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Comparing Intuitions of the Affected and the Non-Affected

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Abstract

The world's population will continue to age significantly in the near future. One strategy to address the growing gap between supply and demand of professional caregivers in many regions is the use of care robots. Although there have been numerous ethical debates about the use of robots in elderly care, the important question of how (potentially) affected people perceive situations with care robots compared to situations with human caregivers has not yet been systematically examined. Using a large-scale experimental vignette study, we investigated the influence of the nature of the caregiver on participants' perceived well-being when confronted with different care situations in nursing homes. Our results show that the views of people already affected by care dependency regarding care robots differ substantially from the views of people not affected by care dependency. The non-affected strongly devalued care robots compared to human caregivers, especially in a service context. This devaluation was not found among those affected; their perceived well-being was not influenced by the nature of the caregiver. These findings also proved robust when controlling for people's attitudes toward robots, gender, and age.

Keywords: Care robots, Elderly nursing care, Robot aversion, Well-being, Vignette experiment

JEL Codes: C83, I12, I31

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1. Introduction

In recent years, the population has been aging rapidly in virtually all countries of the world. Rising life expectancies and falling birth rates are leading to an ever-larger proportion of elderly people [1]. According to the United Nations, these trends are set to continue: Between 2019 and 2050, the number of people over age 65 is expected to double and the number over age 80 to triple [2].

The expected demographic shift will inevitably lead to a higher number of people in need of care. Although some octogenarians can keep up with the physical and mental abilities of twenty-year-olds, older age is usually accompanied by a decline in mobility and sensory, cognitive, and immunological functions [3]. Consequently, elderly people have growing health needs, are more frequently affected by multiple health problems and suffer more often from chronic diseases than young people [3]. For some, this leads to health conditions in which they need help from others to perform activities of daily living[5], i.e., care dependency [3]. Accordingly, the OECD estimates that the number of elderly people in need of care will increase by 100 million globally between 2015 and 2030 [1].

Currently, a large proportion of people in need of care are cared for at home, mostly by female family members as informal caregivers [3]. However, in many parts of the world, established gender norms that saw the key role of women as caretakers of children and elderly family members are changing. In addition, family sizes are decreasing, increasing numbers of older people are living alone, and the physical distance between adult children and their parents is often greater than in the past [3] . Taken together, these developments are increasingly limiting the ability of families to care for older relatives at home [3]. The demand for support from paid long-term care services, including nursing homes and long-term care facilities will therefore increase [1]. At the same time, however, the number of new entrants to the nursing profession is falling, especially in elderly care [5], and employees often leave the profession early due to working conditions that cause high physical and psychological stress [6]. The availability of specialized caregivers is therefore increasingly insufficient in many regions of the world, with

[5] Activities of daily living refer to recurring activities for the fulfilment of basic physical and psychological human needs and range from basic self-care tasks such as personal hygiene, eating and drinking, functional mobility (e.g. getting in and out of bed), to instrumental activities required for independent living, such as shopping, taking medication, managing finances, preparing meals [4] .

several countries already facing a shortage of healthcare personnel to care for their aging populations [2].

Care robots as supplement to human caregiving

One strategy to meet the challenges of an increasing gap between the demand and supply of professional caregivers in an aging society could be the use of assistive technologies and robotics to supplement human caregiving. Care robots are often presented as an attractive technological solution to mitigate the problems of structural demographic change and alleviate the shortage of nursing staff [7]. However, there have been numerous debates about the use of robots in elderly care in recent years. The scenarios discussed range from very optimistic visions of the future, which portray care robots as new family members, fully integrated into society [8], to extremely negative dystopias, in which robotic devices represent the decline of humane and empathic care [9, 10]. The main ethical concerns include the worry that care robots could lead to increased social isolation, reduced well-being, and violation of the dignity of care-recipients [11–13]. Accordingly, "mechanical care" by robots is considered "unworthy" and "not genuine" care, as interpersonal and social aspects of human care would be missing [7, 14].On the other hand, robot devices could possibly improve the autonomy of elderly people, for instance by reducing their dependence on other people for basic activities of daily living, such as bathing or toileting [15, 16]. Shifting routine tasks to robots could also possibly allow human caregivers to focus more on emotional and interpersonal aspects of care. Thus, the use of care robots could even have a positive impact on the sense of dignity and well-being of people in need of care [16, 17].

Purpose of the present research

Although considerable attention has been given to the question of whether the use of care robots increases or decreases human well-being, the important question of how people perceive care situations with care robots *compared* to a situation with human caregivers has not yet been systematically investigated.

Existing research on the acceptance of care robots has so far focused primarily on conceivable areas of application and the influence of design features (e.g. appearance or size) and characteristics of specific robots (e.g. communication style or behavior) or on cognitive and behavioral attitudes (see, for instance, Whelan, Murphy, Barrett, Krusche, Santorelli, Casey [18] for a recent literature review). Moreover, care robot acceptance is often evaluated under the premise that their use could prevent a move to a nursing home in old age. What has not been studied so far, however, are people's affective attitudes (i.e., their feelings or emotions) toward care robots compared to human caregivers and thus the extent to which the nature of the caregiver influences people's *perceived* well-being particularly in the context of nursing homes.

Using a large-scale experimental vignette study, we therefore investigate the influence of the nature of the caregiver on the perceived well-being of participants, when they are confronted with different care situations in nursing homes. Vignettes have long been used in social sciences and nursing research [19] and are considered "a valuable technique for exploring people's perceptions, beliefs and meanings about specific situations" [20].

As outlined above, the development of robots that can perform caregiving tasks is often rejected in public discourse as inhumane and inappropriate. Our study provides important insights into whether people who might be affected by care dependency later in life and those who are already in need of care share this intuition. A better understanding of people's perceptions of potentially useful technologies - especially of those who are already affected by care dependency - could encourage their use to alleviate the problem of caregiver shortages in aging societies.

In the following section, we give an overview of related work and derive our research hypotheses. Section 3 describes the methods used in our study, including the vignette design, the measures, participants and procedure, and materials. In section 4, we present the study results. Their implications are discussed in Section 5, and the final section provides the conclusion.

2. Related work and hypotheses

General attitudes toward care robots

Discussions in the area of care robot acceptance are so far mostly based on surveys, small-sample qualitative studies, such as focus group interviews, or trial studies [21]. Results vary widely by sample (e.g., convenience, elderly, or healthcare professionals), type of robot (e.g., social, assistive, or companion), context (e.g., nursing home, hospital, or own home), and type of study (e.g., quantitative, qualitative, or trial study). People are often asked in very general terms whether they could "in principle imagine being cared for by robots", often on the premise that this would allow them to live in their homes longer in old age rather than moving into a nursing home, to which many respond in the affirmative [22–24]. In their systematic literature review of attitudes toward social robots in general, Naneva, Sarda Gou, Webb, Prescott [25] conclude that people tend to have mildly positive attitudes toward social robots and would not be averse to interacting with them should the opportunity arise. When asked about their perceptions and attitudes toward the specific use of assistive robots for the elderly, however, Plaschka, Sawchuck, Orr, Bailey, Waterhouse, Livingston [26] found in a scoping review very mixed reactions, with only one of the reviewed studies finding no overall negative attitude or rejection toward assistive and care robots. Also, Frennert, Aminoff, Östlund [7] note that study findings regarding the views of healthcare professionals and elderly people on care robots are inconclusive. While reduced dependence on caregivers or family members and thus increased autonomy for elderly robot users are perceived as positive, negative responses often relate to safety concerns and ethical considerations [26]. The latter include concerns that care robots could socially isolate older people, limit their self-determination, threaten their self-efficacy, deprive them of social recognition and violate their dignity [9, 12, 23, 27].

The Eurobarometer, a large-scale survey of nearly 28,000 respondents in EU member states, shows that EU citizens generally have a positive attitude toward robots and see them as a good thing for society, as "they help people do their jobs or carry out daily tasks at home" [28]. However, the proportion of respondents with a positive attitude toward robots has been declining since 2012, indicating a clear negative trend in public opinion toward robots [29]. Also, most respondents would not be comfortable with robots providing services and companionship in old age, nor with their use in caring for children, the elderly, and the disabled, and they believe they should be banned from these areas of life altogether [28, 30, 31]. A survey by the non-partisan Pew Research Center shows that U.S. Americans also have a rather negative attitude toward care robots: Most respondents said they would not be interested in using a care robot for themselves or a family member if they had the option. The most frequently cited reason is that it would reduce human contact and interaction. Similarly, the majority of respondents assume that older adults would feel more isolated by using care robots [32].

Given the above empirical evidence and ethical deliberations, we hypothesized that, in direct comparison with human caregivers, care robots would be perceived less positively than their human counterparts and formulated our first hypothesis:

H1: People's perceived well-being with care robots is lower than with human caregivers.

Influence of the care situation on perceived well-being

The existing literature further suggests that people discriminate in their robot acceptance for different care tasks. The use of robots to perform daily routine activities in nursing homes finds approval, as this could reduce the workload of human caregivers [22, 33]. However, robots that provide services for care recipients, such as picking up and carrying things [23, 33, 34], or bringing drinks and food [33, 35], are also accepted. Surprisingly, Smarr, Mitzner, Beer, Prakash, Chen, Kemp, Rogers [24] found that the older participants in their study would even prefer robot assistance over human assistance for service tasks such as doing household chores, moving items, providing news, or reminding people of their appointments. Study participants also perceived the management of emergency situations, such as calls for help in the event of a fall as conceivable tasks for assistance robots. The same was true for reminder and monitoring functions, e.g. for taking medication or measuring blood pressure. [23, 34, 36].

In contrast, tasks which would involve social interaction or physical contact with a robot are mostly not appreciated. For example, in the studies by Lehmann, Ruf, Misoch [23]and Smarr, Mitzner, Beer, Prakash, Chen, Kemp, Rogers [24], social interaction with a robot, like having a conversation, was hardly imaginable for most participants. Social interaction with robots was strongly rejected by elderly people, especially when this was the main function of the robot [27]. However, nursing and medical students in the study by Łukasik, Tobis, Kropińska, Suwalska [36] considered social functions such as encouraging contact with friends to be useful for a care robot, as this could help elderly people feel less lonely and thus improve their mood. Robot assistance for nursing activities "on humans", such as personal hygiene is usually strongly rejected, especially by older people and caregivers [22–24, 34]. Surprisingly, however, the elderly participants in an experimental study by Beedholm, Frederiksen, Frederiksen, Lomborg [37] did not fundamentally reject the use of a robotic bathtub with human assistance, but did not find the tested application useful. Patient bathing is a significant part of nursing care, because washing the body is one of the most complex activities of daily living and thus among the first that elderly people can no longer perform independently [38]. However, help with personal hygiene is also a very intimate process and therefore often seen as a "shameful" activity, as it involves intimate physical contact with another person. Under certain circumstances, assistance from a technical device could therefore well be perceived as less "shameful" and there are indications that older people could imagine using a robot for personal care [22]. However, as Klein, Graf, Schlömer, Roßberg, Röhricht, Baumgarten [22] point out, there should be a particularly high level of trust between caregiver and care recipient for personal care activities. Based on the above literature, it is questionable whether care robots can elicit this level of trust in humans.

Taking our hypothesis on people's general attitudes toward care robots (H1) and the presented findings on the perception of robots in different care situations, we expected that an intimate scenario will have a more pronounced negative impact on a person's perceived well-being with a robot caregiver as compared to a non-intimate scenario. Accordingly, we formulated our second hypothesis:

H2: People's perceived lower well-being with care robots is more pronounced in an intimate scenario than in a non-intimate scenario.

Influence of the temporal distance to the onset of care dependency

Using text vignettes participants were asked to put themselves in two different nursing care situations. This method requires participants to have the ability to imagine. We conducted our study online using a U.S. convenience sample from CloudResearch's Prime Panels. Despite increased diversity, participants in online experiments are still generally younger than the average U.S. population and largely younger than 60 years old [39]. Given the expected age of our study participants, we anticipated that the need for long-term care may be a purely hypothetical situation for them, as most do not expect to face care dependency until the distant future. Anticipating how they would then feel in the described scenarios might therefore be very difficult for them and bias results. To enhance participants' ability to put themselves in the described care situations, it seems reasonable to include care scenarios that occur in the near future.

Yet, the development of care robots is still in its infancy, and the technology is neither fully mature nor widely available. Therefore, one might also argue that the idea of being cared for by a robot "tomorrow" might seem overly modernistic to our participants. Consequently, participants might be more willing to engage with the idea of being cared for by robots in the more distant future. Confrontation with vignettes perceived as implausible may influence participants' answers to pay less attention to the vignette dimensions causing the implausibility, thus negatively affecting data validity [40]. This, in turn, leads to an argument for also placing the care situations in the more distant future.

Because it is unclear whether (and if so, which) of the two opposing effects dominates the other, we did not formulate a hypothesis about the influence of the described temporal distance to the onset of care dependency.

3. Methods

3.1. Vignette design

The experiment used a 2 x 2 x 2 mixed-design and a text vignette methodology, featuring two between-subjects manipulations and one within-subjects manipulation. As between-subjects manipulations, we chose the nature of the caregiver and the time perspective, according to which the vignettes described either a *human* or a *robot* caregiver and that the care situations would take place either *tomorrow* or *in 25 years*.

We systematically varied the nature of the caregiver – "human" vs. "robot" – to test whether and how this influences people's perceived well-being. We defined a care robot according to its field of application (nursing home), intended use (care practices), and intended users (individuals in need of care), thus not limiting ourselves to a particular appearance or type of robot. To increase participants' ability to empathize with the described care situations (temporal proximity) on the one hand, and to mitigate possible biases due to perceived implausibility (maturity of care robots) on the other, we further systematically varied the time perspective, so that half of our vignettes described care situations taking place "tomorrow," while the other half described these situations as taking place "in 25 years." This resulted in four experimental conditions to which participants were randomly assigned – *human* × *tomorrow* (henceforth "H0"), *human* × *in 25 years* ("H25"), *robot* × *tomorrow* ("R0"), *robot* × *in 25 years* ("R25") (see Table 1).

We designed the intimacy of the care situation as a within-subjects manipulation and presented each participant with two scenarios: one describing an intimate *care scenario* (help with personal hygiene) and one describing a non-intimate *service scenario* (getting something to drink). To address issues of ordering, we balanced the study so that the two scenarios were shown in a randomized order.

Table 1
Overview of experimental design.

	Between subjects			
	Human × Tomorrow	*Human × In 25 years*	*Robot × Tomorrow*	*Robot × In 25 years*
Within subjects*	Service	Service	Service	Service
	Care	Care	Care	Care
Condition	H0	H25	R0	R25

** Shown in randomized order*

3.2. Measures

Perceived level of comfort

Participants' well-being was assessed based on their self-reported perceived level of comfort in the described care situations. For each of the two vignettes, participants rated the statement "I feel comfortable in the described situation" on a 7-point Likert scale from 0 (*completely disagree*) to 6 (*completely agree*).

Demographic factors

Studies on robot acceptance generally show that men and younger people have more positive attitudes toward robots than women and older people [28, 32, 41]. Surprisingly, a systematic literature review on social acceptance of robots by Savela, Turja, Oksanen [21] found that older people had more often a positive than a negative attitude toward the use of assistive robots in elderly care in the studies reviewed. Honekamp, Sauer, Wache, Honekamp [33] assume that many older people already have a need for support, e.g., if they are in need of nursing care, that could be met by new assistive technologies, which is why they may see a concrete benefit in their use and thus have a more positive attitude toward these technologies. For these reasons, we not only asked participants to indicate their age and gender, but also their care dependency status. The latter was queried via a self-assessment with the closed question "Are you in need of nursing care?"

Attitudes toward robots

Attitudes toward robots are also found to correlate with people's experience with them. Therefore, the acceptance of robots might be higher among men and younger people because they are often more familiar with new technologies and thus have a more positive attitude toward them than women and older people. Accordingly, there are indications that attitudes toward robots could mediate the influence of sociodemographic factors on the acceptance of care robots [42]. To control for a potential influence of participants' general attitudes toward robots on their comfort ratings, we therefore included the English version of the Negative Attitudes toward Robots Scale (NARS) by Nomura, Suzuki, Kanda, Kato [43] in the post-experimental questionnaire. This 14-item self-report inventory is the most widely used psychometrically validated scale for assessing the social acceptability of robots [44]. The NARS consists of three sub-scales: *Negative Attitudes toward Situations of Interaction with Robots* (hereafter referred to as the *NARS.Interaction*; an example item reads: "I would feel nervous operating a robot in front of other people"), *Negative Attitudes toward the Social Influence of Robots* (*NARS.Influence*; "I feel that if I depend on robots too much, something bad might happen") and *Negative Attitudes toward Emotions in Interactions with Robots* (*NARS.Emotions*; "I would feel relaxed talking with robots"). Each item was rated on a 5-point Likert scale, with anchors of 1 = *strongly disagree* and 5 = *strongly agree*. Three items on the scale are positively worded; for these, the scores are reversed, so that higher scores reflect more negative attitudes (see questionnaire in Appendix A).

3.3. Participants and procedure

The experiment was conducted online in June 2020 using the survey tool SoSci Survey [45]. Participants were volunteers recruited from the platform CloudResearch's Prime Panels [39]. Online research platforms such as CloudResearch have been widely used in the social sciences, as they have been shown to be a reliable and valid source of experimental data across a variety of tasks and countries [46–49]. In terms of age, family background, religiosity, education, and political views, Prime Panel participants are more diverse and more representative of the U.S. population than, for example, MTurk participants or traditional university subject pools [39]. Using SoSci Survey, participants were randomly assigned to one of the four conditions H0, H25, R0, or R25 (see Table 1). Multiple participation was precluded by CloudResearch. The participants were introduced to the two vignettes about care situations and for each situation, they rated their perceived level of comfort. After the experimental task, participants' attitudes toward robots were assessed. As the last step, participants were asked to fill out a questionnaire including items on gender, age, and care dependency status. In addition to these, participants also responded to a list of additional questions not related to this study. Overall, the study took about 20 minutes and participants were compensated a fixed amount of $1.75 for completion.

Out of 1,413 people who opened the questionnaire, 140 (9.9%) failed to complete it. The remaining 1,273 participants were included in our analysis. They ranged in age from 18 to 92 years (M = 47.27, SD = 18.25) with nine participants reporting no age and 12 reporting either no or a diverse gender. Due to this small number, we limited our analysis to the binary gender categories. 114 participants reported being in need of nursing care at the time of the experiment, 73.7% (84) of whom were male. See Table 2 for sample characteristics.

Table 2

Socio-demographic characteristics.

Baseline characteristic	H0		H25		R0		R25		Full sample	
	n	%	n	%	n	%	n	%	n	%
Gender										
Female	169	57.3	213	62.6	181	58.4	193	58.8	756	59.4
Male	122	41.4	123	36.2	129	41.6	131	39.9	505	39.7
In need of nursing care [a]	25	8.5	32	9.4	29	9.4	28	8.5	114	9.0

Note. N = 1,273. Participants were on average 47.3 years old (SD = 18.3), and participant age did not differ by condition. Nine participants did not report their age, and 12 participants did not report their gender.

[a] Reflects the number and percentage of participants answering "yes" to this question.

A total of 635 participants read the vignettes with a *human caregiver* and 638 the ones with a *care robot*. Of these, 340 and 328 participants, respectively, were assigned to the time perspective "*in 25 years*", while the remaining participants were assigned to the time perspective "*tomorrow*". Each participant saw two care situations: One describing an intimate care scenario and one describing a non-intimate service scenario (see Table 1).

3.4. Materials

For this study, we used a text vignette methodology to evaluate people's attitudes toward care robots compared to human caregivers. Participants were introduced to the vignettes by asking them to put themselves in the situation of unexpectedly becoming in need of nursing care and having to move to a long-term care facility (see Appendix A for the complete wording of the vignettes). The introductory text explained that in this care facility, human caregivers and care robots share the work. As outlined in 3.1, participants were randomly assigned to one of the four described conditions (see Table 1), so that approximately half of the participants read that this situation would occur tomorrow and the other half that it would occur in 25 years. About half of each group read that a human caregiver was responsible for their ward, while the other half read that they would live in a ward with a care robot. It was emphasized that their attitude toward the caregiver responsible for them was of particular interest. This was done to bring the nature of the caregiver into the participants' focus for the subsequent questions. Participants then read the two vignettes that featured the same two characters: a caregiver and a care-recipient (the participant). One vignette described an intimate care scenario of the care-recipient being helped with personal hygiene by the caregiver (*care scenario*). The other vignette dealt with a non-intimate service scenario in which the care-recipient receives a glass of water and is nudged by the caregiver to drink something (*service scenario*). The vignettes neither specified to participants what kind of robot or appearance to consider, nor did they determine any characteristics of the human caregiver.

4. Results

In the first step of our analysis, we investigated the influence of the nature of the caregiver (human vs. robot, H1) on comfort levels. Secondly, we evaluated the interactive influence of caregiver and scenario (H2) and of caregiver, scenario, and time perspective on perceived comfort. In both steps of analysis, we used two-sided non-parametric Wilcoxon rank-sum tests for the independent conditions (i.e., analyses of the effects of the nature of the caregiver and time perspective) and Wilcoxon signed-rank tests for the dependent conditions (i.e., analyses including the scenarios). Following the non-parametric analysis, we applied regression analyses to assess the robustness of our results by including the demographic factors age, gender and care dependency status, and participants' attitudes toward robots as covariates.

4.1. Main effects

On average, participants reported feeling comfortable in the care situations (M = 4.05, SD = 1.54). The main effects on participants' comfort can be inferred from Fig. 1.

Nature of the caregiver

However, as predicted, participants in the robot conditions expressed a significantly lower comfort level (*M* = 3.71, *SD* = 1.72) than in the human conditions (*M* = 4.39, *SD* = 1.25) ($p < .001$, *d* = 0.45), supporting H1.

Intimacy of the scenario

First, we found that the order in which the scenarios were presented had no impact on participants' comfort ratings. We therefore merged the data from the two orderings in our analyses. Comparing the two scenarios revealed a significantly higher comfort level in the non-intimate service scenario (*M* = 4.45, *SD* = 1.16) than in the intimate care scenario (*M* = 3.65, *SD* = 1.16) ($p < .001$, *d* = -0.46).

Concerning the interactive influence of caregiver and scenario, we found that in the care scenario, participants reported significantly higher comfort levels with a human caregiver (*M* = 3.93, *SD* = 1.25) than with a care robot (*M* = 3.37, *SD* = 1.06, *d* = 0.31, $p < .001$), as did participants in the service scenario with a human caregiver (*M* = 4.84, *SD* = 1.25) in contrast to participants with a care robot (*M* = 4.06, *SD* = 1.06, *d* = 0.50, $p < .001$). Fig. 1 summarizes our findings. However, the difference between reported comfort levels for human and robot caregivers was smaller in the care scenario (0.56) than in the service scenario (0.78), refuting H2.

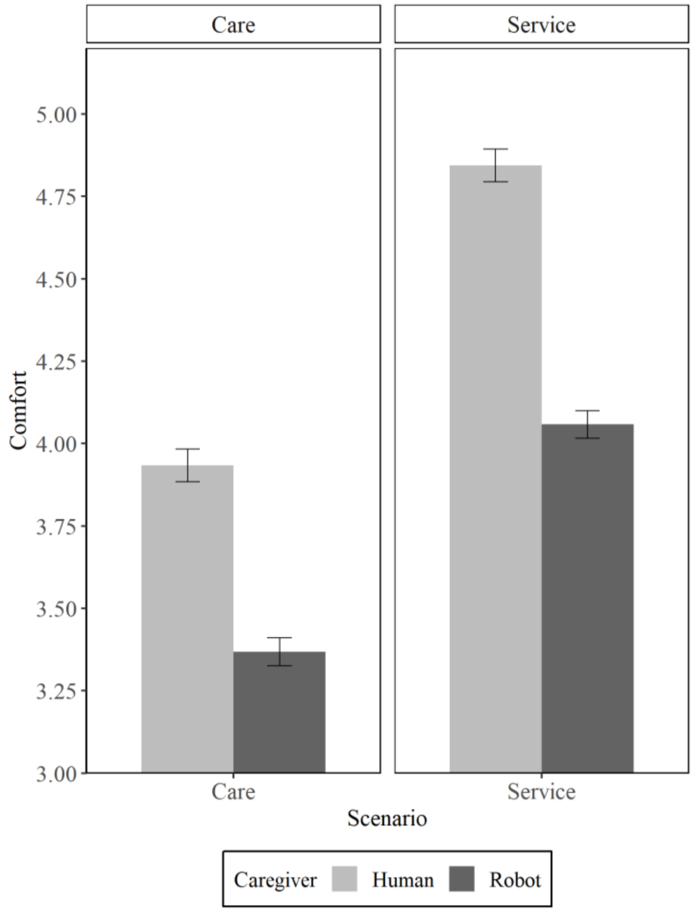

Fig. 1 Perceived comfort depending on caregiver and scenario.

Time perspective

The time of onset of the need for nursing care (time perspective) did not significantly affect participants' comfort level. It neither significantly affected participants' comfort levels in interaction with the caregiver, nor in interaction with both the caregiver and the scenario (see Table B.1 in Appendix B for the respective *p*-values). We therefore no longer distinguished between the time perspectives (tomorrow vs. in 25 years) in the subsequent analyses.

4.2. Robustness checks

Subsequently, we conducted a series of multiple regression analyses with the comfort level as dependent variable. We aimed to explore the potential impact of demographic characteristics (age, gender, care dependency status) as well as participants' attitudes toward robots on their perceived comfort. For the further analysis, the dichotomous variables were dummy coded as specified in Table 3.

Table 3
Designation of dummy-coded, dichotomous independent variables.

Variable	**Category** (Variable Value = 1)	**Reference Category** (Variable Value = 0)
Caregiver	Robot	Human
Scenario	Care Scenario	Service Scenario
Care Dependency Status	Care-Dependent	Non-Care-Dependent
Gender	Female	Male

We started by replicating our non-parametric findings concerning the main effects of the caregiver and scenario on comfort. Consistent with our previous results, the nature of the caregiver (Robot, see Model 1 in Table 4) and the intimacy of the scenario (Care Scenario, see Model 2) were significant predictors of comfort. Model 3 further shows a significant interaction effect of the caregiver and the scenario (Robot × Care Scenario). First, this indicates that the specific nature of the caregiver had a different influence on participants' perceived comfort in the two scenarios and, second, that this influence was less negative in the care scenario. Taken together, this reinforces our previous findings regarding H1 and H2.

Table 4
Regression results for experimental manipulation.

Independent Variable	*Dependent Variable: Comfort*		
	(1)	(2)	(3)
Robot	-.676***		-.786***
	(.084)		(.088)
Care Scenario		-.800***	-.910***
		(.046)	(.070)
Robot × Care Scenario			.221**
			(.092)
Constant	4.389***	4.450***	4.844***
	(.045)	(.045)	(.052)
Observations	2,546	2,546	2,546
Participants	1,273	1,273	1,273
Adjusted R^2	.035	.050	.085

Note: ***p* < .05; ****p* < .01
Robust standard errors, clustered at the individual subject level are shown in parentheses. In all models, the dependent variable is the degree of comfort, subjects claimed to feel in the described situation. Each subject evaluated two situations: An intimate situation (help with personal hygiene, referred to as *care scenario*) and a non-intimate situation (getting something to drink, *service scenario*).

Influence of age and gender

To test the influence of demographic factors on participants' perceived comfort, we split the dataset by scenario and included age, gender, and care dependency status as control variables in the regression (see Table 5). This confirmed a significant negative effect of the care robot on perceived comfort in both scenarios (see Table 5, *Robot* in all models). It also revealed that age and gender of the participants had a different influence on comfort levels across scenarios and caregivers. In the care scenario, older participants reported significantly lower comfort with a care robot than younger participants (see Table 5, *Robot* × *Age* in model 2) and female participants felt significantly less comfortable than males, regardless of the caregiver (see Table 5, *Female* and *Robot* × *Female* in models 1 and 2). In the service scenario, comfort ratings of older participants were significantly higher than those of younger participants for a human caregiver, but significantly lower for a care robot (see Table 5, *Age* and *Robot* × *Age* in model 4). In contrast to the care scenario, the comfort ratings of women and men in the service scenario differed significantly only with a care robot but not with a human caregiver, with female participants again feeling less comfortable than male participants (see Table 5, *Female* and *Robot* × *Female* in model 4).

Table 5
Influence of caregiver and controls on comfort.

Independent Variable	*Dependent Variable: Comfort*			
	Care Scenario		Service Scenario	
	(1)	(2)	(3)	(4)
Robot	-.576***	-.598***	-.797***	-.638***
	(.101)	(.168)	(.088)	(.148)
Age	-.144***	.038	.045	.145***
	(.051)	(.066)	(.043)	(.050)
Female	-.398***	-.375***	-.007	.188
	(.106)	(.143)	(.093)	(.115)
Care-Dependent	1.085***	.870***	.532***	.170
	(.151)	(.207)	(.151)	(.194)
Robot × Age		-.373***		-.206**
		(.101)		(.087)
Robot × Female		-.032		-.375**
		(.211)		(.184)
Robot × Care-Dependent		.459		.747**
		(.298)		(.291)
Constant	4.075***	4.081***	4.804***	4.719***
	(.097)	(.116)	(.082)	(.097)
Observations	1,256	1,256	1,256	1,256
Adjusted R^2	.079	.089	.067	.080

Note: $^{**}p < .05$; $^{***}p < .01$
Robust standard errors are shown in parentheses. The metric variable *Age* was standardized before performing the regression analysis.

Influence of care dependency

The inclusion of participants' care dependency status (*Care-Dependent*) in the regression analyses revealed a remarkable positive influence of one's own experience with care dependency on perceived comfort in both scenarios. In the care scenario, regression coefficients indicate that care-dependent participants generally felt significantly more comfortable than participants without experience with the need of nursing care, both with a human caregiver and with a care robot. In the service scenario, there was no general difference between care-dependent and non-care-dependent participants regarding the human caregiver. However, with a care robot, care-dependent participants felt significantly more comfortable (see Table 5, *Care-Dependent* in all models and *Robot* × *Care-Dependent* in models 2 and 4).

Based on these findings, we examined the specific influence of care dependency on perceived comfort with care robots in more detail. Numeric values (averages and corresponding *p*-values of non-parametric tests) can be inferred from Table B.2 in Appendix B. Table B.2 and Fig. 2 show that care-dependent participants reported significantly higher comfort levels than non-care-dependent participants, in general (regardless of the nature of the caregiver and the intimacy of scenario); with both a human caregiver and a care robot (regardless of the intimacy of scenario); with a care robot in both scenarios and with a human caregiver in the care scenario. Furthermore, we found that in both scenarios, the comfort levels of care-dependent participants did not differ significantly between human caregivers and care robots. Contrary to this, non-care-dependent participants rated their comfort with a care robot significantly lower than their comfort with a human caregiver in both scenarios.

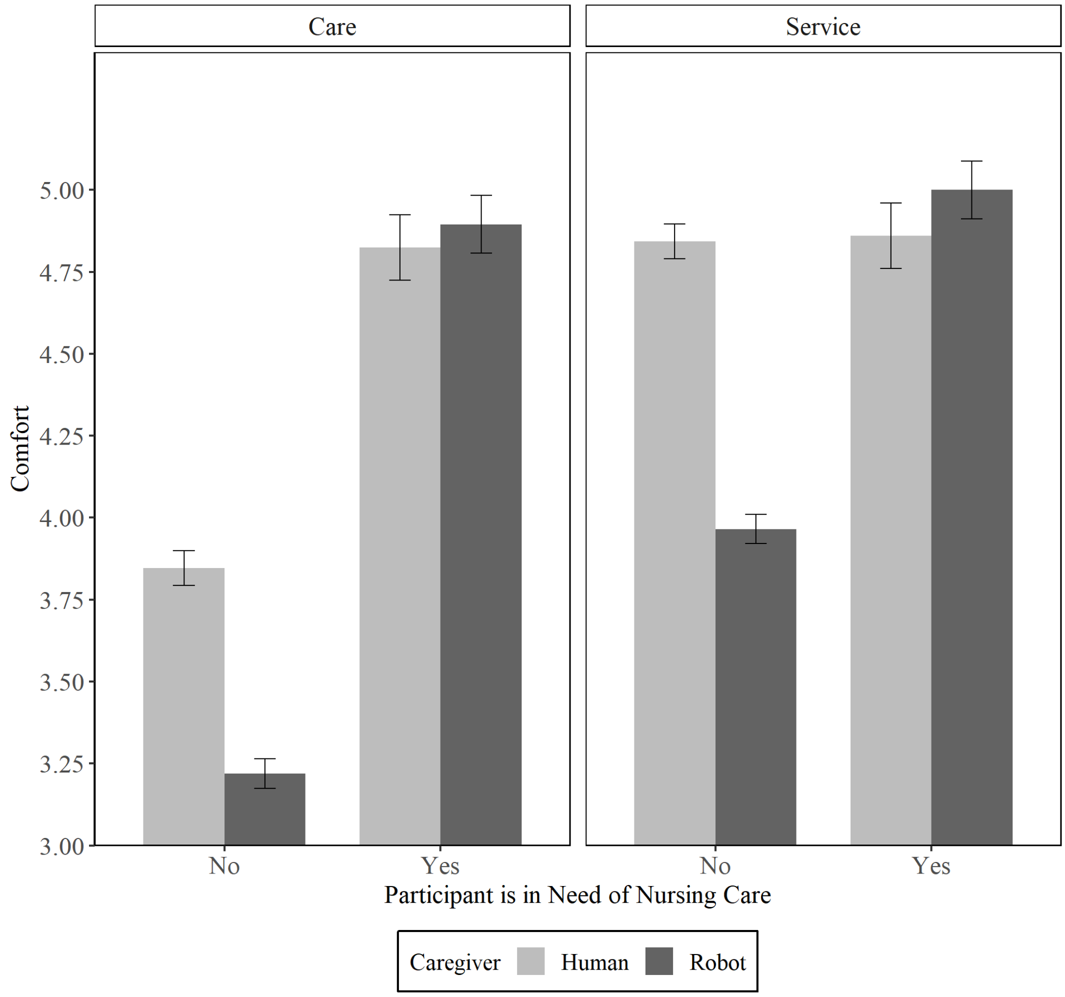

Fig. 2 Perceived comfort of participants depending on need for nursing care, caregiver, and scenario.

Influence of attitudes toward robots

Finally, we evaluated the robustness of our findings for the care robot condition by controlling for participants' robot aversion. Based on participants' responses to the Negative Attitudes toward Robots Scale (NARS) [43], we first performed a reliability analysis of the three subscales using Cronbach's Alpha. One item was removed from each of the NARS.Interaction and NARS.Influence scales due to low item-total-correlation[6]. Due to the very small number of missing answers for the other items, these were imputed with the corresponding item mean[7]. The revised scales showed good internal consistency with Cronbach's Alphas of $\alpha = 0.85$ for NARS.Interaction, $\alpha = 0.76$ for NARS.Influence and $\alpha = 0.80$ for NARS.Emotions. The

[6] Issues with these two items (7: "The word 'robot' means nothing to me" and 14: "I feel that in the future, society will be dominated by robots") are consistent with the results of other studies that have used NARS in Western societies (50–52). Pochwatko, Giger, Różańska-Walczuk [50], for instance, concluded that item 7 may be outdated, while item 14 may be culturally biased due to the different levels of robot exposure in different countries, which could lead to a different perception of the possible future role of robots in society.

[7] One participant who did not respond to any of the NARS items was removed from the data set for this part of the analysis.

subscale scores were then calculated as sums of the corresponding items as suggested by Nomura, Kanda, Suzuki [53].

High scores on the NARS.Interaction and NARS.Emotions scales—i.e., strongly negative attitudes toward situations of interaction with robots and toward emotions in interactions with robots, respectively—significantly reduced participants' perceived comfort with a care robot in both scenarios (see Table 6, *NARS.Interaction* and *NARS.Emotions* in models 2 and 4). However, participants' scores on the NARS.Influence scale, i.e., their level of negative attitudes toward the social influence of robots, did not have a significant effect (see Table 6, *NARS.Influence* in models 2 and 4). Controlling for participants' attitudes toward robots almost completely mitigated the influence of age and gender on perceived comfort with care robots (see Table 6, *Age* and *Gender* in models 2 and 4). Only in the care scenario there was a significant difference in comfort ratings, with older participants feeling significantly less comfortable than younger participants. In the service scenario, we did no longer find any age effect and in none of the scenarios we found a significant difference in comfort ratings between women and men. Although controlling for attitudes toward robots also mitigated the impact of care dependency on perceived comfort, care dependency still significantly influenced participants' comfort ratings with care-dependent participants feeling more comfortable in both scenarios (see Table 6, *Care-Dependent* in models 2 and 4).

Table 6

Influence of age, gender, care dependency and NARS on perceived comfort with a care robot.

Independent Variable	*Dependent Variable: Comfort*			
	Care Scenario		Service Scenario	
	(1)	(2)	(3)	(4)
Care-Dependent	1.329***	.736***	.917***	.475**
	(.214)	(.209)	(.218)	(.219)
Age	-.331***	-.243***	-.060	.004
	(.075)	(.063)	(.070)	(.062)
Female	-.406***	-.052	-.188	.108
	(.154)	(.137)	(.144)	(.129)
NARS.Interaction		-.364***		-.363***
		(.112)		(.104)
NARS.Emotions		-.966***		-.788***
		(.077)		(.080)
NARS.Influence		.007		-.003
		(.112)		(.108)
Constant	3.482***	3.324***	4.080***	3.944***
	(.121)	(.106)	(.112)	(.101)
Observations	631	631	631	631
Adjusted R^2	.095	.380	.025	.270

Note: **$p < .05$; ***$p < .01$
Robust standard errors are shown in parentheses. Metric variables Age, NARS.Interaction, NARS.Emotions and NARS.Influence were standardized before performing the regression analysis.

Finally, to further examine the differences between participants who reported being in need of nursing care and those who did not, we divided the data set according to people's care dependency status (see Table 7). This division revealed differences in the influence of *age*, *NARS.Interaction* and *NARS.Emotions* on perceived comfort: In the care scenario, older non-care-dependent participants felt significantly less comfortable than younger participants (see Table 7, *Age* in model 2), whereas the comfort of care-dependent participants was not affected by their age (see Table 7, *Age* in model 1). In contrast, in the service scenario, older care-dependent participants felt significantly more comfortable than younger participants (see Table 7, *Age* in model 3), while there was no difference among non-care-dependent participants (see Table 7, *Age* in model 4). *NARS.Interaction* significantly influenced non-care-dependent participants' comfort levels, with stronger negative attitudes leading to lower perceived comfort (see Table 7, *NARS.Interaction* in models 2 and 4). *NARS.Emotions* had a significant negative effect on all participants' comfort levels and in both scenarios. However, larger regression coefficients for the care-dependent participants suggest that negative attitudes toward emotions in interaction with robots had a stronger negative impact on their perceived comfort than for non-care-dependent participants (see Table 7, *NARS.Emotions* in all models).

Table 7

Regression results: Robot-scenario-care-dependency-split

Independent Variable	*Dependent Variable: Comfort*			
	Care Scenario		Service Scenario	
	Care-Dependent	Not Care-Dependent	Care-Dependent	Not Care-Dependent
	(1)	(2)	(3)	(4)
Age	.337	-.271***	.605**	-.028
	(.264)	(.065)	(.294)	(.064)
Gender	.092	-.022	.007	.159
	(.508)	(.142)	(.569)	(.134)
NARS.Interaction	.272	-.423***	.148	-.425***
	(.224)	(.119)	(.304)	(.110)
NARS.Emotions	-1.033***	-.935***	-1.015***	-.740***
	(.228)	(.082)	(.282)	(.086)
NARS.Influence	-.188	-.003	-.017	-.030
	(.186)	(.120)	(.249)	(.116)
Constant	3.926***	3.299***	4.229***	3.905***
	(.372)	(.108)	(.451)	(.104)
Observations	55	576	55	576
Adjusted R^2	.339	.351	.300	.261

Note: ***p* < .05; ****p* < .01
Robust standard errors are shown in parentheses. Metric variables Age, NARS.Interaction, NARS.Emotions and NARS.Influence were standardized before performing the regression analysis.

5. Discussion

In the not-too-distant future, many societies will face a large-scale shortage of specialized caregivers due to an aging population and the lack of attractiveness of the nursing profession. One strategy to meet the challenges of the growing gap between the need and supply of professional caregivers is the use of assistive technologies and robots to supplement human caregiving. In current public discourse, the development of robots that can perform caregiving tasks is often rejected as inhumane and inappropriate. The opinion leaders in this discourse are mostly not (yet) themselves affected by care dependency.

In this paper, we provided insights into how people perceive the use of care robots, while controlling for care dependency. We started with the assumption that people's perceived well-being with care robots would be lower than with human caregivers. We also expected that the lower well-being with care robots would be more pronounced in intimate care scenarios than in non-intimate service scenarios and that whether these scenarios occur tomorrow rather than in the more distant future could potentially influence well-being.

Using responses to a large factorial vignette study, we found support for the notion that people prefer human caregivers to robot caregivers. However, the views of participants who are actually in need of care differed significantly from the responses of participants who only imagined being in need of care: while non-care-dependent people strongly devalued care robots compared with human caregivers especially in the service context, care-dependent respondents did not express such a devaluation. In fact, they did not distinguish in their perceived comfort levels between the caregivers' nature and the care scenarios. The fact that the perceived well-being of care-dependent participants was generally higher than the perceived well-being of non-care-dependent participants suggests that their similar evaluation of human and robot caregivers does not stem from a more misanthropic attitude, but from a lower robot aversion. The results proved robust when respondents' attitudes toward robots were considered.

Contrary to our assumption and previous studies (see for instance 33 and 24), robot aversion was stronger for a non-intimate scenario than for an intimate scenario. A possible explanation for this finding could be that the idea of receiving help with personal hygiene is generally rather unpleasant for many people, so that the specific nature of the caregiver has less influence on their well-being than in a more physically distanced service scenario. Moreover, it is possible that imagining being cared for in an intimate situation by a robot that can provide the same level of care as a human (as in our scenario) is perceived as positive for one's privacy, and this mitigates to some extent people's aversion to robots. Further research is needed to disentangle these effects. We further found no evidence that the temporal distance to the onset of care dependency, i.e., whether the described care scenarios occurred tomorrow or in the distant future, had a significant impact on people's perceived well-being.

Our results also indicate that people's general attitudes toward robots influence their acceptance of care robots. First, controlling for participants' attitudes toward robots almost completely mitigated the influence of age and gender on perceived comfort with care robots. Second, strongly negative attitudes toward situations of interaction with robots significantly reduced the perceived well-being of non-care-dependent participants, but not of care-dependent participants. As the latter are likely to have a greater need for support in daily living, they may also be more familiar with the use of assistance technologies in general. As a result, they may also see greater benefit in the future use of care robots than people who do not need assistance [see also 33], and therefore accept interaction with robots as a necessity for autonomy in daily life, even if they do not necessarily like it. Third, participants' attitudes toward emotions in the interaction with robots strongly influenced their perceived well-being with care robots: the intimate caregiving scenario in our study, in particular, is a situation in which people often feel vulnerable, and thus "want to feel respected and cared for" [54]. Our results now suggest that those participants who could imagine that robots could express emotions, such as compassion, and who would perceive this positively (i.e., those with a low score on the NARS.Emotions scale), felt significantly more comfortable than those who could not, in scenarios with care robots. This implies, first, that even though care robots may not be able to provide "genuine" (in the sense of "human") care, they do not necessarily diminish people's well-being. In some circumstances it may be sufficient for a care robot to provide the care recipient with a feeling of being respected and cared for. Second, this underscores that for care robots to be accepted, it may not be enough that they function in a technically correct and reliable manner, but that they should also be able to express some kind of compassion and concern for those in need of care (see also 55) .

Taken together, our most important findings are that (1) care-dependent people are less averse to care robots than often assumed, (2) the attitudes of people toward robots in general and to the social aspects of human-robot interaction in particular play an essential role in their well-being with care robots and (3) that for the acceptance of care robots not only are their technically correct function and reliability important, but also that they have characteristics related to social, "interpersonal" interaction, such as e.g. appearing benevolent and respectful toward the person being cared for.

Limitations and further research potential

A potential limitation of this study is that we used a convenience participant sample. In 2019, the average age of care recipients in the U.S. was 68.4 years, with a median age of 72 years [56]. Thus, although the median age of our sample was 44 years, and therefore higher than the median age of the U.S. population, which was 38.4 years in 2019 [57], the participants were still largely younger than most care recipients. Nevertheless, we chose to use a convenience sample due to the inaccessibility of elderly people in need of nursing care. Given the current constraints of COVID19-pandemic containment, it was impossible to ensure comparable study conditions and perform a random treatment assignment in inaccessible nursing homes. However, as our sample included a substantial proportion of participants who reported being in need of nursing care at the time of the experiment, we are confident that our results are meaningful. Nonetheless, an interesting approach for future work is to survey elderly people in nursing homes to assess their perceptions and experiences with assistive technologies and compare their responses with those of younger respondents who are not yet in need of care.

A second potential limitation is that we conducted our study exclusively with U.S. citizens and did not differentiate between different ethnic groups. However, culture has been found to influence not only people’s health, but also the quality of communication (e.g., in patient-physician encounters) and care [58]. Similarly, views on aging (or "anti-aging") and care of the elderly differ across countries, cultures, and ethnicities, e.g., in terms of whether supporting and caring for the elderly is seen as a societal, family, or individual responsibility [59]. Previous research has further revealed significant influences of people’s cultural background on their attitudes toward robots, their interactions with them, acceptance of and preference for a particular appearance of robots, and conceivable application domains and tasks (see, for instance, 58 for a recent literature review). These country-specific differences may stem from different belief systems and motivations, but also from different experiences with and exposure to robots [60]: While western (pop) culture often serves a message of doom that robots will take over the world, with robots in the role of evil, this is less common in Japanese culture, for example [61]. Cultural differences related to aging, elder care, and attitudes toward technology in general and robots in particular may also influence how people perceive care situations involving human and robot caregivers. Examining the interaction between these factors and perceived well-being therefore opens opportunities for further promising research.

A potential strength of our study design is its quantitative nature. Through the systematic quantitative assessment of participants’ perceived well-being, we are able to concretely illustrate the differences in the perceptions of care-dependent and not care-dependent people when confronted with a robot caregiver. People and policy makers who are not (yet) care-dependent themselves dominate the public debate about the ethicality of the possible use of robots in elderly care. Consequently, it is of utmost importance that those who are not yet affected themselves be informed about the ways in which, and the extent to which, their own views and perceptions of these new technologies differ from the perceptions of those who would currently be potentially affected by the use of the technology. Especially since policymakers, like any other individuals, may tend to project their current affective state onto their future one and thus underestimate how much their own views may change if they themselves become affected by care dependency at some point in the future [62]. For future studies, we encourage conducting more quantitative experiments in the realm of technology acceptance with diverse subject samples.

6. Conclusion

Our study supports the notion that ethical advice to policymakers should not be based solely on the introspective attitudes of ethicists but should systematically focus on the intuitions of the population (see, for instance, 63–65). Our findings suggest that for the ethical assessment of a novel technology, such as care robots, a comprehensive picture of the prevailing intuitions in the population should be obtained. In particular, an explicit consideration of the attitudes of the people who are potentially affected (e.g., people in need of care) by the specific technology is desirable. This is all the more true if the intuitions of those potentially affected differ from those of the rest of the population, as the intuitions of the former may reflect much less pronounced reservations about the use of new technologies. It is precisely the more adequate assessment of the status quo of affectedness, which by definition remains inaccessible to the non-affected, that must be incorporated into an ethical evaluation of a new technology. It should also be a matter of measuring future technologies by their potential for ethically improving the initial situation rather than measuring them exclusively by an ethical potentially unattainable ideal. For such a more realistic assessment, the involvement of those affected proves particularly valuable. A better understanding of how affected people perceive potentially useful care technologies could promote their use to alleviate the societal problem of caregiver undersupply.

References

1. OECD (2019) Health at a Glance 2019: OECD Indicators. OECD Publishing, Paris. https://doi.org/10.1787/19991312
2. United Nations, Department of Economic and Social Affairs, Population Division (2020) World Population Ageing 2019. ST/ESA/SER.A/444, New York, USA. https://www.un.org/en/development/desa/population/publications/pdf/ageing/WorldPopulationAgeing2019-Report.pdf. Accessed 19 Aug 2021
3. World Health Organization (2015) World report on ageing and health. World Health Organization, Geneva, Switzerland
4. South-Paul JE, Matheny SC, Lewis EL (eds) (2020) CURRENT Diagnosis & Treatment: Family Medicine, 5th Edition. A Lange medical book. McGraw-Hill Education, New York, USA
5. Koskinen S, Salminen L, Stolt M et al. (2015) The education received by nursing students regarding nursing older people: a scoping literature review. Scandinavian journal of caring sciences 29:15–29. https://doi.org/10.1111/scs.12135
6. van der Heijden B, Brown Mahoney C, Xu Y (2019) Impact of Job Demands and Resources on Nurses' Burnout and Occupational Turnover Intention Towards an Age-Moderated Mediation Model for the Nursing Profession. Int J Environ Res Public Health 16. https://doi.org/10.3390/ijerph16112011
7. Frennert S, Aminoff H, Östlund B (2020) Technological Frames and Care Robots in Eldercare. Int J of Soc Robotics. https://doi.org/10.1007/s12369-020-00641-0
8. Wagner C (2010) „Tele-Altenpflege" und „Robotertherapie": Leben mit Robotern als Vision und Realität für die alternde Gesellschaft Japans. Japanstudien 21:271–298. https://doi.org/10.1080/09386491.2010.11826998
9. Sparrow R (2016) Robots in aged care: a dystopian future? AI & Soc 31:445–454. https://doi.org/10.1007/s00146-015-0625-4
10. Stösser A von (2011) Roboter als Lösung für den Pflegenotstand? Ethische Fragen. Archiv für Wissenschaft und Praxis der sozialen Arbeit 42:99–107
11. Misselhorn C, Pompe U, Stapleton M (2013) Ethical Considerations Regarding the Use of Social Robots in the Fourth Age. GeroPsych 26:121–133. https://doi.org/10.1024/1662-9647/a000088
12. Sharkey A, Sharkey N (2012) Granny and the robots: ethical issues in robot care for the elderly. Ethics Inf Technol 14:27–40. https://doi.org/10.1007/s10676-010-9234-6
13. Sparrow R, Sparrow L (2006) In the hands of machines? The future of aged care. Minds & Machines 16:141–161. https://doi.org/10.1007/s11023-006-9030-6
14. Graf P, Maibaum A, Compagna D (2020) Pflege-, Therapie- oder Sexroboter? TATuP 29:52–57. https://doi.org/10.14512/tatup.29.2.52
15. Papadopoulos I, Sgorbissa A, Koulouglioti C (2017) Caring robots are here to help. Nursing standard (Royal College of Nursing (Great Britain): 1987) 31:18–20. https://doi.org/10.7748/ns.31.51.18.s22
16. Wachsmuth I (2018) Robots Like Me: Challenges and Ethical Issues in Aged Care. Front Psychol 9:432. https://doi.org/10.3389/fpsyg.2018.00432
17. Sorell T, Draper H (2014) Robot carers, ethics, and older people. Ethics Inf Technol 16:183–195. https://doi.org/10.1007/s10676-014-9344-7
18. Whelan S, Murphy K, Barrett E et al. (2018) Factors Affecting the Acceptability of Social Robots by Older Adults Including People with Dementia or Cognitive Impairment: A Literature Review. Int J of Soc Robotics 10:643–668. https://doi.org/10.1007/s12369-018-0471-x

19. Hughes R, Huby M (2002) The application of vignettes in social and nursing research. J Adv Nurs 37:382–386. https://doi.org/10.1046/j.1365-2648.2002.02100.x
20. Barter C, Renold E (1999) The Use of Vignettes in Qualitative Research. Social Research Update 25:1–4
21. Savela N, Turja T, Oksanen A (2018) Social Acceptance of Robots in Different Occupational Fields: A Systematic Literature Review. Int J of Soc Robotics 10:493–502. https://doi.org/10.1007/s12369-017-0452-5
22. Klein B, Graf B, Schlömer IF et al. (eds) (2018) Robotik in der Gesundheitswirtschaft: Einsatzfelder und Potenziale. medhochzwei, Heidelberg
23. Lehmann S, Ruf E, Misoch S (2020) Robot Use for Older Adults – Attitudes, Wishes and Concerns. First Results from Switzerland. In: Stephanidis C, Antona M (eds) HCI International 2020 - Posters. HCII 2020, vol 1226. Springer, Cham, pp 64–70
24. Smarr C-A, Mitzner TL, Beer JM et al. (2014) Domestic Robots for Older Adults: Attitudes, Preferences, and Potential. Int J of Soc Robotics 6:229–247. https://doi.org/10.1007/s12369-013-0220-0
25. Naneva S, Sarda Gou M, Webb TL et al. (2020) A Systematic Review of Attitudes, Anxiety, Acceptance, and Trust Towards Social Robots. Int J of Soc Robotics 12:1179–1201. https://doi.org/10.1007/s12369-020-00659-4
26. Plaschka C, Sawchuck D, Orr T et al. (2019) Global policies on assistive robots for care of the elderly: A scoping review. IJH 6:63. https://doi.org/10.5430/ijh.v6n1p63
27. Deutsch I, Erel H, Paz M et al. (2019) Home robotic devices for older adults: Opportunities and concerns. Computers in Human Behavior 98:122–133. https://doi.org/10.1016/j.chb.2019.04.002
28. European Commission (2017) Special Eurobarometer 460: Attitudes towards the impact of digitisation and automation on daily life, Brussels
29. Gnambs T, Appel M (2019) Are robots becoming unpopular? Changes in attitudes towards autonomous robotic systems in Europe. Computers in Human Behavior 93:53–61. https://doi.org/10.1016/j.chb.2018.11.045
30. European Commission (2012) Special Eurobarometer 382: Public Attitudes Towards Robots. Digitalisation in Our Daily Lives
31. European Commission (2015) Special Eurobarometer 427: Autonomous systems, vol 427. European Commission Directorate General Communication, Brussels. https://doi.org/10.2759/41391632.
32. Smith A, Anderson M (2017) Automation in Everyday Life. Pew Research Center. https://www.pewresearch.org/internet/2017/10/04/automation-in-everyday-life. Accessed 19 Aug 2021
33. Honekamp I, Sauer L, Wache T et al. (2019) Akzeptanz von Pflegerobotern im Krankenhaus. TATuP 28:58–63. https://doi.org/10.14512/tatup.28.2.s58
34. Pigini L, Facal D, Blasi L et al. (2012) Service robots in elderly care at home: Users' needs and perceptions as a basis for concept development. Technology and Disability 24:303–311. https://doi.org/10.3233/TAD-120361
35. Graf B, Jacobs T (2014) Einsatzpotenziale und Erfahrungen aus der Erprobung von Servicerobotern in stationären Altenpflegeeinrichtungen: Opportunities and experiences of applying service robots in residential elderly care facilities. In: Wichert R, Eberhardt B (eds) Ambient Assisted Living: 5. AAL-Kongress 2012 Berlin, Germany, January 24-25, 2012, Aufl. 2012. Springer Berlin, Berlin
36. Łukasik S, Tobis S, Kropińska S et al. (2020) Role of Assistive Robots in the Care of Older People: Survey Study Among Medical and Nursing Students. J Med Internet Res 22:e18003. https://doi.org/10.2196/18003

37. Beedholm K, Frederiksen K, Frederiksen A-MS et al. (2015) Attitudes to a robot bathtub in Danish elder care: A hermeneutic interview study. Nursing & health sciences 17:280–286. https://doi.org/10.1111/nhs.12184
38. Dunlop DD, Hughes SL, Manheim LM (1997) Disability in activities of daily living: patterns of change and a hierarchy of disability. American journal of public health 87:378–383. https://doi.org/10.2105/AJPH.87.3.378
39. Chandler J, Rosenzweig C, Moss AJ et al. (2019) Online panels in social science research: Expanding sampling methods beyond Mechanical Turk. Behav Res Methods 51:2022–2038. https://doi.org/10.3758/s13428-019-01273-7
40. Augsburg K, Hinz T, Liebig S et al. (2015) The Factorial Survey as a Method for Measuring Sensitive Issues. In: Engel U, Jann B, Lynn P et al. (eds) Improving Survey Methods: Lessons From Recent Research. Routledge, pp 137–149
41. Turja T, van Aerschot L, Särkikoski T et al. (2018) Finnish healthcare professionals' attitudes towards robots: Reflections on a population sample. Nursing open 5:300–309. https://doi.org/10.1002/nop2.138
42. Flandorfer P (2012) Population Ageing and Socially Assistive Robots for Elderly Persons: The Importance of Sociodemographic Factors for User Acceptance. International Journal of Population Research 2012:1–13. https://doi.org/10.1155/2012/829835
43. Nomura T, Suzuki T, Kanda T et al. (2006) Altered Attitudes of People toward Robots: Investigation through the Negative Attitudes toward Robots Scale. In: Proc. AAAI-06 Workshop on Human Implications of Human-Robot Interaction, pp 29–35
44. Krägeloh CU, Bharatharaj J, Sasthan Kutty SK et al. (2019) Questionnaires to Measure Acceptability of Social Robots: A Critical Review. Robotics 8:88. https://doi.org/10.3390/robotics8040088
45. Leiner DJ (2020) SoSci Survey. (Version 3.2.12) [Computer software]. https://soscisurvey.de
46. Hauser DJ, Schwarz N (2016) Attentive Turkers: MTurk participants perform better on online attention checks than do subject pool participants. Behav Res Methods 48:400–407. https://doi.org/10.3758/s13428-015-0578-z
47. Litman L, Robinson J, Abberbock T (2017) TurkPrime.com: A versatile crowdsourcing data acquisition platform for the behavioral sciences. Behav Res Methods 49:433–442. https://doi.org/10.3758/s13428-016-0727-z
48. Litman L, Robinson J, Rosenzweig C (2015) The relationship between motivation, monetary compensation, and data quality among US- and India-based workers on Mechanical Turk. Behav Res Methods 47:519–528. https://doi.org/10.3758/s13428-014-0483-x
49. Paolacci G, Chandler J, Ipeirotis PG (2010) Running experiments on Amazon Mechanical Turk. Judgment and Decision Making 5:411–419
50. Pochwatko G, Giger J-C, Różańska-Walczuk M et al. (2015) Polish Version of the Negative Attitude Toward Robots Scale (NARS-PL). JAMRIS 9:65–72. https://doi.org/10.14313/JAMRIS_3-2015/25
51. Piçarra N, Giger J-C, Pochwatko G et al. (2015) Validation of the Portuguese version of the Negative Attitudes towards Robots Scale. European Review of Applied Psychology 65:93–104. https://doi.org/10.1016/j.erap.2014.11.002
52. Syrdal DS, Dautenhahn K, Koay KL et al. (2009) The Negative Attitudes towards Robots Scale and Reactions to Robot Behaviour in a Live Human-Robot Interaction Study. In: Adaptive and Emergent Behaviour and Complex Systems: Procs of the 23rd Convention of the Society for the Study of Artificial Intelligence and Simulation of Behaviour, AISB 2009, SSAISB, pp 109–115

53. Nomura T, Kanda T, Suzuki T (2006) Experimental investigation into influence of negative attitudes toward robots on human–robot interaction. AI & Soc 20:138–150. https://doi.org/10.1007/s00146-005-0012-7
54. Stuck RE, Rogers WA (2018) Older Adults' Perceptions of Supporting Factors of Trust in a Robot Care Provider. Journal of Robotics 2018:1–11. https://doi.org/10.1155/2018/6519713
55. Stuck RE, McDonald EM, Rogers WA (2018) Older Adult Preferences for Robot Care Providers. Proceedings of the Human Factors and Ergonomics Society Annual Meeting 62:1032–1036. https://doi.org/10.1177/1541931218621238
56. AARP and National Alliance for Caregiving (2020) Caregiving in the United States 2020: Research Report. AARP, Washington, DC
57. United States Census Bureau (2020) Median age of the resident population of the United States from 1960 to 2019. Graph. https://www.statista.com/statistics/241494/median-age-of-the-us-population. Accessed 19 Aug 2021
58. Papadopoulos I, Koulouglioti C (2018) The Influence of Culture on Attitudes Towards Humanoid and Animal-like Robots: An Integrative Review. J Nurs Scholarsh 50:653–665. https://doi.org/10.1111/jnu.12422
59. Kruse A (2009) Altersbilder in anderen Kulturen: Studie in der Reihe „Alter und Demographie". Robert Bosch Stiftung, Stuttgart
60. Broadbent E, Stafford R, MacDonald B (2009) Acceptance of Healthcare Robots for the Older Population: Review and Future Directions. Int J of Soc Robotics 1:319–330. https://doi.org/10.1007/s12369-009-0030-6
61. Bartneck C, Suzuki T, Kanda T et al. (2006) The influence of people's culture and prior experiences with Aibo on their attitude towards robots. AI & Soc 21:217–230. https://doi.org/10.1007/s00146-006-0052-7
62. Loewenstein G, O'Donoghue T, Rabin M (2003) Projection Bias in Predicting Future Utility. The Quarterly Journal of Economics 118:1209–1248. https://doi.org/10.1162/003355303322552784
63. Alexander J (2012) Experimental Philosophy: An Introduction, Cambridge, UK
64. Appiah KA (2009) Experiments in Ethics. The Mary Flexner Lectures of Bryn Mawr College. Harvard University Press, Cambridge, Mass.
65. Lütge C, Rusch H, Uhl M (eds) (2014) Experimental Ethics: Toward an Empirical Moral Philosophy. Palgrave Macmillan UK, London

Appendix A: Questionnaire

1. Introduction

All participants read the following introduction:

Welcome to this questionnaire! We are interested in your views on various situations in nursing care. For this purpose, we will first present you with two short descriptions of the situation and then ask you some questions. Please read the texts carefully and answer the questions conscientiously and truthfully. Answering the questionnaire will take about 20 minutes. Thank you in advance for your participation!

2. Experimental Part

After reading the introduction, participants were randomly assigned to one of four conditions: H0, H25, R0 or R25. Each participant was introduced to the vignettes and subsequently read two vignettes: One dealt with an intimate care situation, in which the caregiver helps with personal hygiene and one with a non-intimate service task, in which the caregiver brings the participants something to drink. The order of the vignettes was randomized. For both vignettes, participants were asked to rate their perceived level of comfort in the described situation (see 2.3).

2.1 Condition: Human Caregiver

2.1.1 Introduction to vignettes

Condition H0

Please put yourself in the following situation: Due to a physical illness, you will unexpectedly be **in need of nursing care tomorrow** and from then on you will need support in various activities of daily living. Therefore, you will move at short notice from your previous place of residence to a **care facility**. In this facility, **human caregivers and care robots** share the work. A **human caregiver** is responsible for your ward.
In the following we are particularly interested in your attitude toward the **human caregiver.**

Condition H25

Please put yourself in the following situation: Due to a physical illness, you will unexpectedly be **in need of nursing care in 25 years** and from then on you will need support in various activities of daily living. Therefore, you will move at short notice from your previous place of residence to a **care facility**. In this facility, **human caregivers and care robots** share the work. A **human caregiver** is responsible for your ward.
In the following we are particularly interested in your attitude toward the **human caregiver**.

2.1.2 Vignettes

Care scenario

In the following we are particularly interested in your attitude toward the **human caregiver**.
One month after moving into the nursing home, you are in your room at 9 am, just like every day at this time, when there is a knock at your door. You invite in. **The human caregiver responsible for your ward** on this morning enters your room and asks you if he*she may **help you with your personal hygiene as usual**. You answer in the affirmative. Since you have difficulty keeping your balance in the bathroom, you are washed in bed. The caregiver places your toothbrush on your usual place on the bedside table. He*She asks you about your preferred body care products and the desired water temperature. You brush your teeth. Meanwhile, the caregiver prepares the necessary care products and towels for washing, helps you to undress and hands you a damp washcloth. You wash your face and upper body yourself. The caregiver then continues with the personal hygiene. He*she turns you on your side and washes your back and buttocks. Then the caregiver washes your legs and intimate area. After washing, the caregiver helps you to get dressed again and to sit comfortably in bed. He*She puts the used care products and towels back into their usual place in the bathroom. The caregiver says goodbye and leaves your room.

Service scenario

In the following we are particularly interested in your attitude toward the **human caregiver**.
One month after moving into the nursing home, you are in your room at 2 pm, just like every day at this time, when there is a knock at your door. You invite in. **The human caregiver responsible for your ward** on this afternoon enters your room and asks if he*she **may bring you something to drink, as usual at this time of day**. You answer in the affirmative. Since you have difficulty keeping your balance when carrying objects, the caregiver brings a drinking glass and a water bottle on a tray to your bed. He*She places the tray on your usual place on the bedside table. He*She pours you some water and hands you the glass. You take a sip. The caregiver reminds you that you have drunk very little on this day so far and suggests that you might drink a little more. You realize that this is true and take another sip. Then, you put the glass down on your bedside table. The caregiver helps you to sit comfortably in bed. He*She says goodbye and leaves your room.

2.2 Condition: Care robot

2.2.1 Introduction to vignettes

Condition R0

Please put yourself in the following situation: Due to a physical illness, you will unexpectedly be **in need of nursing care tomorrow** and from then on you will need support in various activities of daily living. Therefore, you will move at short notice from your previous place of residence to a **care facility**. In this facility, **human caregivers and care robots** share the work. A **care robot** is responsible for your ward.
In the following we are particularly interested in your attitude toward the **care robot.**

Condition R25

Please put yourself in the following situation: Due to a physical illness, you will unexpectedly be **in need of nursing care in 25 years** and from then on you will need support in various activities of daily living. Therefore, you will move at short notice from your previous place of residence to a **care facility**. In this facility, **human caregivers and care robots** share the work. A **care robot** is responsible for your ward.
In the following we are particularly interested in your attitude toward the **care robot**.

2.2.2 Vignettes

Care scenario

In the following we are particularly interested in your attitude toward the **care robot**.
One month after moving into the nursing home, you are in your room at 9 am, just like every day at this time, when there is a knock at your door. You invite in. **The care robot responsible for your ward** enters your room and asks if it may **help you with your personal hygiene as usual**. You answer in the affirmative. Since you have difficulty keeping your balance in the bathroom, you are washed in bed. The care robot puts your toothbrush on its usual place on the bedside table. It asks you about your preferred body care products and the desired water temperature. You brush your teeth. Meanwhile, the caregiver prepares the necessary care products and towels for washing, helps you to undress and hands you a damp washcloth. You wash your face and upper body yourself. The care robot then continues with the personal hygiene. It turns you on your side and washes your back and buttocks. Then the care robot washes your legs and intimate area. After washing, the care robot helps you to get dressed again and to sit comfortably in bed. It puts the used care products and towels back into their usual place in the bathroom. The care robot says goodbye and leaves your room.

Service scenario

In the following we are particularly interested in your attitude toward the **care robot.**
One month after moving into the nursing home, you are in your room at 2 pm, just like every day at this time, when there is a knock at your door. You invite in. The **care robot responsible for your ward** on this afternoon enters your room and asks if it may **bring you something to drink, as usual at this time of day**. You answer in the affirmative. Since you have difficulty keeping your balance when carrying objects, the care robot brings a drinking glass and a water bottle on a tray to your bed. It places the tray on your usual place on the bedside table. It pours you some water and hands you the glass. You take a sip. The care robot reminds you that you have drunk very little on this day so far and suggests that you might drink a little more. You realize that this is true and take another sip. Then, you put the glass down on your bedside table. The care robot helps you to sit comfortably in bed. It says goodbye and leaves your room.

Rating of perceived comfort level

After reading the respective scenario, participants were asked to rate their perceived level of comfort in the described situation on a 7-point Likert scale.

Please indicate the degree to which you agree/disagree with the following statement.	Completely disagree	Largely disagree	Slightly disagree	Neither disagree nor agree	Slightly agree	Largely agree	Completely agree
I feel comfortable in the described situation.							

3. Questionnaires

After completing the experimental part of the study, all participants were shown the following questionnaires

3.1 Negative Attitudes toward Robots Scale (NARS)*

Please indicate the degree to which you agree/disagree with the following statements.		Strongly disagree	Disagree	Undecided	Agree	Strongly agree
01	I would feel uneasy if robots really had emotions.					
02	Something bad might happen if robots developed into living beings.					
03	I would feel relaxed talking with robots.**					
04	I would feel uneasy if I was given a job where I had to use robots.					
05	If robots had emotions, I would be able to make friends with them.**					
06	I feel comforted being with robots that have emotions.**					
07	The word "robot" means nothing to me.***					
08	I would feel nervous operating a robot in front of other people.					
09	I would hate the idea that robots or artificial intelligences were making judgments about things.					
10	I would feel very nervous just standing in front of a robot.					
11	I feel that if I depend on robots too much, something bad might happen.					
12	I would feel paranoid talking with a robot.					
13	I am concerned that robots would be a bad influence on children.					
14	I feel that in the future, society will be dominated by robots.****					

*Note. * Order of items was randomized. **Item was reverse coded for analysis. *** Item was removed from analysis.*

3.1 Need for Nursing Care

Intro: **Now we would like to ask you some questions about the topic "need for nursing care".**

Item	Scale
Are you in need of nursing care?	• Yes • No

3.2 Sociodemographic Questions

Intro: **Finally, we would like to ask you for some personal details.**

Item	Scale
What is your age?	*[Please enter a number]*
What is your gender?	• Male • Female • Other

Appendix B: Descriptive Statistics and Results of Non-Parametric Tests

Table B.1

Non-parametric test results of comfort ratings for the two time perspectives.

			p-value
Time Perspective			
Tomorrow vs. In 25 Years			.246
Caregiver × Time Perspective			
Human	Tomorrow vs. In 25 Years		.678
Robot	Tomorrow vs. In 25 Years		.159
Caregiver × Scenario × Time Perspective			
Human	Care	Tomorrow vs. In 25 Years	.751
Human	Service	Tomorrow vs. In 25 Years	.899
Robot	Care	Tomorrow vs. In 25 Years	.246
Robot	Service	Tomorrow vs. In 25 Years	.529

Table B.2

Comfort and non-parametric test results depending on participants' care dependency status.

			Not Care-Dependent			**Care-Dependent**			**Non-parametric test results**	
			N	Mean	SD	N	Mean	SD	p-value	d
Care Dependency										
			1159	3.97	1.54	114	4.89	1.29	<.001	-0.612
Caregiver × Care Dependency										
Human			578	4.34	1.24	57	4.84	1.25	<.001	-0.401
Robot			581	3.59	1.70	57	4.95	1.35	<.001	-0.810
Caregiver × Scenario × Care Dependency										
Service	Human		578	4.84	1.28	57	4.86	0.76	.90	-0.013
	Robot		581	3.97	1.09	57	5.0	0.66	<.001	-0.583
Care	Human		578	3.85	1.28	57	4.82	0.76	<.001	-0.572
	Robot		581	3.22	1.09	57	4.89	0.66	<.001	-0.886
Caregiver × Care Dependency										
Not Care-Dependent	Human vs. Robot								<.001	0.505
Care-Dependent	Human vs. Robot								.338	-0.081
Caregiver × Scenario × Care Dependency										
Not Care-Dependent	Service	Human vs. Robot							<.001	0.559
	Care	Human vs. Robot							<.001	0.341
Care-Dependent	Service	Human vs. Robot							.261	-0.101
	Care	Human vs. Robot							.766	-0.05

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