  29 Jahre | 1 to 11 | 12 to 16 | 17 to 18 | 19 | 20 |
| **Frauen** | 30  44 Jahre | 1 to 9 | 10 to 15 | 16 to 18 | 19 | 20 |
| **Frauen** | 45  59 Jahre | 1 to 7 | 8 to 12 | 13 to 16 | 17 to 19 | 20 |
| **Frauen** | 60  74 Jahre | 1 to 7 | 8 to 13 | 14 to 17 | 18 to 19 | 20 |
| **Frauen** | 75 Jahre und mehr | 1 to 4 | 5 to 9 | 10 to 14 | 15 to 18 | 19 to 20 |

## Restrictions in daily life

Sensorische, körperliche funktionelle und kognitive Einschränkungen 2019 nach

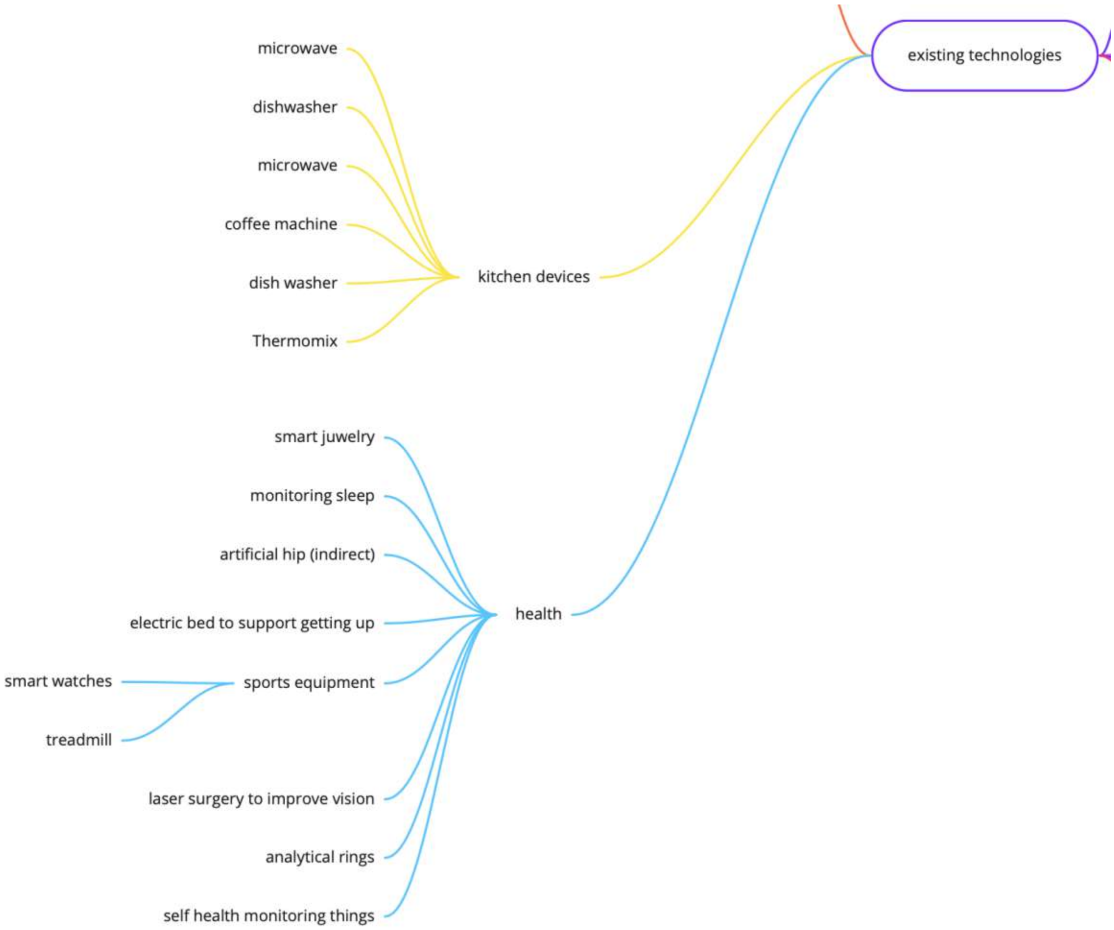
| **Geschlech** | **Alter** | **Sehen (trotz Se** | | **Hören in ruhig** | | **Gehen auf ebe** | | **Treppensteig** | | **Erinnern und Ko** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | |
| **Non binary** | 15  29 Jahre | 8 | 10 to 11 | 1,8 | 10 | 0,8 | 10 | 1,1 | 10 | 8,8 | 10 to 11 |
| **Non binary** | 30  44 Jahre | 9,3 | 10 to 11 | 2,3 | 10 | 2,1 | 10 | 3,2 | 10 | 8,6 | 10 to 11 |
| **Non binary** | 45  59 Jahre | 16,8 | 10 to 12 | 5 | 10 | 5,6 | 10 | 7,8 | 10 to 11 | 12,3 | 10 to 11 |
| **Non binary** | 60  74 Jahre | 12,8 | 10 to 12 | 9,3 | 10 to 11 | 11 | 10 to 11 | 15,7 | 10 to 12 | 14,9 | 10 to 12 |
| **Non binary** | 75 Jahre un | 30,3 | 10 to 15 | 29,5 | 10 to 15 | 45,1 | 10 to 19 | 49 | 10 to 20 | 42,5 | 10 to 19 |
| | | | | | | | | | | | |
| **Männer** | 15  29 Jahre | 7,3 | 10 | 2,1 | 10 | 1 | 10 | 0,9 | 10 | 7,8 | 10 to 11 |
| **Männer** | 30  44 Jahre | 8,7 | 10 to 11 | 2,4 | 10 | 2,3 | 10 | 3,1 | 10 | 8,8 | 10 to 11 |
| **Männer** | 45  59 Jahre | 16,8 | 10 to 12 | 6,7 | 10 | 5,1 | 10 | 7 | 10 | 9,5 | 10 to 11 |
| **Männer** | 60  74 Jahre | 12,5 | 10 to 12 | 11,4 | 10 to 11 | 10,3 | 10 to 11 | 13,4 | 10 to 12 | 14,3 | 10 to 12 |
| **Männer** | 75 Jahre un | 24,3 | 10 to 14 | 29,4 | 10 to 15 | 36,8 | 10 to 16 | 39,7 | 10 to 17 | 39,3 | 10 to 17 |
| | | | | | | | | | | | |
| **Frauen** | 15  29 Jahre | 8,9 | 10 to 11 | 1,5 | 10 | 0,7 | 10 | 1,3 | 10 | 9,8 | 10 to 11 |
| **Frauen** | 30  44 Jahre | 9,9 | 10 to 11 | 2,3 | 10 | 1,8 | 10 | 3,4 | 10 | 8,4 | 10 to 11 |
| **Frauen** | 45  59 Jahre | 16,8 | 10 to 12 | 3,4 | 10 | 6 | 10 | 8,6 | 10 to 11 | 15,1 | 10 to 12 |
| **Frauen** | 60  74 Jahre | 13,1 | 10 to 12 | 7,4 | 10 | 11,7 | 10 to 11 | 17,9 | 10 to 13 | 15,4 | 10 to 12 |
| **Frauen** | 75 Jahre un | 34,4 | 10 to 16 | 29,6 | 10 to 15 | 50,9 | 10 to 20 | 55,5 | 9 to 20 | 44,8 | 10 to 19 |

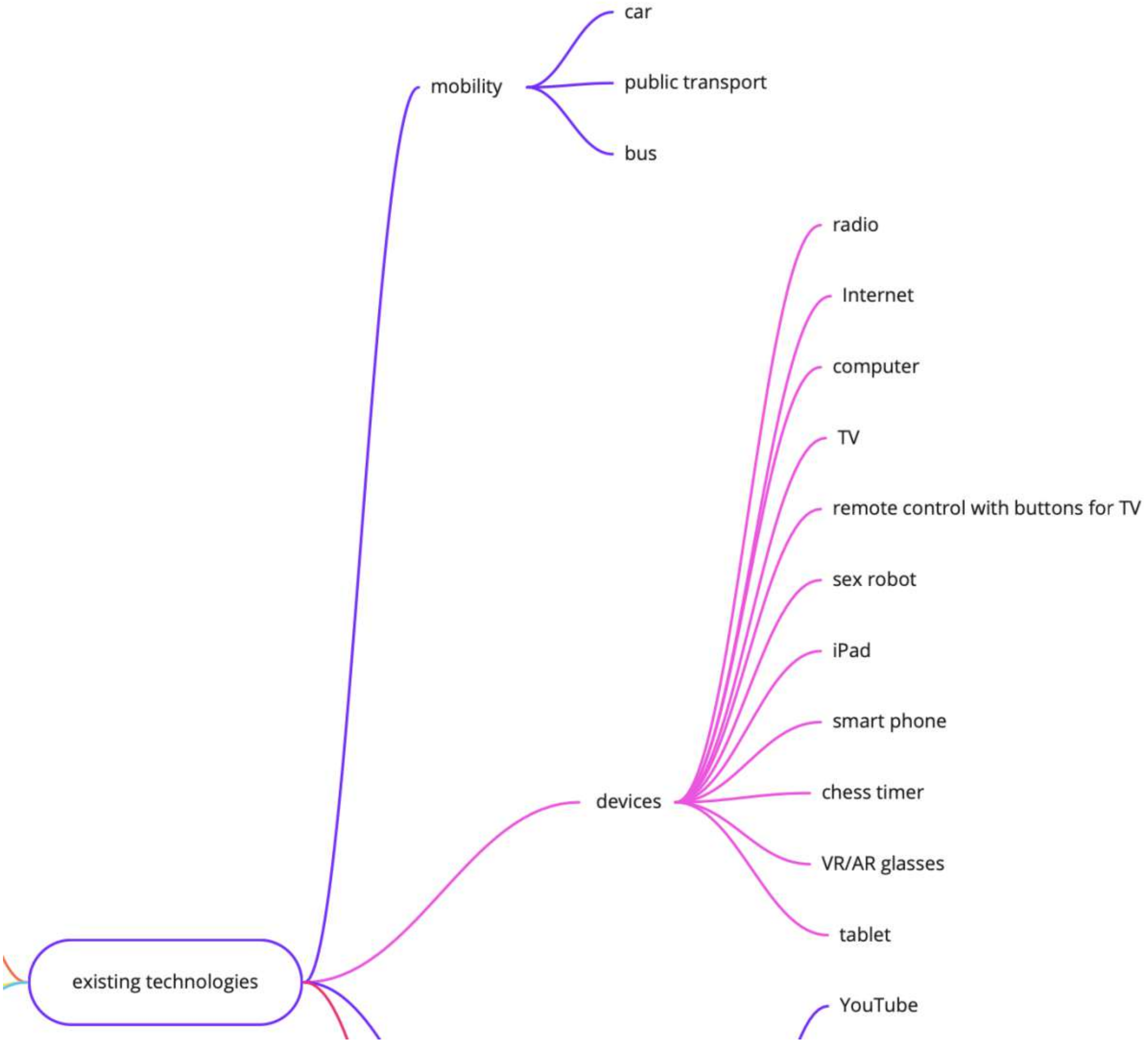

existing technologies
household/cleaning devices
self-cleaning toilet
toilet
alarm clock
robot lawn mower
vacuum robot
smart/technified furniture
delivery robots
chair in the shower
vacuum robot
vacuum cleaner
anti-slip mat in the shower
smart lights
vacuum cleaner
kitchen devices
microwave
dishwasher
microwave
coffee machine
dish washer
Thermomix
health
smart juwelry
monitoring sleep
artificial hip (indirect)
electric bed to support getting up
sports equipment
smart watches
treadmill
laser surgery to improve vision
analytical rings
self health monitoring things
mobility
car
public transport
bus
devices
radio
Internet
computer
TV
remote control with buttons for TV
sex robot
iPad
smart phone
chess timer
VR/AR glasses
tablet
services
YouTube
podcast
online forum
voice assistant
Alexa
speech interface
screen reader
TV UI interface for old people (big icons, simpler navigation)
facebook group
audio books
Netflix
others
sensors like GPS (in the bus)
robots for tests in labs
robots for logistics and medigation delivery


future/potential technologies
household
robot for waste collection
robot to help in the garden (planting, watering plants, detecting overwatered plants, etc)
robots bringing food on carts to care home residents
vacuum cleaner + alarm clock
houshold robot
robot opening the door when a delivery comes
cooling system (cryonic cell)
home alert systems to inform citizens about solar flares
ordering online with vision impairment
smart lights turning on when someone gets up at night
robots for medicin delivery in care homes
robot for dishes
robots for interacting with residents
robots for serving foods to residents
cooking and kitchen
3d printing food and drinks
a robot (making and) bringing tea
Thermomix integrated in a fridge to automate cooking
shopping helper (carrying groceries? delivery?)
smart fridge (ordering food)
automated cooking machine with speech recognition
bathroom and toilet
smarter toilet analyzing excrements and adapting nutrition via automated cooking machine
smarter toilet reminding to drink enough water
smarter toilet
smart toilet filtering waste water into usable water
mobility
remote controlling a bus from home (home office for bus drivers)
automated/self-driving busses
AR glasses for additional information when driving a bus
more sensors (in the bus) for tracking activities
smarter car (supporting driving)
health and health tracking
smarter juwelry
smart matress detecting incontinence
personal trainer bot for fitness
full-body suite against solar flares
monitoring sleep
analytical rings to track your period
entertainment and social contacts
treadmill with augmentation mask
robots to talk with residents
sex robot (using male and female names)
technology to stay in contact with friends (non-smart phone-based)
voice controlling devices (e.g. a train)
DIY robots
building robots as a bonding activity with family (grandchildren)
build your robot-kits
smart(er) TV
watching videos/pictures on TV provided by family members
sleep reminder (alert function)
video call
remote controll for support
connecting with smart phone
social robot telling bedtime stories or playing podcasts
mask to augment sensual experiences (visual, smell, taste, etc)
VR/AR glasses to watch movies
companion robot
keep company in the morning
motivate to prepare/eat breakfast
against loneliness
help solving crossword puzzles
starting a phone call
ordering stuff online via speech interface
reading/playing audio books
turning on the radio
a cute AI assistant
looking like a pet/animal/small human/puppet
some kind of face
calender/social meetup function
full-body-robot suit

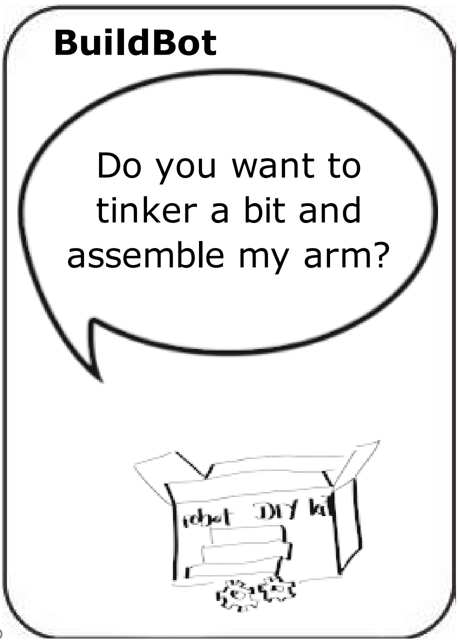

using technologies
food
ordering stuff online
online ordering of groceries
meal delivery
microwave to warm up food
using the automated cooking machine for dinners (porridge, drinks, etc)
household
filtering waste water into usable water
keep grass short with robot lawn mower
a robot to open the door and receive a parcel
relationships
smartphone to call family
call from family to check in
shutting off the companion robot
sex robot to spend time and ignore relationship problems
leisure
listening to audio books on the phone
watching old movies
iPad to watch movies/series in bed
hobby tinkering to socialize with someone
building robots as a hobby
watching TV/Netflix
staying informed
looking up information on the Internet
exchange information online about hobbies
screen reader for reading newspapers
watching the news to stay informed
search stuff on the Internet
walking/running on a treadmill
public transport


self-cleaning toilet
toilet
alarm clock
robot lawn mower
vacuum robot
smart/technified furniture
delivery robots
chair in the shower
vacuum robot
vacuum cleaner
anti-slip mat in the shower
smart lights
vacuum cleaner
household/cleaning devices
microwave
dishwasher
existing technologies


existing technologies
kitchen devices
microwave
dishwasher
microwave
coffee machine
dish washer
Thermomix
health
smart juwelry
monitoring sleep
artificial hip (indirect)
electric bed to support getting up
sports equipment
smart watches
treadmill
laser surgery to improve vision
analytical rings
self health monitoring things


car
mobility
public transport
bus
radio
Internet
computer
TV
remote control with buttons for TV
sex robot
iPad
smart phone
devices
chess timer
VR/AR glasses
tablet
existing technologies
YouTube

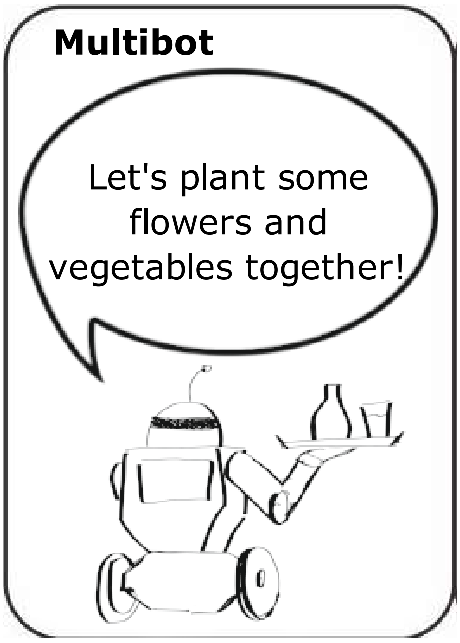

tablet
existing technologies
YouTube
podcast
online forum
Alexa
speech interface
services
voice assistant
screen reader
TV UI interface for old people (big icons, simpler navigation)
facebook group
audio books
Netflix
sensors like GPS (in the bus)
others
robots for tests in labs
robots for logistics and medigation delivery

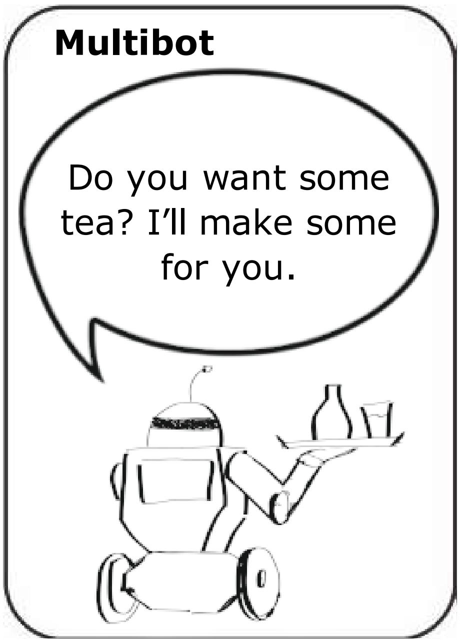

BuildBot
Do you want to tinker a bit and assemble my arm?
robot DIY kit


BuildBot
You haven’t finished building my body. Do you want to continue?
robot DIY kit


BuildBot
Your friend is coming by today. How about pair programming for a bit?
robot DIY kit


Multibot
Leave the dishes on the table. I will clean up for you.


Multibot
Let's plant some flowers and vegetables together!


Multibot
Do you want some tea? I’ll make some for you.

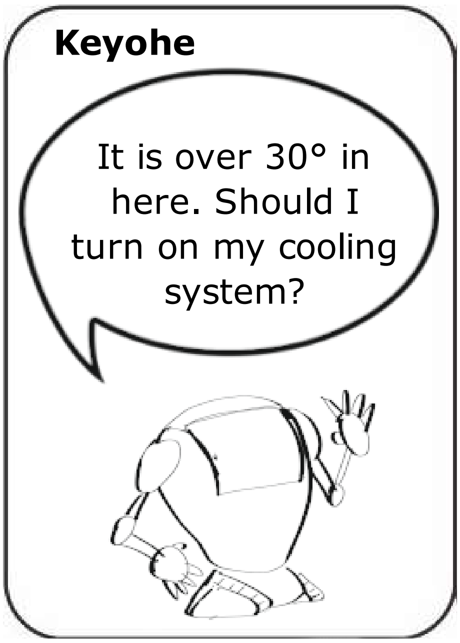

Multibot
I'll collect and take out the trash for you.


Companio
Do you want to listen to an audio book?

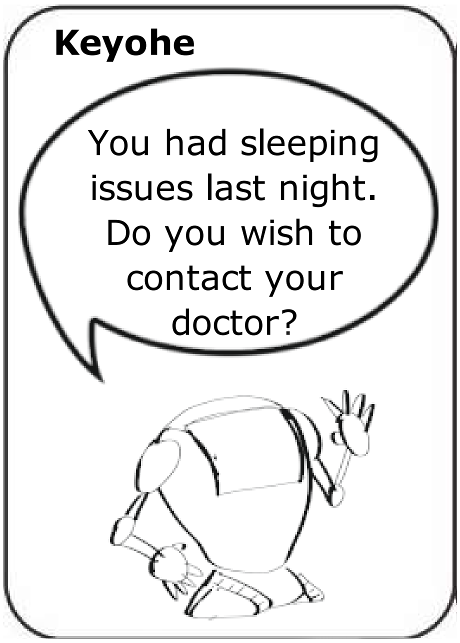

Companio
Do you need inspiration for cooking today?


Companio
Your friends are meeting for coffee and cake, do you want to join them?


Companio
Hello! Did you sleep well today?


Keyohe
It is over 30° in here. Should I turn on my cooling system?


Keyohe
I updated your personal fitness programm. It's time for your daily exercises.


Keyohe
You had sleeping issues last night. Do you wish to contact your doctor?

# Bridging the Gap: Using a Game-based Approach to Raise Lay People's Awareness About Care Robots

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## ABSTRACT

As people's expectations regarding robots are still mostly shaped by the media and Science Fiction, there exists a gap between imaginaries of robots and the state-of-the-art of robotic technologies. Care robots are one example of existing robots that the general public has little awareness about. In this report, we introduce a card-based game prototype developed with the goal to bridge this gap and explore how people conceive of existing care robots as a part of their daily lives. Based on the trial game runs, we conclude that game-based approach is effective as a device to inform participants in a playful setting about existing care robots and to elicit conversations about the role such robots could play in their lives. In the future, we plan to adapt the prototype and create a design game prototype to develop novel use cases for care robots.

## CCS CONCEPTS

• **Human-centered computing → Field studies.**

## KEYWORDS

human-robot interaction, card game, game prototype

**ACM Reference Format:**
Katharina Brunnmayr and Astrid Weiss. 2023. Bridging the Gap: Using a Game-based Approach to Raise Lay People's Awareness About Care Robots. In *Companion of the 2023 ACM/IEEE International Conference on Human-Robot Interaction (HRI '23 Companion), March 13–16, 2023, Stockholm, Sweden.* ACM, New York, NY, USA, 4 pages. https://doi.org/10.1145/3568294.3580125

## 1 INTRODUCTION

From existing research in Human-Robot Interaction (HRI), we know that expectations that people have about robots are still predominantly shaped by the media and Science Fiction [9]. This opens up a gap between the imaginaries of robots that people have and the state-of-the-art robotics. In this report, we introduce a novel way of introducing robotics to lay people via a card-based game prototype we developed with an aim to bridge the gap between robots as imagined and the existing technologies used in care context, and to explore in a playful setting how people envision the role of such technologies in their daily lives. We also outline preliminary results from the trial runs of the game with 35 participants recruited among visitors of a technical museum.

In the field of Human-computer Interaction (HCI), games and game-based approaches have been used successfully as a means of research [13, 14]. In HRI, however, game-based approaches are commonly used in the context of studies wherein participants play games with robots [1, 4]. Thus, expanding game-based approaches to include also games as eliciting and informing devices holds a potential for the HRI research to diversify and deepen research on different perspectives on care robots, as well as provide data that can be insightful for future use cases.

The report proceeds to introduce the related work on game-based approaches. We then introduce the low-fidelity card-based game prototype we developed. Lastly, we introduce the setting and the main insights we gathered during the trial runs conducted with participants recruited spontaneously among visitors of a museum of technology.

### 1.1 Related Work

The role of game and play in designing and using technologies has been widely recognized and studied in the HCI community. On the one hand, simple games have been used as eliciting tools for collecting qualitative and quantitative data. For example, Rapp [14] used the game World of Warcraft to collect data about user behavior and habits. In another study, Mayer and Zach [13] used imaginary characters and simple games to explore the needs of people with dementia. Furthermore, card-based approaches have been used as focus tool. For instance, Schwaninger et al. [15] used elicitation cards as an interview guide to explore user needs with a focus on trust in the context of assistive technologies.

In HRI, game and play have also been addressed, though to a lesser extent. For instance, Chernova et al. [2] collected quantitative data via an online game where two players played together and recreated the game in a physical setting with a robot as a counterpart to explore HRI aspects. Further, Collins et al. [3] developed a tabletop game for co-designing a robot companion to support people with depression to cope with the challenges of their daily lives.

Using a game helps to immerse the players in a potential scenario and characters via role-play [3]. Playful approaches and participatory design play well together, for instance, when the aim is to "eliminate the functional knowledge designers usually bring to their work" [8], using game elements as thinking tools for engaging



*HRI '23 Companion, March 13–16, 2023, Stockholm, Sweden*

ACM ISBN 978-1-4503-9970-8/23/03.
https://doi.org/10.1145/3568294.3580125

participants and "entering the realm of the imaginary"[10], or using a game as dialogue tool to change perspectives and emphasize empathy [12].

In our work, we created a low-fidelity game prototype to (1) introduce different robots used in care contexts, and (2) introduce tasks and activities these robots were designed to perform with care receivers. The created card game is based on existing care robots as a tool to anchor participants' expectations about such robots and similar technologies, and elicit conversations about current and future care technologies.

## 2 METHOD

As the trial run was conducted at the Vienna Museum of Science and Technology, the prototype had to be portable and easy to set up. Thus, developing a low-fidelity prototype seemed like a good fit and it also came with benefits like low cost of materials.

### 2.1 Game Prototype

The developed game prototype consists of two parts: a game board and a set of cards depicting existing care robots. The idea of the game is to play through a day of living and interacting with different care robots, thus the board has 24 fields representing 24 hours of a day (see Fig. 1).


**Figure 1: Game board of the prototype. The cards are drawn from the two stacks in the middle and placed on the corner stacks depending on how the player decides.**

The created card deck includes the following robots: Bestic Arm (1 card), Care-O-Bot 3 (2 cards), Cody (1 card), Hobbit (5 cards), Mobiserv (4 cards), Nao (5 cards), Palro (4 cards), Paro (1 card), and Pepper (4 cards). The different number of cards per robot results from focusing on providing a wide range of care interactions. Also, the robots Paro and Bestic Arm are more limited regarding interactions compared to robots like Pepper or Hobbit. Every card shows the picture and name of the robot and a speaking bubble suggesting an interaction to the player (see Figure 2). In total, 27 cards were created for the card deck. The texts suggesting specific interactions to the players are based on interactions described in

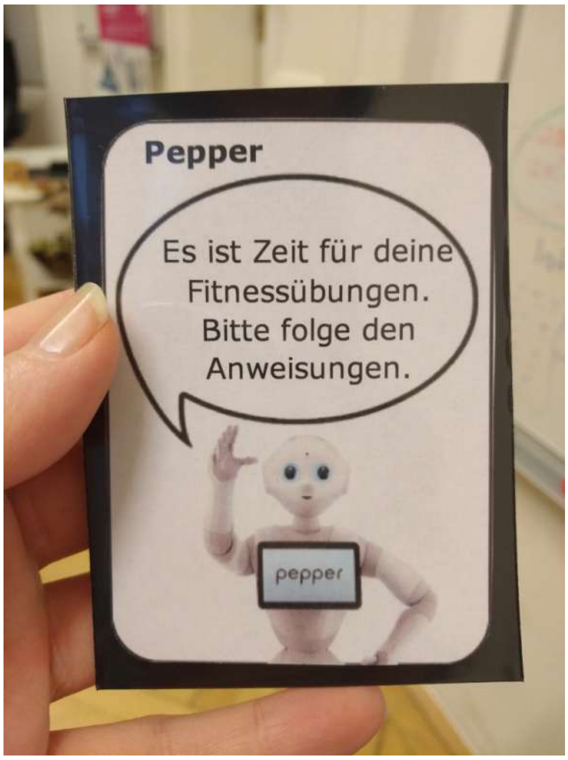


**Figure 2: Card showing the robot Pepper suggesting to do your daily fitness exercises.**

papers by Ghafurian et al. [7], Dino et al. [5], Vincze et al. [16], Fischinger et al. [6], and Kerruish [11].

We aimed for the game to last in between 5 to 10 minutes for a play session. This short interaction span is intentional, as the trial run of the game prototype was held at a museum event.

### 2.2 Playing the Game

Drawing on experiences from playing board- and card games, the game play was designed to follow a simple play sequence. The player rolls a die and advances the pawn that represents them on the fields of the board. Every turn, the player also draws a card with an interaction suggested by the robot depicted on the card, and decide on which stack on the game board the card is to be placed: (1) accept the interaction unconditionally, (2) accept the interaction including a condition, (3) refuse and change the interaction significantly, or (4) refuse the interaction completely. When no explanation for the decision made is provided by the participant, the research prompts one with a question(s). The game ends after playing through one day of interacting with care robots, but there is the possibility to play until no cards are left.

### 2.3 Data Collection

The trial run of the game was played at the Vienna Museum of Science and Technology and participants were recruited spontaneously among passing-by visitors. Demographic data were not collected from the participants in a structured way, although sometimes the occupation or age was mentioned by the participant while playing the game.

For the trial of the game, each play round was documented by taking pictures of the cards the participants placed on the four stacks on the game board. The placement of the cards onto one of the four stacks was transferred into an excel sheet for quantitative analysis.

After each play round, handwritten notes were taken to document the likes and dislikes of the participants regarding the robots and suggested interactions, and any other relevant insights from the conversations had with the participants. As the play sessions and the note-taking were done by one person only, the first round of notes turned out fragmented and missing some aspects participants talked about. Thus, a second round of notes was taken by going through the card deck and taking notes for each card. The second round of note-taking helped to capture card-specific aspects participants mentioned during the game that were missed out in the first round of note-taking. The handwritten notes were digitized, read multiple times, and key insights were summarized.

## 3 KEY INSIGHTS

In total 20 rounds were played in the duration of 6 hours. In total, 35 participants joined the game sessions at the museum event.

### 3.1 Methodological Insights

Inviting participants to play a game worked well in the museum context with many visitors passing by. The game worked well as a conversation starter regarding the topics of care and care robots. There was a smooth transition from playing the game to discussing a topic most participants were not familiar with. Thus, the game worked well as an ice-breaker for informal conversations about care technologies. Multiple participants said that they had not thought about care and care robots until engaging in the game.

Although, there is not a limit on the number of players who could join the game, the setup for the trial run was intended for 1 or 2 players to join the game to keep the setup simple. Thus, 5 rounds were played with one participants and 15 rounds were played with two participants. When two participants joined the game there also developed discussion between them regarding their decisions. There was a different dynamic to the game sessions because the participants knew each other quite well and expressed surprise impulsively or even teased each other while playing the game.

### 3.2 Game Content Related Insights

Among all robots, only the robotic seal Paro was recognized by one participant during the game. The robot Pepper was recognized by another participant after having finished the game and continuing the conversation about the robots they had already encountered. Most participants reacted with surprise when they learned that the robots used in the game exist and that the suggested interactions were based on ongoing research. Most participants anticipated that the robots and the interactions were purely fictional and designed for the game.

The robots were perceived differently by the participants. For instance, when the Paro card was drawn, multiple participants noted that they found the robot cute. The robot Cody irritated some participants because of its crude design: as the picture used on the card had no shell, the robot looked 'unfinished' to the participants. Also, the task the robot suggested was a sponge bath, and some participants asked how this would work. The robot Pepper surprised participants with its emotion recognition feature.

Time of the day was an important aspect for participants when deciding how to react to the suggested interaction. Some participants decided against an interaction when it was too late in the evening, during the night or too early in the morning, although they would have interacted with the robot during daytime. For instance, drinking water was refused by some participants because they did not want to get up at night to go to the toilet. During the day, some participants decided against video chatting with another person because they did not want to disturb someone else.

### 3.3 Quantitative Insights

The pictures of the cards the participants placed on the game board were used for quantitative analysis. The four decision options the participants had were: (1) accept the interaction unconditionally ("yes, sure"), (2) accept the interaction including a condition ("yes, but"), (3) refuse and change the interaction significantly ("no, except..."), or (4) refuse the interaction completely ("no").

Summing up the participants' tendencies to interact or refuse to interact with the robots into two simplified categories: (1) Positive (adding the stacks "yes, sure" and "yes, but") and (2) Negative (adding the stacks "no, except..." and "no"). According to these two simplified categories, the participants were most willing to interact with the robots in the following order: Bestic Arm (88.9%), Cody (87.5%), Hobbit (76.2%), Mobiserv (75.9%), Paro (71.4%), Care-O-Bot 3 (66.7%), Pepper (65.4%), Nao (63.2%), Palro (48.3%). It is likely that the low number of cards had an impact on the placing of the robots. The Bestic Arm robot is intended to help people with eating in a hypothetical situation where they can no longer use a spoon themselves. Thus, this interaction card was seen as vital for maintaining health. The robot Cody was also perceived as vital when it comes to personal hygiene. The low interaction rate with the robot Palro is likely connected to the entertainment focus of the interaction cards used for the robot.

As the data were not sufficient to analyze each card individually, the cards were put into three categories: Health (including interaction cards aiming at physical and mental health), Reminder (including interaction cards working as reminders for tasks), and Entertainment (including interaction cards aiming at entertaining the person interacting with the robot)(see Table 1). Some cards were a part of two categories, for instance, all cards regarding drinking water or exercising could be sorted into the categories Health and Reminder.

Overall, the participants' tendency to interact was highest when the card was in the Reminder category (77.8% interaction rate), as reminders were considered useful by most participants. Also, health-related interactions were seen as important and useful (72.3%

| | Reminder | Health | Entertainment |
|---|---|---|---|
| Yes, sure | 35 (55.6%) | 58 (51.8%) | 38 (39.6%) |
| Yes, but... | 14 (22.2%) | 23 (20.5%) | 18 (18.8%) |
| No, except... | 4 (6.4%) | 11 (9.8%) | 14 (14.6%) |
| No | 10 (15.9%) | 20 (17.9%) | 26 (27.1%) |
| Positive | 49 (77.8%) | 81 (72.3%) | 56 (58.3%) |
| Negative | 14 (22.2%) | 31 (27.7%) | 40 (41.7%) |

**Table 1: Summed up interactions and percentages for the categories Reminder, Health, and Entertainment.**

interaction rate). Compared to the categories Reminder and Health, the Entertainment category was not so well received (58.3% interaction rate). This might be caused by the personal preferences of the participants, for instance, some participants did not like the suggested entertainment activities like singing, dancing or listening to music with a robot.

## 4 DISCUSSION, LIMITATIONS, AND FUTURE WORK

In this report, we presented a novel way of introducing robotics to lay people via designing a card-based game prototype. We generated insights from qualitative and quantitative data gathered in a first trial run at the Vienna Museum of Science and Technology. In total, 20 play rounds with 35 participants were conducted. In our experience, the game prototype worked well as an ice-breaker and conversation starter regarding the topics concerning care and care robots, with which most participants were not familiar or did not think about until engaging in the game. Also, playing the game was perceived as a fun and enjoyable activity by the participants.

However, the collected data were not sufficient to analyze each card individually, thus, collecting more data would be beneficial to get more reliable quantitative results. Also, most participants were in their 20s to 30s, so there might be an age bias in the data as well.

The game prototype served as a proof of concept to showcase the potential that game-based interviews can have in HRI for tapping into people's perspectives and for bridging the gap between imaginaries of robots and actual technologies. The conversations and discussions initiated via playing the game prototype were documented with hand-written notes after each game session. The collected data was sufficient for trial runs and collecting first impressions. For further iterations of the study audio recording the game session is considered.

In the future, we plan to adapt the game prototype and extend it towards a design game prototype to develop novel use cases for care robots. To achieve this, we plan to draw on the creative potential of Design Fictions as a part of the gameplay, and also try to break stereotypical imaginations of care technologies.

## 5 ACKNOWLEDGMENT

A big thank you goes to Anna Dobrosovestnova for giving feedback on the first draft of the report. We also want to thank Jürgen Öhlinger from the Vienna Museum of Science and Technology for the opportunity to play the trial run at the museum event.

This work was partly funded by a FWF #ConnectingMinds grant to the project Caring Robots // Robotic Care (CM 100-N).

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