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Social Robots for People with Dementia: A Literature Review on Deception from Design to Perception

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Abstract As social robots increasingly enter dementia care, concerns about deception, intentional or not, are gaining attention. Yet, how robotic design cues might elicit misleading perceptions in people with dementia, and how these perceptions arise, remains insufficiently understood. In this scoping review, we examined 26 empirical studies on interactions between people with dementia and physical social robots. We identify four key design cue categories that may influence deceptive impressions: cues resembling physiological signs (e.g., simulated breathing), social intentions (e.g., playful movement), familiar beings (e.g., animal-like form and sound), and, to a lesser extent, cues that reveal artificiality. Thematic analysis of user responses reveals that people with dementia often attribute biological, social, and mental capacities to robots, dynamically shifting between awareness and illusion. These findings underscore the fluctuating nature of ontological perception in dementia contexts. Existing definitions of robotic deception often rest on philosophical or behaviorist premises, but rarely engage with the cognitive mechanisms involved. We propose an empirically grounded definition: robotic deception occurs when Type 1 (automatic, heuristic) processing dominates over Type 2 (deliberative, analytic) reasoning, leading to misinterpretation of a robot's artificial nature. This dual-process perspective highlights the ethical complexity of social robots in dementia care and calls for design approaches that are not only engaging, but also epistemically respectful.

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1 Introduction

More than 55 million people worldwide have a diagnosis of dementia, and the number is expected to reach 78 million by 2030 due to the aging population [6]. Dementia is a term that encompasses several diseases (e.g., Alzheimer's disease, vascular dementia, frontotemporal dementia) that over time damage nerve cells and the brain, typically leading to deterioration in cognitive function and changes in behavior, emotion, and motivation [102].

Social robots have emerged as a promising technology intervention to enhance the quality of life and psychological well-being of people with dementia [2]. Research has demonstrated their potential in mitigating symptoms such as agitation, anxiety, and depression [46, 48, 51, 87], and promoting social engagement among people with dementia or with other stakeholders [15, 29, 58, 69, 97]. Although social robots have various benefits for people with dementia, they also bring with them ethical concerns related to deception, loss of dignity, isolation, privacy, and safety [67]. Among these concerns, deception is one particularly contentious and complex to unpack [7, 12, 37, 65, 79].

Social robots lack the genuine emotions they appear to possess, which might create inherently misleading impressions in users [19, 84]. Such robotic deception can in fact produce positive results, such as enhancing interaction quality, providing emotional comfort and offering therapeutic benefits [4, 45, 99, 104]. However, it may also inadvertently cause overestimation of the robot's functionality, or the illusions of sentience or cognition [86], leading to misplaced trust, unrealistic expectations, or even emotional harm [25, 61, 85]. This is especially problematic for people with dementia, who may struggle to distinguish between genuine and artificial interactions. For example, people with dementia may experience *Turing deception*, and assume that the robots they interact with are real beings with their own motives, goals, beliefs, and feelings [71, 76]. If a robot resembles a trusted person, people with dementia may be more willing to cooperate with the robot or share personal information with it [61, 75]. Furthermore, the emotional relationship people with dementia might form with a social robot could potentially lead to a disconnection from reality [95]. People with dementia can falsely believe that a robot is alive or can truly offer friendship and thus experience sorrow when it is broken or taken away [25, 26], or neglect their relationships with humans if the robot is around [83, 85].

Despite these concerns, the topic of robotic deception in dementia remains underexplored. Previous literature reviews have mainly focused on the effectiveness and acceptance of social robots for people with dementia and provided key design guidelines [34, 38, 42, 49, 52, 57, 66, 81, 101]. However, they have overlooked the ethical concerns surrounding deception. Although some researchers have briefly mentioned issues such as misperception, attachment, and infantilization [49, 52, 68], there remains a significant gap in the analysis of robotic deception in people with dementia and how it occurs. In this scoping review, we focus on the specific design cues embedded by HRI scholars in social robots intended for people with dementia, and how these cues shape users' perceptions and responses. Our goal is to uncover how certain design elements may contribute to robotic deception, intentionally or not, by examining their behavioral and interpretive effects. This analysis aims to reveal the underlying mechanisms of such deception and inform more ethically attuned design practices moving forward.

1.1 Understanding deception in HRI from design and user perspectives

Many studies in HRI draw on the "Computers Are Social Actors (CASA)" paradigm, which suggests that humans respond to robots as they would to other social agents [32, 64, 74]. Within this context, ethical concerns about robotic deception have sparked debates on its identification and characteristics. From a design perspective, several scholars define robotic deception by emphasizing the significance of robot design features. Wallach and Allen [5] suggest that enabling robots to respond with human-like social cues is a form of deception. Similarly, Matthias [60] contends that it is deception when a robot suggests a mental or emotional capability that it does not possess. Sharkey and Sharkey [84] further assert that creating the illusion of mental states in robots is inherently deceptive, as robots lack thoughts or subjective experiences. Ethical behaviorism posits that the ethical status of our interactions with robots should be evaluated solely on the basis of their observable behaviors and external cues [18]. Based on this, Danaher [19] defines robotic deception as the phenomenon whereby "a robot, as an artificial agent, creates a misleading impression through its representations or signals" [19]. According to Danaher, these behavioral cues provide the most compelling evidence of genuine capabilities, without requiring confirmation of the robot's internal state (i.e., whether the robot actually possesses emotion or attention). Following the design perspective, this literature review attempts to unpack those design cues embedded into social robots for people with dementia which could disguise the artificial nature of the robot. As such, we posit the following research question:

- RQ1: What specific design cues are embedded in social robots used with people with dementia, and how might these cues contribute to perceptions that blur the line between artificial and lifelike behavior?

Furthermore, growing discussions highlight the need to identify robotic deception through user perception and response. Coeckelbergh [16] further emphasizes the role of human subjectivity in interpreting robotic behaviors based on their relations and experience with robots, arguing that deception is the result of user interpretation. Sharkey et al. [83, 85, 86] highlight the importance of focusing on the deceived rather than the deceiver, highlighting how false beliefs can arise even without intentional deception. Grodzinskii et al. [35] argue that robotic deception occurs when people interpret a robot's behavior as indicative of a human or other biological life form. Sorell and Draper [88] narrow the definition, stating that only when people are explicitly misled by the design of a robot and believe it to be a genuine human or animal, it is robotic deception. In this way, understanding how human-robot interaction is experienced and interpreted by people with dementia can provide evidence of whether robotic deception is occurring or not. Following this line of thought, this literature review will also analyze people with dementia's perception of social robots to pinpoint potential misleading impressions arising from robots' behavior and appearance. Hence, we formulate a second research question:

– RQ2: What perceptions and responses do social robots elicit in people with dementia? To what extent do they reveal a misinterpretation of the robot's artificial nature?

Existing definitions of robotic deception are largely grounded in philosophical theory, but they fall short of incorporating systematic insights into the nuanced cognitive processes and user responses documented in empirical studies. To bridge this gap, Esposito et al. [27] suggest that future research should integrate psychological theories and methods into the study of robotic deception, ensuring a more structured and empirical approach. In this literature review, we aim to extend this trajectory through an analysis of empirical evidence, examining how misperceptions of robots emerge and influence interaction.

1.2 Understanding deception within dementia care

Deception is a central ethical issue, not only in Social Robotics but also in dementia care [21, 40, 82], as caregivers often face the difficult choice of correcting misconceptions, lying, or distracting people with dementia [14, 96]. In this context, deception is generally understood as intentional, aligned with definitions such as "all that we do or do not do, say or do not say, with the intention of misleading other" [82].

Existing literature categorizes different types of deception. For instance, Dresser [24] proposes a hierarchy of deception, ranging from distraction and redirection, which acknowledge someone's false beliefs and other minor distortions that fit into their subjective realities, to deceptive claims and outright lies that intentionally contradict truth, justified only as a last resort to protect people with dementia from physical and psychological harm. For instance, a caregiver may go along with a man's mistaken belief that his caregiver is his office assistant, rather than correcting him, to avoid disorientation and distress. In another case, a man whose wife became upset every time he said goodbye chose instead to tell her he was going shopping. This allowed her to feel reassured that he would return soon, reducing her anxiety. Dementia-specific prosocial lies, which are intended to mislead but benefit people with dementia, can sometimes be considered more ethical than honesty [53, 54]. For example, caregivers might falsely inform people with dementia that their family is coming soon to encourage them to get dressed or clean up. Caregivers may also construct misleading scenarios by introducing objects tied to a person's past life, no longer present, or by shaping environments that evoke a reality different from the current one [24]. Similarly, it is common practice to acknowledge and accept false beliefs held by people with dementia without offering correction. These discussions primarily frame deception from a practical perspective, where what is deemed ethical deception is often determined by the caregiver without interrogating the person with dementia.

Another focus on deception in dementia care is associated with its acceptability, which is typically framed also from the perspective of caregivers based on their practical considerations in dementia care and researchers' theoretical conceptualization. Researchers conclude that morally defensible deception should prioritize dignity, align with cognitive capacities [24, 33, 40], and consider the possibility of recovery [3]. However, they largely overlook the perspectives of people with dementia themselves. Although some studies have attempted to capture their views, they primarily rely on post-hoc reflections. For example, Casey et al. [14] and Day et al. [21] explore how people with dementia consider acceptability according to whether it is in their best interest. In summary, the acceptability of deception in dementia care depends on the perception and response of people with dementia, the type and content of deception, and the method and scenario of introducing deception. Moving beyond social robots, Tummers-Heemels, Brankaert, and IJsselsteijn [94] offer nuanced ethical reflection on the continuum between benevolent lies and harmful deception in the broader context of dementia care technologies. They emphasize that deception in care is not inherently unethical but must be evaluated in light of its intention, transparency, and impact on the person's dignity and autonomy. Their work highlights the importance of situational and relational ethics, suggesting that the acceptability of deception depends not only on outcomes but also on the degree to which people with dementia are meaningfully included in shaping their own care context. However, little is known about how deception is experienced during an interaction, particularly its manifestation.

The ethical evaluation of deception in dementia care, particularly in the use of social robots, requires a shift in focus: from the intentions of designers or caregivers to the lived experiences and interpretations of people with dementia themselves, in line with [43, 90]. This underscores the need for empirical investigation into both the design features of these technologies and the ways they are perceived and responded to in practice. To address this, our review systematically examines empirical studies of social robot use with people with dementia, focusing on both design cues and user perceptions, as detailed next.

2 Methodology

In order to identify the papers to include in this scoping review, we performed an electronic search in the following six databases: Web of Science, IEEE Xplore, Science Direct, Scopus, ACM Digital Library, and

PubMed. We limited our search to the past ten years, as the use of social robots for people with dementia has increased significantly during this period. Only papers written in English were searched. We used the following search strings:

- Search string1: "Robot*" AND ("Cognitive* Impairment" OR Dementia* OR Alzheimer*)
- Search string2: "Robot" AND ("Cognitive Impairment" OR Dementia OR Alzheimer)

The search yielded a list of 991 papers of which:

- 365 from Web of Science (search string 1)
- 170 from Scopus (search string 1)
- 115 from IEEE Xplore (search string 1)
- 102 from PubMed (search string 1)
- 96 from ACM Digital Library (search string 1)
- 143 from Science Direct (search string 2)

In the first exclusion round, the articles obtained from the search were imported into Rayyan, an online review platform. Six hundred and eighty-eight papers were left after 303 duplicate papers based on their titles and DOIs were removed. The first author read the abstracts of all 688 papers and excluded 373 of them. These excluded papers were review articles or articles other than research articles, such as prefaces, keynote abstracts or posters (N = 126) or articles that did not fit the topic of our review (N = 247), for example, articles (1) employing technologies other than social robots or therapies without social robots (N = 100) or (2) focusing on end users other than people with dementia (N = 147). This screening process left us with 315 articles that were then independently screened by the first author and an independent researcher.

In the second round of exclusion, all articles were skimmed and 234 of them were excluded because: (1) it was not possible to access the full article (N = 7); (2) the article did not present a qualitative or quantitative user study that focused on people with dementia (N = 95); (3) the article did not focus on a physical social robot (N = 45); and (4) the article did not describe the interaction session(s) between a physical social robot and people with dementia (N = 87). These exclusion criteria were applied because physical social robots uniquely suit people with dementia by combining physical presence and affective communication modalities (e.g. facial expressions, gestures, body movements) with natural language interfaces, and our focus is on analyzing how people with dementia perceive and respond to them.

After this step, we were left with 81 papers that were read by the two researchers independently in their entirety. The two researchers independently screened the same batch of articles and discussed their results during weekly meetings to ensure consistency. During this round of screening, we excluded 52 articles that (1) did not describe how people with dementia react and perceive social robots (N = 36); (2) were short articles, lacking sufficient methodological detail or empirical evidence (N = 9); or (3) were alternative versions of other articles already featured in the review (e.g. conference papers or previous drafts) (N = 7).

A quality evaluation was conducted for the remaining articles using a modified Critical Appraisal Skills Programme (CASP) qualitative checklist tool [56]. In this review, we applied the tool with eleven questions, and answers with yes, no, somewhat, and can't tell. We prioritized three questions from the checklist that aligned with the review's objectives, ensuring methodologically rigorous and meaningful information to analyze robot design cues and user perceptions in dementia care. (1) *Have ethical issues been taken into consideration?* (2) *Was the data analysis sufficiently rigorous?* (3) *Is there a clear statement of findings?* Papers that received a "No" as an answer to these three questions were considered not to meet the minimum quality threshold, which led to the exclusion of three papers that failed to meet the minimum quality threshold. Thus, the present literature review focuses on 26 papers. The selection pipeline is described in Figure 1.

The first authors performed a process of information extraction of the 26 included papers. For each paper, she recorded the following details: (1) *general information*: authors, date of publication, type of paper, reported location of the study; (2) *study characteristics*: number of participants, age of participants, gender of participants, dementia severity of participants, type of activity, presence of facilitator, duration of the studies and sessions, robot introduction; (3) *social robot information*: name, embodiment, morphology, body parts, surface materials, behaviors; (4) *perception and response information*: verbal expression of participants, emotional expression of participants, behaviors of participants.

After extracting paper excerpts describing how people with dementia perceived and responded to the robots, we copied and pasted them to a new document and conducted thematic analysis following Braun and Clarke's six-phase approach [11]. The first author began by familiarizing herself with the data segments and excerpts from the reviewed papers. She then systematically coded features related to perception and response, based on both behavioral observations (reported by caregivers or researchers) and verbal expressions from people with dementia or their caregivers, as reported in the reviewed papers. Relevant data were collated under each code.

Next, two researchers grouped the codes regarding perception and response into potential themes, compiling all associated data for each theme. The remaining two authors then reviewed these preliminary themes. The first author grouped the codes regarding design cues that could lead to potential deception and gen-

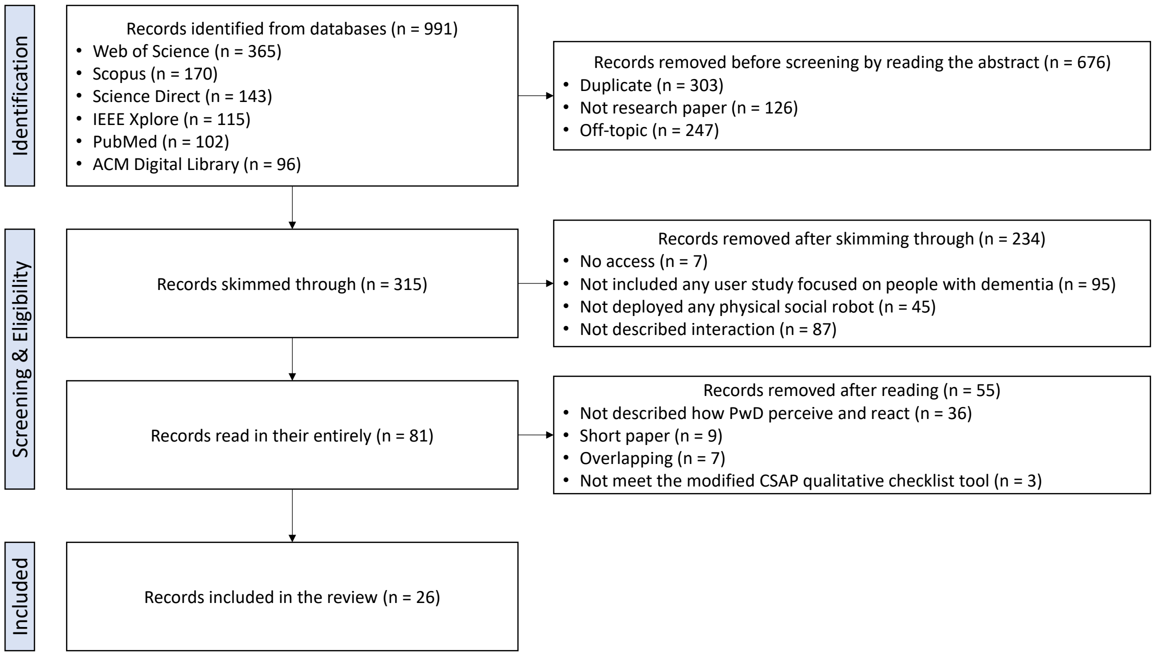

Fig. 1: PRISMA diagram for the paper selection pipeline

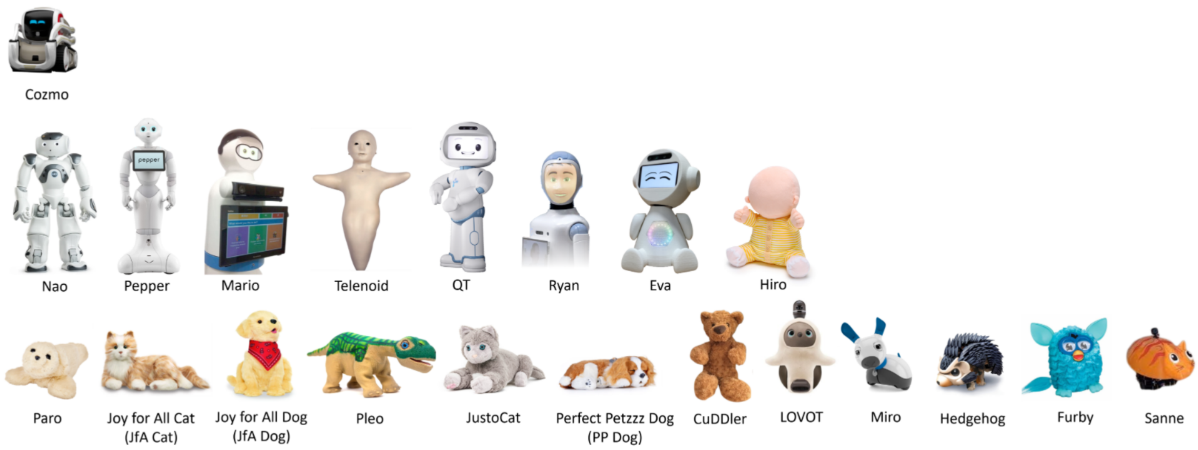

Fig. 2: The robots utilized in the included studies. The first row shows abstract robot, the second row shows anthropomorphic robots, and the third row shows biomorphic robots. The robots are presented in descending order based on their frequency of use, from left to right.

erated themes. All authors participated in refining the themes, generating clear definitions and names.

Finally, the first author organized and reported the themes in the draft of this literature review. Weekly discussions among the authors were held throughout the process to support iterative reflection on different patterns of how people with dementia perceive and respond to social robots and ensure analytical consistency.

3 Results

To contextualize the scope of our analysis, Section 3.1 presents the relevant information in terms of study characteristics, social robots, and activity information. We report how social robots were introduced and framed by facilitators in Section 3.2. Then we focus on the design cues built in social robots for people with dementia in Section 3.3 and response of people with dementia to social robots that indicate their perception in Section 3.4.

3.1 Characteristics of the Included Studies

Of the 26 papers included in this review, 19 are journal papers, and 7 are full papers included in the proceedings of a conference. According to the reported locations of the studies, the majority were conducted in Europe (n

Table 1: Overview of the structures and HRI details in the included studies (NS = not specified). '-*" in the Length of the HRI column represents one-session activity; '-*" in the Duration of the sessions column represents daily-based activities.

Author	Structure	Length of the HRI	Duration of the sessions
Abdollahi et al. (2022) [1]	structured	3 weeks, twice a week	about 15 minutes
Bradwell et al. (2022) [9]	free interaction	4 months; 8 months	15-minute sessions to 24/7 "adoption"
Bradwell et al. (2021) [10]	free interaction	-	about 30 to 45 minutes in total
Casey et al. (2020) [13]	free interaction	2 months	average of 41.3 minutes across sites
Cruz-Sandoval et al. (2020) [17]	structured	7 weeks	about 30 minutes
Dinesen et al. (2022) [23]	free interaction	IS: over 4 weeks, twice a week; GS: over 12 weeks, twice a week	IS: about 20–30 minutes; GS: 30–45 minutes
Feng et al. (2019) [30]	free interaction	4 weeks, once per week	up to 20 minutes
Gustafsson et al. (2015) [36]	free interaction	7 weeks	-
Hsu et al. (2023) [39]	structured	5 weeks, once per week	15 to 45 minutes
Hung et al. (2021) [41]	free interaction	2 weeks–6 months or longer, 2–4 times	about 20 to 30 minutes
Inoue et al. (2021) [44]	free interaction	1 to 3 months, over 3 times per week	15 to 180 minutes
Joshi et al. (2019) [47]	free interaction	over 4 months, 4 sessions	NS
Kuwamura et al. (2016) [50]	free interaction	3 months, once or twice a week	up to 15 minutes
Marchetti et al. (2022) [59]	free interaction	3 days	7 to 20 minutes, 2:07 hours in total
Moyle et al. (2019) [62]	free interaction	10 weeks, 3 times per week	15 minutes
Moyle et al. (2016) [63]	free interaction	5 weeks, 3 times per week	30 minutes
Pike et al. (2021) [70]	free interaction	3 months	-
Pu et al. (2020) [72]	free interaction	6 weeks, 5 days per week	30 minutes
Raß et al. (2023) [73]	structured	2 months, 8 times per week	NS
Rouaix et al. (2017) [78]	structured	-	35 sessions in total, average of 22.15 minutes
Sarabia et al. (2018) [80]	free interaction	5 days	1st interaction: average of 7 min 10 s; 2nd interaction: average of 3 min 23 s
Sumioka et al. (2021) [91]	free interaction	-	up to 5 minutes
Tanioka et al. (2021) [92]	free interaction	-	about 20 to 30 minutes
Thunberg et al. (2020) [93]	free interaction	RC: 9 months; RD: 3 months	NS
Whelan et al. (2020) [100]	free interaction	5 weeks, 3 times per week	NS
Yamazaki et al. (2014) [103]	free interaction	-	about 2 hours

Table 2: Overview of the structured activities in the included studies.

Author	Activities
Abdollahi et al. (2022) [1]	Conversational interaction with robots on preset topics, such as family, music, movies, etc.
Cruz-Sandoval et al. (2020) [17]	Robot-assisted therapeutic session including elements of musicotherapy, reminiscence, cognitive games (complete to wisdom sayings), and relaxation.
Hsu et al. (2023) [39]	Co-design workshops including discovering through storytelling, building a robot through hearing, dressing up the robot, dancing, and refective storytelling.
Raß et al. (2023) [73]	Robot-assisted group sessions for physical activities and conversations over biographics of the residents between the residents and the professional caregiver.
Rouaix et al. (2017) [78]	Robot-assisted psychomotor therapy, including guided motor exercises, cognitive stimulation, body expression activities, and personalized interactions.

= 17, the UK, Denmark, Germany, Italy, Ireland, the Netherlands, France, and Sweden), followed by Latin America (n = 5, the US, Mexico, and Canada), Asia (n = 4, Japan), and Oceania (n = 3, Australia), indicating an imbalanced representation of the countries and cultures of the participants.

3.1.1 Participants

The 26 studies included a total of 558 people with dementia, with sample sizes ranging from 2 to 138 people. The studies included in this review reported age in very different ways (e.g., age ranges, average age). As such, we provide information about the age of participants following the format used in each study in Table 3. The gender of the participants was not always reported in the papers. The 22 papers that reported gender show an unequal distribution across participants with 72.22% women and 27.78% men. Only 16 studies report the dementia severity of participants. The majority of these focus on mild dementia (59.44%), followed by moderate dementia (27.22%) and severe dementia (13.33%).

Table 3: Overview of the robots, types, and participant information in the studies included in the scoping review. (Abbreviations: CLP = Co-located physical, PR = Partially remote, AM = Anthropomorphic, BM = Biomorphic, AB = Abstract, FB = Full-body, PB = Partial-body, HP = Hard plastic and metal, SF = Soft fur or plush fabrics, SS = Semantic speech, SFS = Semantic-free speech, NS = No sound, F = female, M = male, NS = not specified, IS = individual sessions, GS = group sessions, RC = robot cat, RD = robot dog))

Author	**Robot**	**Type**	**N**	**Age (M)**	**Gender**	**Dementia Severity**
Abdollahi et al. (2022)	Ryan	CLP, AM, PB, HP, SS	10	77.1 years	7 F, 3 M	10 mild
Bradwell et al. (2022)	JfA Cat, JfA Dog	CLP, BM, FB, SF, SFS	83	87.21 years	61 F, 22 M	DSRS: $0-54$, $M = 32.11$ (moderate)
Bradwell et al. (2021)	Pleo, Miro, PP Dog, Paro, JfA Dog, JfA Cat, Furby, Hedgehog	CLP, BM, FB, HP, SFS	26	62–107 years*	20 F, 6 M	NS
Casey et al. (2020)	Mario	CLP, AM, FB, HP, SS	38	UK: 60+ years; Italy: 76+ years; Ireland: 70+, 55+	UK: 5 F, 3 M; Italy: 12 F, 8 M; Ireland: NS	UK: 8 mild; Italy: 20 mild; Ireland: 2 mild, 6 moderate
Cruz-Sandoval et al. (2020)	Eva	CLP, AM, FB, HP, SS	9	83.77 years	6 F, 3 M	2 mild; 7 moderate
Dinesen et al. (2022)	LOVOT	CLP, BM, FB, HP, SFS	42	IS: 83 years; GS: 84 years	IS: 11 F, 1 M; GS: 22 F, 8 M	42 mild
Feng et al. (2019)	Pleo	CLP, BM, FB, HP, SFS	9	84.11 years	7 F, 2 M	2 mild; 3 moderate; 4 severe
Gustafsson et al. (2015)	JustoCat	CLP, BM, FB, SF, SFS	4	82–90 years	2 F, 2 M	4 severe
Hsu et al. (2023)	QT	CLP, AM, FB, HP, SS	12	66–96 years	8 F, 4 M	12 moderate
Hung et al. (2021)	Paro	CLP, BM, FB, SF, SFS	10	60+ years	4 F, 6 M	2 mild; 5 moderate; 3 severe
Inoue et al. (2021)	Paro	CLP, BM, FB, SF, SFS	7	87.29 years	6 F, 1 M	1 mild; 4 moderate; 2 severe
Joshi et al. (2019)	Paro, JfA Cat, Nao, Cozmo	CLP, BM, FB, SF, SFS; CLP, AM, FB, HP, SS; CLP, AB, -, HP, SS	28	55+ years	NS	NS
Kuwamura et al. (2016)	Telenoid	PR, AM, PB, HP, NS	3	91.33 years	3 F	2 moderate; 1 severe
Marchetti et al. (2022)	Sanne	CLP, BM, FB, HP, NS	30	NS	16 F, 14 M	Most are severe
Moyle et al. (2019)	Paro	CLP, BM, FB, SF, SFS	138	NS	NS	NS
Moyle et al. (2016)	CuDDler	CLP, BM, FB, SF, SFS	5	84 years	5 F	2 mild; 3 moderate
Pike et al. (2021)	JfA Cat	CLP, BM, FB, SF, SFS	12	NS	11 F, 1 M	Mild; moderate; severe
Pu et al. (2020)	Paro	CLP, BM, FB, SF, SFS	11	84.36 years	9 F, 2 M	MMSE: $9-24$ (mild; moderate)
Raß et al. (2023)	Pepper	CLP, AM, FB, HP, SS	12	$64-91$ years	7 F, 5 M	NS
Rouaix et al. (2017)	Nao	CLP, AM, FB, HP, SS	9	86 years	7 F, 2 M	MMSE: $12-22$ (mild; moderate)
Sarabia et al. (2018)	Nao	CLP, AM, FB, HP, SS	7	$79-99$ years	7 F	NS
Sumioka et al. (2021)	Hiro	CLP, AM, FB, SF, SFS	21	86.6 years	18 F, 3 M	NS
Tanioka et al. (2021)	Pepper	PR, AM, FB, HP, SS	2	90+ years	NS	1 moderate; 1 severe
Thunberg et al. (2020)	JfA Cat, JfA Dog	CLP, BM, FB, SF, SFS	17	RC: NS; RD: $80-90$	RC: NS; RD: 1 F, 1 M	NS
Whelan et al. (2020)	Mario	CLP, AM, FB, HP, SS	10	83 years	7 F, 3 M	2 mild; 6 moderate; 2 severe
Yamazaki et al. (2014)	Telenoid	PR, AM, PB, HP, NS	5	87.8 years	5 F	5 severe

3.1.2 Activities

This section provides details on the duration of the study and session, the type of sessions, and the structure of the activities.

Study and Session Duration. The length of the included studies ranged from short-term studies lasting a single session up to a few days, to long-term studies lasting up to nine months. Most of the studies fell within the range of 4 to 12 weeks (See Table 1 for more details).

Type of Sessions. Most studies (n = 15, 58%) presented individual sessions where only one person with dementia interacted with robots, while fewer studies (n = 8, 31%) focused on the group sessions where multiple people with dementia interacted with one or more robots simultaneously. Three papers (12%) featured both individual and group sessions.

Of the 22 papers that specified facilitator presence, 20 (91%) featured the presence of a facilitator (e.g., formal caregivers, informal caregivers, researchers, or students), as shown in Table 4. A facilitator is defined as someone who assists in activities involving people with dementia, either by guiding the interaction or maintaining engagement. Two papers (9%) featured people with dementia interacting with robots alone.

Types of Activities. Most of the articles (n = 21, 81%) focused on free play with the robot, the robots being left with people with dementia, and the people with dementia having free interaction with the robot. The remaining papers (n = 5, 19%) focused on structured activities in which robots are brought to people with dementia to engage them in specific interactions. The activities range from physical activities and cognitive stimulation sections, as shown in Table 2.

3.1.3 Social Robots

The included studies employed 21 robots (see Figure 2). Four studies [9, 10, 47, 93] involved multiple robots, while the others focused on a single robot. In this section, we describe the robots included in these reviewed studies, focusing on their embodiment, morphology, body structure, surface material, and sound/speech (see Table 3).

Embodiment. Based on the classification of Wainer et al. [98], all robots used in the reviewed studies were co-located physical robots. Only Telenoid in [50, 103] was remotely teleoperated, and Pepper in [92] was controlled by operators with a Wizard-of-Oz technique.

Form. Based on the classification by Bartneck & Forlizzi [8], the majority of robots used in the reviewed studies had a biomorphic form (n = 12, 57%), followed by the anthropomorphic form (n = 8, 38%). Only one robot (5%), Cozmo, had an abstract form. Most of the biomorphic robots resembled existing animals such as seals, cats, and dogs.

Body structure. Most robots in the studies (n = 18, 90%) had a full-body design. A small portion of them (n = 2, 10%) featured only the upper body, such as the head and torso (Ryan and Telenoid). Cozmo was not included because of its abstract form.

Surface material. Most robots (n = 13, 62%) were made of hard plastic and metal materials, while a smaller percentage (n = 8, 38%) of the robots were made of soft materials such as synthetic fur and plushy fabric. Most humanoid robots (88%) were made of hard materials except for Hiro, and most zoomorphic robots (67%) were made of soft materials except for Pleo, Miro, Hedgehog, and Sanne.

Sounds/Speech. Following the classification in Robinson et al. [77], most robots in the included studies (n = 11, 52%) could make semantic-free speech that does not convey specific meaning, such as vocalization or non-verbal sound, while a smaller portion of the robots in the included studies (n = 6, 29%) could verbally communicate, and an even smaller fraction (n = 4, 19%) of these robots did not produce sound at all.

3.2 Framing the Nature of Social Robots

In this section, we present the different ways in which facilitators introduce social robots to people with dementia in the reviewed papers. We consider this relevant as the way the robot is framed might reveal or disguise its artificial nature.

Introducing the robot. As shown in Table 5, out of the 26 reviewed papers, only seven (27%) provided descriptions of how robots were first introduced to people with dementia. Among these, four (57%) studies introduced robots with clear identification as robotic entities, such as saying "This is a social robot" and explaining how it interacts with people [36, 41, 63, 103], while in one study (14%), the caregiver introduced the robot in a way that blurred its artificial nature, treating it similarly to a human baby [91]. In addition to presenting robots as either machines or living beings, two studies (29%) [47, 59] adopted a neutral approach. In these cases, the facilitators did not clearly define the robot's ontological status. Instead, the robots were referred to simply as "it," or participants were invited to form their own interpretations (See Table 5).

Frame nature during interaction As shown in Table 6, in five (19%) out of 26 papers, the facilitators maintained the illusion of lifelikeness, mainly by interpreting the robot's behavioral cues such as breathing [36] or baby voice [50], intentions such as going to live with the person with dementia or trying to say something [44, 59], or emotions such as loving the person with dementia [41]. In three (12%) papers, facilita-

Table 4: Overview of the facilitators and types of interaction in the studies included in the scoping review (NS = not specified).

Author	Robot	Facilitator	Type
Abdollahi et al. (2022) [1]	Ryan	NS	Individual
Bradwell et al. (2022) [9]	JfA Cat, JfA Dog	NS	Individual & Group
Bradwell et al. (2021) [10]	Pleo, Miro, PP Dog, Paro, JfA Dog, JfA Cat, Furby, Hedgehog	No Facilitator	Group
Casey et al. (2020) [13]	Mario	Researcher	Individual
Cruz-Sandoval et al. (2020) [17]	Eva	NS	Group
Dinesen et al. (2022) [23]	LOVOT	Formal caregiver	Individual & Group
Feng et al. (2019) [30]	Pleo	Researcher	Individual
Gustafsson et al. (2015) [36]	JustoCat	Formal caregiver	Individual
Hsu et al. (2023) [39]	QT	Researcher	Group
Hung et al. (2021) [41]	Paro	Formal caregiver	Individual
Inoue et al. (2021) [44]	Paro	Informal caregiver	Individual
Joshi et al. (2019) [47]	Paro, JfA Cat, Nao, Cozmo	Formal caregiver; Researcher	Group
Kuwamura et al. (2016) [50]	Telenoid	Others	Individual
Marchetti et al. (2022) [59]	Sanne	Researcher	Group
Moyle et al. (2019) [62]	Paro	No Facilitator	Individual
Moyle et al. (2016) [63]	CuDDler	Researcher	Individual
Pike et al. (2021) [70]	JfA Cat	Informal caregiver	Individual
Pu et al. (2020) [72]	Paro	NS	Individual & Group
Raß et al. (2023) [73]	Pepper	Formal caregiver	Group
Rouaix et al. (2017) [78]	Nao	Formal caregiver	Individual
Sarabia et al. (2018) [80]	Nao	Researcher	Individual
Sumioka et al. (2021) [91]	Hiro	Formal caregiver	Individual
Tanioka et al. (2021) [92]	Pepper	Formal caregiver; Researcher	Group
Thunberg et al. (2020) [93]	JfA Cat, JfA Dog	Formal caregiver	Group
Whelan et al. (2020) [100]	Mario	Researcher	Individual
Yamazaki et al. (2014) [103]	Telenoid	Researcher	Individual

tors used prompts or mentioned beneficial outcomes to motivate people with dementia to interact with social robots [9,70,91]. For instance, motivating a person with dementia to get up in the morning by saying JfA Cat was waiting for the person [70]. The vague or redirected response was also found in two (8%) papers, in which facilitators dodged people with dementia's doubts about the nature of the robot by changing the subject [44,59]. While a more neutral or truthful approach was observed in eight (31%) studies, where facilitators explained the robot's nature with clear information about their artifactuality and functionalities [30,36,41,47,59,63,73,93]. For example, a care staff explained [41],

> *This is a social robot, PARO; it has sensors in his whiskers. If you talk to it, it responds to you.*

None of the 26 included studies explicitly reported a debriefing process. It remains unclear whether debriefing was omitted from the methodology or simply not conducted.

3.3 Design Cues of Social Robots

In this section, we will look at the collections of design cues embedded in social robots for people with dementia. The first author collected all cues that were displayed in studies and classified them into four categories: resembling physiological signs, social intentions, familiar beings, and revealing artificial nature.

3.3.1 Design Cues Resembling Physiological Signs

Several studies incorporated subtle movements to mimic physiological signs of life, signaling that the robot is alive, even when the robot was not actively interacting. For example, Rouaix et al. [78] program Nao to slightly undulate when not talking, giving the impression of breathing and being alive. The simulated heartbeat rhythm was included as a design feature in the robots used in the studies by Bradwell et al. [10] and Thunberg et al. [93]. Blinking is also a movement reported among the included studies [10,44,63]. Biological needs, such as hunger, can be found in Ryan's speech, saying "I (Ryan) sure am feeling hungry now" [1].

3.3.2 Design Cues Resembling Social Intentions

Some cues could suggest social intentions that are beyond the actual capabilities of the robot. For example, Bradwell et al. [9] describe how the JfA Cat and Dog performed playful movements such as rolling on their back to invite interaction, like a real dog or cat. In addition to nonverbal cues, Nao's speech in Rouaix et al. [78]

Table 5: Introduction of the robots in the included studies.

Author (Date)	Description of the introduction of the robots
Gustafsson et al. (2015) [36]	The professional caregivers presented JustoCat and demonstrated how to stroke it and make it purr. In approaching participants with JustoCat, it was presented as a robotic pet and not a live animal.
Hung et al. (2021) [41]	Staff Gail: (Showing PARO to Max) "This is a social robot, PARO; it has sensors in his whiskers. If you talk to it, it responds to you."
Yamazaki et al. (2014) [103]	Prior to the trial, one of our staff and caretakers introduced Telenoid to the participants by showing its picture and explaining that it was a robot for communication, and that somebody would be on the other end and communicate through the robot. Immediately before the session, we put Telenoid on the stand in front of the participants and explained again that somebody would operate the robot from another room and communicate through it.
Moyle et al. (2016) [63]	CuDDler was introduced to each participant with a statement of “Hello participant. This is CuDDler. CuDDLer is a robotic bear. Would you like to get to know CuDDler?”
Joshi et al. (2019) [47]	We showed them slides about social robots used for social and assistive interactions with older adults and children and discussed their benefits in dementia care. For one session using Paro, the preschool teacher sourced a library book and conducted a storytelling activity about ‘baby seals’ before introducing the robot. Two Paro robots were then placed on the center table in the living room, and children and residents were asked what they thought it was, whether it was a living thing, a baby seal, or a robot.
Marchetti et al. (2022) [59]	Sanne was introduced 7 times as a floor cleaner/washer, 6 times as a cat, and in 5 situations, she was neutrally referred to as “1it’.
Sumioka et al. (2021) [91]	The staff and an experimenter entered the participant’s room, introduced the robot they were holding. The staff and experimenter treated the robot like a human baby.

Table 6: Framing nature of the robots during interaction.

Author (Date)	Description of the framing of the robots nature
Gustafsson et al. (2015) [36]	Is it smooth? Is it breathing? Is it purring?
Kuwamura et al. (2016) [50]	The speakers also often adapted to the participants by changing their voice using a voice changer to sound more like a child.
Marchetti et al. (2022) [59]	It’s going to live here, It’s Sanne; Look, the cat is coming there.
Inoue et al. (2021) [44]	PARO has arrived; PARO is saying hello; PARO is looking at you.
Hung et al. (2021) [41]	I think it [PARO] likes you. It’s looking right at you, Max. What do you think it’s trying to say?
Bradwell et al. (2022) [9]	Oh, can you just keep an eye on the dog (or the puppy)?
Pike et al. (2021) [70]	(The cat’s name) is waiting for you (to prompt people with dementia to get out of bed in the morning).
Sumioka et al. (2021) [91]	He (the experimenter) needs my help. Do you mind looking after this baby?
Inoue et al. (2021) [44]	My mother (a person with dementia) asked, “Is this child a seal?” So, I responded to her with another question, “Do you know where this child (PARO) came from?” My mother answered, “I wonder maybe somewhere cold?”
Marchetti et al. (2022) [59]	H (a person with dementia): “Hello little dog.” H reaches out a hand, bends over and softly pets Sanne’s nose: “Yeah that’s nice.” She changes from stroking with the back of her hand to more intense touching of head and ears. H: “Uh it’s hard on top.” Staff: “Doesn’t it look nice?” H: “It looks really cute and could easily be a regular one. But it can‘t say something.”

was designed to make a “well-mannered” contact with participants by asking about their feelings.

3.3.3 Design Cues Resembling Familiar Beings

Most robot designs display combinations of movements mimicking humans or familiar animals, as reported in 3.1.3. For example, Bradwell et al. [9, 10] reported JfA Cat and Dog featured body and head movements such as turning its head, lifting its head up, and rolling over onto its back to be tickled like a real cat and dog. In addition, Paro exhibited more specific body and head movements similar to seals, such as wagging its back flippers [41]. Rouaix et al. [78] designed Nao to perform some childlike gestures to align with its size and childlike appearance. In terms of gender, Abdollahi et al. [1] adopted female characteristics such as the appearance of a 3D animated face and a female voice.

Semantic-free speech that related to similar animal/human were widely used. Fourteen (53.8%) studies deployed social robots that make semantic-free speech, such as meowing and purring of cat-like robots [9, 10, 36, 47, 70, 93], barking of dog-like robots [9, 10, 93], cooing of seal-like robots [10, 41, 44, 47, 62, 72], and crying of baby-like robot [91].

3.3.4 Design Cues Revealing Artificial Nature

While some design cues might enhance lifelike qualities, others might signal the robot's artificial nature. Hsu et al. [39] reported that the body movements of the QT robot did not meet the expectations of people with dementia of dancing abilities because they were too primitive due to technological limitations. In other instances, the robot's design appeared to intentionally preserve aspects of its artificial nature. CuDDler and Furby, for example, retained simplified toy-like appearances with plush textures [10, 63]. Robots with plastic materials (as reported in Sec 3.1.3) also reflect the design choices that do not prioritize visual mimicry of humans or animals.

3.4 Decipher Deception Through Perceptions and Responses of People with Dementia Towards Robots

In this subsection, we look at how people with dementia perceive and respond to social robots during the interaction, and report four main themes that emerged from the thematic analysis (See process in Sec 2). The following sub-sections present the themes and sub-themes in detail.

3.4.1 People with Dementia Attribute Biological Traits to Social Robots

One prominent theme emerging from the analysis highlights how people with dementia attribute biological traits to social robots by associating operational states, movement behaviors, and physical characteristics with signs of life. For example, Bradwell et al. [10] reported that PP Dog was perceived as "dead, poor old sod" because of noninteractive movement, and people with dementia commented that Miro may be "sick" when it was turned off. Pepper was placed in sleep mode, leading a resident to interpret, "He is so saggy, isn't he?" [73]. Thunberg et al. [93] also reported a person with dementia asking if JfA Cat was injured because "she had never seen the cat jump or walk." They further observed people with dementia interpreting the hard texture of JfA Cat as injuries, saying, "It must be injured."

People with dementia have also been observed to attribute biological feelings, such as hunger or pain, to social robots. Sumioka et al. [91] reported that a crying sound was perceived as an indication of hunger. Similarly, some people with dementia interpreted the meowing and barking sounds of JfA Cat and Dog, as well as rolling over on their back, as signals of pain or hunger [93]. Although no further explanation was provided, Ryan was perceived as not hungry by people with dementia [1]:

> *I would like to take her out to dinner, but she wasn't hungry. Maybe next time.*

3.4.2 People with Dementia Attribute Social Categories to Social Robots

Gender and age are the attributed social categories seen in the reviewed studies. Although in most cases gender attribution is only observed through verbal references by people with dementia without further reasoning, Abdollahi et al. [1] reported that some people with dementia referred to the Ryan robot with feminine pronouns due to its face and voice. Several studies have reported that people with dementia often interact with robots such as Telenoid, Hiro, and LOVOT by changing voice tones and physically engaging as if they were children or infants [10, 23, 44, 50], showing that age attribution extends beyond embodiment, body structure, surface material, and speech ability. A person with dementia even described a perceived age more specifically, saying [73],

> *He must be eleven or twelve years old.*

3.4.3 People with Dementia Perceive Social Robots as Having Mental Capacities

The third theme reflects people with dementia perceiving social robots as having mental capabilities. Thunberg et al. [93] study report that people with dementia generally perceive the purring sound of zoomorphic robots as a signal of calmness, as seen in their statement,

> *At first when he (JfA Cat) is with me, he is a bit worried but after a while, he calms down, that is so cozy.*

People with dementia project human-like intentionality onto robots, interpreting their actions as deliberate and meaningful. For example, Sarabia et al. [80] report people with dementia perceived Hiro's babbling as denying, saying, "Don't say no," while others perceived it as an introduction, stating, "It said its name is Kentaro". Hsu et al. [39] report two people with dementia discussed QT's intention behind blinking, interpreting it as:

> *– He has a lot to say...I think he's winking at me.*
> *– Oh, no, he's blinking at me.*

> *– We're new to what he is expecting from us. And he's getting acquainted with it. So I think he's happy to do that.*
> *–...When he acts jolly and friendly, then he expects people to return that, I think.*

Bradwell et al. [10] report similar discussions around the intention of laughing occurred with Furby:

– He's laughing because I'm tickling his belly.
– Oh, I thought he was laughing at your face!

Similarly, Hung et al. [41] report people with dementia interpreted Paro's cooing, head movements, gaze, blinking, and specific seal-like motions such as wagging its flippers as signals of the robot showing love and interest toward them.

PARO: (Moved its head and returned its gaze to Max with wide opened eyes. Then, it cooed with a nod.)
Max: (Max smiled). Oh man, you like me?
PARO: (leaned its body on Max, turned its head down and wagged its back flippers)
Max: What? I thought you liked me? (laughed)
PARO: (cooed, moved its head, and looked at Max; stayed still for a minute)
Max: Yes, you like me. (Cheered, raised his palm in the air.) Good, give me ten.

3.4.4 People with Dementia Actively Define Social Roles of Social Robots

The fourth theme emphasizes how people with dementia actively define the social roles of social robots, treating them as if they were pets, children, students, or other companion figures from their familiar social relationships. These roles reflect how people make sense of the robot through recognizable patterns of human-animal or human-human interaction.

People with dementia often adopt caregiving or ownership roles toward social robots. For instance, Dinesen et al. [23] report a caregiver observed a person with dementia "stepping into a mother role" with LOVOT, treating it like a child. Healthcare professionals noted in a focus group, "She sits and rocks her leg just like you do with an infant or at least a little baby. She really just wants to sit with it and then just have that feeling".

Hung et al. [41] reported a person with dementia referring to Paro as "This is cute, my pet. I like him." Similarly, PP Dog, JfA Cat, and JfA Dog were frequently mentioned as being adopted by residents. Thunberg et al. [93] noted that three of the resident women in departments A and B "adopted" JfA Cat on the same day, believing it was their own cat.

Yamazaki et al. [103] documented a case where a person with dementia viewed Telenoid as a "student." As the conversation progressed, the participant took books from the shelf and started discussing literature with Telenoid, sometimes as if it were his student.

People with dementia also treated robots as meaningful companions. For example, Raß et al. [73] described people with dementia who asked for Pepper's name during the first encounter and showed reluctance to part from Pepper after a short session. Taniko et al. [92] reported that people with dementia placed JfA Dog in a walker or in bed as a companion, and described what was happening on TV to it while watching.

The social role attribution also shows dynamism. Marchetti et al. [59] observed that a participant sometimes gave Sanne commands like "go over there" and displayed either relaxation or frustration depending on Sanne's obedience. At other times, she spoke to Sanne in a friendly and affectionate voice, referred to herself as "Mama," and asked Sanne to come closer.

G (in a low voice): "Go over there. There, over there." (G looks a little angry. Sanne wiggles on the spot) G: "Will you not listen to what I'm saying? You need to do what I'm saying. – Now!"

G: "Sanne! Go to Mama. Just gallop a little, friend!" (Sanne comes closer) G: "Yeah, that's fine. You have to come here!" (Sanne drives backwards again) G: "No, not that way." (... some back and forth of the robot, conversation with care staff ...) G (high voice): "Go over there now. To little Mom. Come over here now, it must be now." (Sanne drives away) G: "Now you must go. Move along now. Away with you. Go back. Yes, you have to go home."

3.4.5 People with Dementia Show Empathy and Caretaking Tendency toward Social Robots

The fifth theme is that people with dementia express empathy toward social robots, perceiving them as entities requiring care and attention. People with dementia often display emotional concern for social robots. For example, Thunberg et al. [93] report a person with dementia screamed and looked for JfA Dog when it was taken away for cleaning and changing battery. Similarly, Bradwell et al. [10] reported that a person with dementia demonstrated empathy by gently promising not to harm the JfA Dog, saying, "I won't hurt you, darling." Moreover, Marchetti et al. [59] reported that a participant expressed empathy towards the robot Sanne by remarking:

I feel bad for you that you have to be inside a shell.

Bradwell et al. [9] also mentioned a person with dementia, despite realizing the robotic nature of JfA Cat, expressed empathy by commenting, "The poor cat has got two broken legs. Good job it's not real!"

Further, people with dementia often exhibit a strong sense of care toward social robots, perceiving them as helpless creatures requiring care and affection. Pike et al. [70] reported that participants frequently inquired about feeding or letting JfA Cat out. Bradwell et al. noted a person with dementia enjoyed feeding a JfA Cat [9]:

> *We did have a lady that enjoyed feeding it. And she had a puree diet*, said a caregiver.

Rouaix et al. [78] observed inquiries about what Nao eats, suggesting a projection of empathetic care onto the robots. Thunberg et al. [93] also noted participants asking about emptying litter boxes and described a situation where a person with dementia attempted to assist JfA Cat in sitting up, further demonstrating the tendency to perceive robots as requiring physical support. Other caregiving behaviors include checking Hiro's diaper when it cried [91]:

> *"Participant C, who has severe dementia in the face group, repeatedly touched the robot's crotch and tried to undress it when it started crying. The staff member suggested that it looked like she was checking the robot's diaper"*, as reported by the author.

Even when recognizing their limitations, people with dementia demonstrate an awareness of the perceived needs of robots. For example, Sumioka et al. [91] reported that the humanoid robot Hiro emitting a crying sound was perceived as an indication of hunger, prompting a person with dementia to respond with concern like toward a baby, saying,

> *I can't breastfeed him.*

> *"When the robot meowed or rolled over on its back, he thought that the robot was in pain or needed help. He asked it what was wrong and tried to help it sit up again,"* reported by the authors.

The awareness of their inability to respond to the robot's needs even caused distress. This was observed by Pike et al. [70], who reported that some people with dementia regarded meowing as the cat asking for something, and when they were unable to respond to the perceived need, it led to emotional distress.

3.4.6 People with Dementia Perceive the Ontological Status of Social Robots in an Ambivalent and Fluctuating Way.

The last theme is that the perception of social robots by people with dementia is not static. Instead, it fluctuates between viewing the robot as a mechanical object and as a lifelike being. Robotic behaviors, particularly motion, play a crucial role in shaping and sustaining the perception of lifelike qualities, and triggering this shift. As Bradwell et al. [9] reported, although people with dementia recognized the misalignment between the robot and real animals in terms of size and weight, behaviors such as turning and moving the head made JfA Dog appear more realistic. Gustafsson et al. [36] described a case in which a participant's perception of JustoCat shifted from day to day, recognizing it as robotic at times and at others as a real cat, influenced by its behaviors, especially purring and breathing. Similarly, caregivers in Thunberg et al. [93] noted that while most residents understood the robot was not a real animal, their perceptions often changed when it moved, leading them to believe it was real.

This oscillation suggests a form of cognitive ambivalence, where reality and misperception coexist and shift dynamically. For example, Hung et al. [41] report a person with dementia who said to Paro "oh my god, are you a friendly little seal? (singing cheerfully) I love you." while partially recognizing its machine nature, "I am scratching his tummy. There are his batteries. He's not dead yet." Similarly, Pu et al. [72] report people with mild dementia chose to consider Paro as a real seal, while they were aware that it was a robot, saying "It's like a real toy... Pretty much like a seal."

4 Discussion

4.1 Summary of Results and Answers to RQ

Verbal cues, including semantic speech and semantic-free speech, as well as nonverbal cues, including gestures, gaze, facial expression, and body and head movement, have been widely used in social robots for people with dementia (RQ1). Different combinations of design cues might stimulate lifelikeness, suggest social intentionality, and enhance familiarity. While some design cues might enhance lifelike qualities, others might suggest the robot's artificial nature. From the user side, our findings suggest that people with dementia tend to perceive social robots as possessing biological, mental capacities, and social role attributes, blurring the distinction between artifactual and living entities and influencing their interactions (RQ2). We also conclude that the ontological status of social robots is ambivalent and fluctuating.

4.2 Methodology Pitfalls

4.2.1 Interpretation of Perception

Our understanding of social robotic deception in dementia care remains incomplete due to the lack of direct insights from people with dementia. As Kant said, "We do not have unmediated access to things as they are 'in themselves' (noumena), but only to things as they appear to us (phenomena), shaped by the innate structures of our mind." In the context of dementia care, this epistemological challenge is compounded by a practical one: although many people with mild dementia retain the capability of articulating their own experiences, their perspectives are often overlooked [90]. In the reviewed papers, responses and perceptions of social robots are mostly filtered through the eyes of researchers, caregivers, or in general third-persons, and are thus not necessarily representative of people with dementia's perspectives. A true understanding of deception should start from the inclusion of people with dementia's in research practice and the representation of their perspectives.

In addition, cognitive decline further increases the variability and unpredictability of misperception. Differences in the degree of cognitive decline among people with dementia lead to varying levels of susceptibility to misperception. For example, many included studies noted that people with severe dementia believe the robots are real humans or animals, while people with mild dementia hold the view of reality, thinking they are just toys or machines [10, 41, 63, 72, 93]. Considering the compromised capacity of people with dementia to articulate or reflect on their own perceptions, future research could address this by combining observational methods with the participatory approach to incorporate first-hand accounts to provide a more nuanced understanding of how people with dementia experience robotic deception.

4.2.2 Introducing and Framing the Nature of Social Robots

Most studies involved the presence of facilitators. Introducing robots in a lifelike way, such as having names, intentions, and emotions, can impact how people perceive and treat a robot [20], adding to the complexity of social robotic deception in dementia care. For example, some people with dementia took care of JfA Dog when asked to "keep an eye on the puppy" [9]. Although using deceptive prompts to reach beneficial outcomes or prevent unnecessary harms has been ethically justified within the nursing field [53, 54], it might be problematic in HRI because robots cannot interpret subtle social and emotional cues to judge when deception is appropriate [94], and it remains unclear who should be held responsible when such deception leads to unintended consequences. Therefore, future studies should systematically examine the role of facilitators as co-constructors of deception in HRI settings and establish practical guidelines for introducing and framing robots to minimize unintentional reinforcement of deceptive perceptions.

4.2.3 Debriefing about the Nature of Social Robots

The reviewed articles do not report whether a debriefing process was conducted. Debriefing is an important practice in HRI, as it helps prevent persistent misperceptions and effects on participants. However, disclosing the robot's artificial nature to people with dementia, especially those who have already formed strong beliefs that the robot is a living being, a companion, child, or pet, may cause emotional distress. Interesting paradox: doing empirical research into the psychological effects of deception can in itself offer a context where acts of deception may be used, and need to be mitigated. Therefore, future research should explore context-sensitive and ethically informed debriefing strategies that balance the need for transparency with the psychological well-being of people with dementia. We also call for the consistent reporting of debriefing procedures in future studies, as their absence in documentation limits ethical evaluation and replication.

4.3 Social Robotic Deception in Dementia Care

4.3.1 Design Cues of Social Robots (RQ1)

Design cues often appear in holistic configurations that may reinforce or contradict each other. Therefore, robotic deception cannot be attributed to isolated cues alone. For instance, a cat-like appearance with meowing and purring and rolling over on their back may strengthen the illusion that a robot is a real cat [93], while a human-like appearance without expected behaviors may create perceptual oscillation between artificiality and realism [39]. If we look at the appearance, humanoid robots made of hard plastic often break the illusion of aliveness. Irrespective of this, it is interesting to note that robots such as NAO, QT, Eva, Hiro, Paro, Pleo, JustoCat, Cuddler, Lovot, Miro, Furby, and Sanne exhibit infantile features across species. Those baby schema features, such as big eyes, round faces, large heads, and short limbs, are prevalent in social robot design, eliciting age-related perception and caregiving responses [28].

However, we do not know much about how these different design features interplay. We therefore call for a systematic investigation of how design cues interact to shape perception, moving beyond the analysis of individual design features and instead examining cue configurations in context. Understanding which cues most strongly elicit misperception, under what conditions, and leading to what consequences is essential for developing socially responsible robots. For example, empirical studies could compare different combinations of cues to assess their impact on perception and response.

Moreover, such investigations should be situated in a real setting, such as a long-term care home, where the lived experience of users can be observed over time. Mixed-methods approaches combining field observation and interviews with caregivers may help identify which configurations of cues are most likely to lead to unintended misperceptions or overattribution. This knowledge can inform the development of ethical design guidelines that balance engagement with transparency.

4.3.2 Perceptions and Response of People with Dementia (RQ2)

From the review results, we found that people with dementia take an intentional stance towards social robots [22]. They treat them as a rational agent whose actions are motivated by goals, beliefs, and desires [22]. As Złotowski et al. [104] note, people may project deeply human attributes onto robots, "even if these entities are nothing more than a plastic shell with an engine in it." Their responses are formed immediately upon interaction, reflecting intuitive anthropomorphic or zoomorphic attributions to the robot's nature and capabilities without requiring additional information or validation.

However, robots are often designed to feature animal-like or human-like appearances, suggesting biological traits and mental states they do not actually possess, or responding to users with familiar social patterns. This is a widely used design strategy in HRI, which exploits natural tendencies of anthropomorphism and zoomorphism to enhance engagement and interaction. Therefore, some philosophers argue that design cues such as those identified in this review constitute robotic deception [5, 60, 84]. Their critique aligns with concerns about the potential for misperception among people with dementia, highlighting the ethical importance of scrutinizing how seemingly benign design features may unintentionally mislead vulnerable users.

We also hypothesize that the social cues embedded in robot design can significantly shape how people with dementia perceive and respond to these technologies. This insight emerges from the patterns observed across the reviewed studies, where different categories of design features are similar with distinct perceptions and responses as shown in Fig 3. For example, cues resembling physiological signs (e.g., breathing, heartbeat, or blinking) may be interpreted as indicators of biological life (e.g., alive, sick, or dead). Cues that mimic social intentions (e.g., playful movement to invite interaction) could prompt users to attribute mental capacities, such as intention or agency. Similarly, features that evoke familiar beings (e.g., female appearance and voice, childlike gestures, or seal-like head movements) can lead participants to assign social categories (e.g., gender or age), define social roles (e.g., pet or companion), and even express empathy or caretaking behaviors (e.g., feeding or checking diaper). Conversely, cues that expose the robot's artifactuality (e.g., mechanical movements or plush texture) can draw attention to its non-human status and reframe its ontological categorization. Together, we suggest that robot designers and developers co-construct deception.

Given this tension and hypotheses, future research should develop ethically grounded design principles that balance engagement with transparency. Designers should critically assess the social cues embedded in robots and the consequences of over-attribution by users with cognitive impairment. To support this, a more systematic understanding and reflection on how design decisions are made is required. Empirical approaches such as ethnographic fieldwork in robotics companies or interviews with designers shed light on how ethical considerations are incorporated into practice and guide more responsible development in dementia care.

Additionally, although people with dementia sometimes found inconsistencies between the robot's design cues and the living entity or social role to which they related them, they still had emotional and behavioral responses to social robots. They often rationalize these inconsistencies, as if they wandered in a liminal perception space between reality and fiction. Some people with dementia recognized that robots were just machines but still responded to them as if they were alive, suggesting an intentional suspension of disbelief and co-creating the "deception phenomena" together with the robots [16]. Crucially, this susceptibility is not unique to people with dementia. Even individuals without cognitive impairments routinely respond to social cues from artificial agents as if they were interacting with sentient beings, an effect well-documented in Human-Computer Interaction and media psychology [55]. When people willingly suspend disbelief, they may consciously overlook inconsistencies or mechanical traits in favor of emotional or relational engagement. This makes it challenging to distinguish responses that stem from genuine deception from those that arise through voluntary, playful immersion. In this light, the boundary between deception and engagement becomes ethically and conceptually complex, particularly when designing for vulnerable populations.

In addition, different people with dementia may misperceive and emotionally or behaviorally react to the same robot in different ways, reflecting the subjectivity of deception. Even within the same individual, perceptions may fluctuate due to broader interactional dynamics (e.g., introduction by facilitators, interaction with other people with dementia or caregivers, etc.). In this sense, we highlight the dynamic nature of robotic deception in people with dementia, supporting Coeckelbergh's argument that robotic deception is not merely a static feature of the robot itself but rather a phenomenon shaped through a dynamic interaction in the

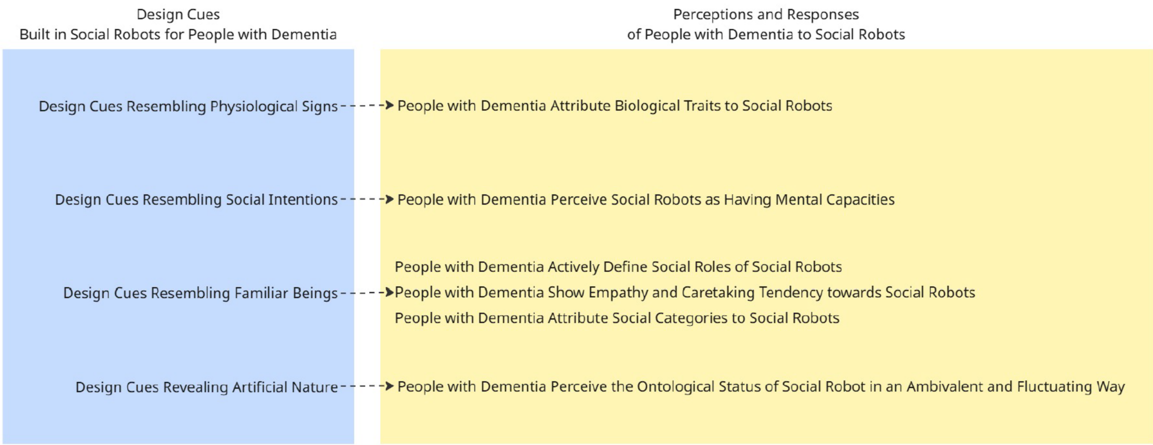

Fig. 3: Mind map summarizing design cues categories of social robots and perceptions and responses of people with dementia

performance and narrative that users and social robots co-create [16].

Importantly, cognitive decline introduces further complexity, as it affects people in varied ways and progresses differently over time, even within the same person. This reveals a gap in current research: much of the existing literature tends to conceptualize deception in social robots as an immutable property, often overlooking how it unfolds and is interpreted in situated, evolving interactions, particularly in dementia care contexts. Therefore, we call for a focus on a more context-sensitive understanding of deception. This is crucial to developing ethical frameworks and design strategies that better align with the lived realities of people with dementia and their caregivers, as well as other vulnerable user groups.

4.4 Reframing Robotic Deception in HRI: A Dual-Process Perspective

Despite extensive discussions on the definition of robotic deception, we found in the review process that there remains a vagueness in providing clear guidance for identifying deception in real-world cases. For instance, without paying attention to design characteristics, many philosophers describe robotic deception through its effects, so-called misleading impressions on the robots [19, 35, 88, 89]. However, there remains a lack of research specifically addressing how misleading effects can be systematically identified through dynamics of user perceptions and responses.

To address this gap, we draw upon dual-process theory to move beyond static definitions of deception and instead describe deception as a dynamic moment-to-moment situated processing of social robots. This aligns with insights from the CASA paradigm and presence theory, which highlight the automatic, “hard-wired” nature of our social responses to media at the visceral/emotional and behavioral levels (fast, reactive) versus our cognitive appraisal (slow, reflective) of the same mediated experience (i.e., knowing full well that it is not real).

According to dual-process theory [31], when a person interact with the world, two distinct processing types are performed. Type 1 operates rapidly and unconsciously, relying on heuristic cues and pattern recognition to make judgments with minimal cognitive effort. In contrast, Type 2 involves slow, effortful, and analytical thinking, allowing users to question, verify, and rationalize their perceptions.

Applying dual process theory to human-robot interaction, in Type 1 processing, users interact with robots based on social intuitions rather than reflective analysis. For instance, robots designed with features such as humanlike characteristics or social behaviors may activate preexisting human social schemas, leading users to attribute human biological traits or mental capabilities to the robot. Type 2 processing is crucial to escape illusionism, as it enables people to compare their expectations with reality and recognize inconsistencies, for example, asking whether the behavior of a robot is due to a real or artificial ontological status.

In people with dementia, the balance between Type 1 and Type 2 processing may shift, with intuitive, automatic responses (Type 1) often taking precedence as deliberative, analytical reasoning (Type 2) becomes less consistently accessible. People with dementia may thus come to rely more heavily on superficial social signals, such as the sound of a robot or its facial expressions, without critically evaluating the underlying mechanics or capabilities of the robot. As a result, they may intuitively form false beliefs about the robot's agency (e.g., the robot is a sentient being), intentions (e.g., the robot genuinely likes them), or identity (e.g., the robot is their child) and exhibit responses typically directed toward living beings (e.g., trying to breastfeed the robot and checking the diaper).

From a dual-process theory perspective, social robot deception in people with dementia can be understood as a failure of Type 2 reasoning to correct an initial, intuitive perception generated by Type 1 processing. That is, deception happens when a user's heuristic-driven cognition (Type 1) leads them to misinterpret the robot's nature, and their analytic reasoning (Type 2) either fails to override this misinterpretation or reinforces it through rationalization. That leads to what was observed in the included studies: some people with dementia believed that the robot possessed life-like qualities, such as biological traits and mental capabilities. For example, a person with dementia asked her daughter, "Is this child a seal?" [44]. A person with dementia asked Nao robot "Will you grow up?" [78]. Similarly, another person with dementia commented Pepper "He must be eleven or twelve years old." [73].

It is important to note that not all emotionally driven behavior can be regarded as proof of the occurrence of social robotic deception. We hypothesize that instances where users consciously suspend disbelief or engage with the robot through emotionally colored interpretations do not constitute robotic deception, as these responses do not arise from a failure in cognitive processing, but from a voluntary, often playful, re-framing of reality. The critical distinction lies in whether the user's internal model of the robot has been unintentionally distorted—i.e., whether a misperception has been cognitively constructed and accepted as truth.

This can be seen in numerous cases. For instance, Marchetti et al. (2022) observed people with dementia identifying Sanne as machine-like, but engaging with it in a playful manner as if it were a real cat [59]. In another case, a person with dementia spoke with LOVOT as if it were a child even though she knew it was a robot [23]. Similarly, in [70], a person with dementia expressed affection by putting JfA Cat to bed on a sofa at night, saying how much she loved it, even though she knew it was not real.

4.5 Limitation

The quality and scope of this literature review are inherently shaped by the data available in the included studies. Notably, there is a clear geographical bias, with most research conducted in the United States, Europe, and Japan, while contributions from other regions remain underrepresented. Similarly, participant samples reveal significant imbalances in terms of gender and dementia severity: the majority of participants were women and in the early stages of cognitive decline. Given that perception is inherently subjective and shaped by both cultural and cognitive contexts, these limitations potentially constrain the generalizability of applying dual-process theory to social robotic deception in dementia care. For instance, cross-cultural studies could offer valuable insights into how different sociocultural and individual factors mediate perceptions of social robots. Much of the research on people with dementia does not primarily involve them because of these types of claims (complexity to execute, burden to participants, ethics). As a consequence, the voice of people with dementia is underrepresented. Recognizing these constraints does not diminish the importance of striving for more inclusive research but rather highlights the need for methodological creativity and institutional support to make such inclusivity feasible.

Variability among the reviewed studies and a lack of precision were also evident in the reporting of interaction sessions. While most studies involved free-interaction sessions, the ways in which people with dementia engaged with social robots was not clearly and systematically documented, thus impeding rigorous interpretation and comparison.

5 Conclusion

Drawing on 26 empirical studies involving people with dementia interacting with social robots, this review synthesizes how people with dementia perceive and respond to social robots, revealing consistent patterns of attributing biological traits, social categories, mental states, and relational roles to the robots, often accompanied by expressions of empathy and caregiving behavior. Moreover, their understanding of a robot's ontological status is frequently ambivalent and subject to fluctuation over time. Building on these findings, we introduce a novel theoretical framework grounded in dual-process theory: we argue that robotic deception arises when heuristic, automatic cognition (Type 1) leads to a misinterpretation of the robot's nature, and deliberative, analytical reasoning (Type 2) is either impaired or insufficient to counter this impression. To our knowledge, this is the first framework to explicitly connect robotic deception in dementia care to the cognitive mechanisms underlying users' interpretations.

Conflict of interest

The authors have no conflicts of interest to declare that are relevant to the content of this article.

Ethics declaration

Not applicable.

Authors' contributions

FW, GP, and YF conceptualized this literature review and contributed to the development of the research questions and the framework. FW, GP, and YF contributed to the literature screening and analysis. FW prepared the original draft. GP, YF contributed to the writing, reviewing and editing. WI contributed to reviewing the final manuscript. GP, YF, and WI supervised the whole process. All authors read and approved the final version.

Data Availability

This article does not contain any original data. All data discussed are available in the publications cited in the reference list.

Statement of Using Generative AI

Generative AI (ChatGPT 4o) was used for proofreading and polishing language.

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References

1. Abdollahi, H., Mahoor, M.H., Zandie, R., Siewierski, J., Qualls, S.H.: Artificial emotional intelligence in socially assistive robots for older adults: a pilot study. IEEE Transactions on Affective Computing **14**(3), 2020–2032 (2022)
2. Abdollahi, H., Mollahosseini, A., Lane, J.T., Mahoor, M.H.: A pilot study on using an intelligent life-like robot as a companion for elderly individuals with dementia and depression. In: 2017 IEEE-RAS 17th International Conference on Humanoid Robotics (Humanoids), pp. 541–546 (2017)
3. Abdool, R.: The ethics of deception in caregiving: A patient-centered approach (2015)
4. Admoni, H., Scassellati, B.: Social eye gaze in human-robot interaction: a review. Journal of Human-Robot Interaction **6**(1), 25–63 (2017)
5. Allen, C., Wallach, W.: Moral machines (2009)
6. Alzheimer's Disease International: Dementia statistics (2024). URL `https://www.alzint.org/about/dementia-facts-figures/dementia-statistics/`. Accessed: 2024-1-19
7. Arkin, R.C., Ulam, P., Wagner, A.R.: Moral decision making in autonomous systems: Enforcement, moral emotions, dignity, trust, and deception. Proceedings of the IEEE **100**(3), 571–589 (2011)
8. Bartneck, C., Forlizzi, J.: A design-centred framework for social human-robot interaction. In: RO-MAN 2004. 13th IEEE international workshop on robot and human interactive communication (IEEE Catalog No. 04TH8759), pp. 591–594. IEEE (2004)
9. Bradwell, H., Edwards, K., Winnington, R., Thill, S., Allgar, V., Jones, R.: Implementing Affordable Socially Assistive Pet Robots in Care Homes Before and During the COVID-19 Pandemic: Stratified Cluster Randomized Controlled Trial and Mixed Methods Study. JMIR Aging **5**(3) (2022)
10. Bradwell, H.L., Edwards, K., Shenton, D., Winnington, R., Thill, S., Jones, R.B.: User-centered design of companion robot pets involving care home resident-robot interactions and focus groups with residents, staff, and family: Qualitative study. JMIR rehabilitation and assistive technologies **8**(4), e30337 (2021)
11. Braun, V., Clarke, V.: Using thematic analysis in psychology. Qualitative research in psychology **3**(2), 77–101 (2006)
12. Broadbent, E.: Interactions With Robots: The Truths We Reveal About Ourselves. Annual Review of Psychology **68**(1), 627–652 (2017). DOI 10.1146/annurev-psych-010416-043958
13. Casey, D., Barrett, E., Kovacic, T., Sancarlo, D., Ricciardi, F., Murphy, K., Koumpis, A., Santorelli, A., Gallagher, N., Whelan, S.: The perceptions of people with dementia and key stakeholders regarding the use and impact of the social robot mario. International journal of environmental research and public health **17**(22), 8621 (2020)
14. Casey, D., Lynch, U., Murphy, K., Cooney, A., Gannon, M., Houghton, C., Hunter, A., Jordan, F., Smyth, S., Felzman, H., Meskell, P.: Telling a 'good or white lie': The views of people living with dementia and their carers. Dementia **19**(8), 2582–2600 (2020). DOI 10.1177/1471301219831525
15. Chan, J., Nejat, G.: Promoting engagement in cognitively stimulating activities using an intelligent socially assistive robot. In: 2010 IEEE/ASME International Conference on Advanced Intelligent Mechatronics, pp. 533–538. IEEE (2010)
16. Coeckelbergh, M.: How to describe and evaluate "deception" phenomena: recasting the metaphysics, ethics, and politics of icts in terms of magic and performance and taking a relational and narrative turn. Ethics and Information Technology **20**(2), 71–85 (2018)
17. Cruz-Sandoval, D., Morales-Tellez, A., Sandoval, E.B., Favela, J.: A social robot as therapy facilitator in interventions to deal with dementia-related behavioral symptoms. In: Proceedings of the 2020 ACM/IEEE international conference on human-robot interaction, pp. 161–169 (2020)

18. Damiano, L., Dumouchel, P.: Anthropomorphism in Human–Robot Co-evolution. Frontiers in Psychology **9** (2018)
19. Danaher, J.: Robot Betrayal: A guide to the ethics of robotic deception. Ethics and Information Technology **22**(2), 117–128 (2020)
20. Darling, K.: 'who's johnny?'anthropomorphic framing in human-robot interaction, integration, and policy. Anthropomorphic framing in human-robot interaction, integration, and policy (March 23, 2015). Robot Ethics **2** (2015)
21. Day, A.M., James, I.A., Meyer, T.D., Lee, D.R.: Do people with dementia find lies and deception in dementia care acceptable? Aging & Mental Health **15**(7), 822–829 (2011)
22. Dennett, D.C.: The intentional stance. MIT press (1989)
23. Dinesen, B., Hansen, H., Grønborg, G., Dyrvig, A.K., Leisted, S., Stenstrup, H., Schacksen, C., Oestergaard, C.: Use of a Social Robot (LOVOT) for Persons With Dementia: Exploratory Study. JMIR Rehabilitation and Assistive Technologies **9**(3) (2022)
24. Dresser, R.: A tangled web: deception in everyday dementia care. Journal of Law, Medicine & Ethics **49**(2), 257–262 (2021)
25. Elder, A.: False friends and false coinage: A tool for navigating the ethics of sociable robots. ACM SIGCAS Computers and Society **45**(3), 248–254 (2016)
26. Elder, A.: Robot friends for autistic children: Monopoly money or counterfeit currency? In: Robot Ethics 2.0, pp. 113–126. Oxford University Press (2017)
27. Esposito, R., Rossi, A., Rossi, S.: Deception in hri and its implications: a systematic review. ACM Transactions on Human-Robot Interaction (2024)
28. Feng, S., Yamato, N., Ishiguro, H., Shiomi, M., Sumioka, H.: Baby schema in human-robot physical interaction: Influence of baby likeness in a communication robot on caregiving behavior. Computers in Human Behavior: Artificial Humans **4**, 100150 (2025)
29. Feng, Y., Perugia, G., Yu, S., Barakova, E.I., Hu, J., Rauterberg, G.M.: Context-enhanced human-robot interaction: exploring the role of system interactivity and multimodal stimuli on the engagement of people with dementia. International Journal of Social Robotics pp. 1–20 (2022)
30. Feng, Y., Yu, S., Van De Mortel, D., Barakova, E., Hu, J., Rauterberg, M.: Livenature: Ambient display and social robot-facilitated multi-sensory engagement for people with dementia. In: Proceedings of the 2019 on designing interactive systems conference, pp. 1321–1333 (2019)
31. Frankish, K.: Dual-process and dual-system theories of reasoning. Philosophy Compass **5**(10), 914–926 (2010)
32. Gambino, A., Fox, J., Ratan, R.A.: Building a stronger CASA: Extending the computers are social actors paradigm. Human-Machine Communication **1**, 71–85 (2020). DOI 10.3316/INFORMIT.097034846749023
33. Gastmans, C.: Dignity-enhancing nursing care: a foundational ethical framework. Nursing ethics **20**(2), 142–149 (2013)
34. Ghafurian, M., Hoey, J., Dautenhahn, K.: Social Robots for the Care of Persons with Dementia: A Systematic Review. ACM Transactions on Human-Robot Interaction **10**(4), 1–31 (2021). DOI 10.1145/3469653
35. Grodzinsky, F.S., Miller, K.W., Wolf, M.J.: Developing automated deceptions and the impact on trust. Philosophy & Technology **28**, 91–105 (2015)
36. Gustafsson, C., Svanberg, C., Müllersdorf, M.: Using a robotic cat in dementia care: a pilot study. Journal of gerontological nursing **41**(10), 46–56 (2015)
37. Hancock, P.A., Billings, D.R., Schaefer, K.E., Chen, J.Y.C., de Visser, E.J., Parasuraman, R.: A Meta-Analysis of Factors Affecting Trust in Human-Robot Interaction. Human Factors **53**(5), 517–527 (2011). DOI 10.1177/0018720811417254
38. Hirt, J., Ballhausen, N., Hering, A., Kliegel, M., Beer, T., Meyer, G.: Social Robot Interventions for People with Dementia: A Systematic Review on Effects and Quality of Reporting. Journal of Alzheimer's Disease **79**(2), 773–792 (2021). DOI 10.3233/JAD-200347
39. Hsu, L.J., Bays, J.K., Tsui, K.M., Sabanovic, S.: Co-designing social robots with people living with dementia: Fostering identity, connectedness, security, and autonomy. In: Proceedings of the 2023 ACM Designing Interactive Systems Conference, pp. 2672–2688 (2023)
40. Huang, Y., Liu, H., Cong, Y.: Is deception defensible in dementia care? A care ethics perspective. Nursing Ethics **29**(7-8), 1589–1599 (2022). DOI 10.1177/09697330221092336
41. Hung, L., Gregorio, M., Mann, J., Wallsworth, C., Horne, N., Berndt, A., Liu, C.: Exploring the perceptions of people with dementia about the social robot PARO in a hospital setting. DEMENTIA-INTERNATIONAL JOURNAL OF SOCIAL RESEARCH AND PRACTICE **20**(2), 485–504 (2021). DOI 10.1177/1471301219894141
42. Hung, L., Liu, C., Woldum, E., Au-Yeung, A., Berndt, A., Wallsworth, C., Horne, N., Gregorio, M., Mann, J., Chaudhury, H.: The benefits of and barriers to using a social robot PARO in care settings: A scoping review. BMC Geriatrics **19**(1), 232 (2019). DOI 10.1186/s12877-019-1244-6
43. IJsselsteijn, W., Tummers-Heemels, A., Brankaert, R.: Warm Technology: A Novel Perspective on Design for and with People Living with Dementia. In: R. Brankaert, G. Kenning (eds.) HCI and Design in the Context of Dementia, pp. 33–47. Springer International Publishing (2020). DOI 10.1007/978-3-030-32835-1_3
44. Inoue, K., Wada, K., Shibata, T.: Exploring the applicability of the robotic seal paro to support caring for older persons with dementia within the home context. Palliative Care and Social Practice **15**, 26323524211030285 (2021)
45. Ishowo-Oloko, F., Bonnefon, J.F., Soroye, Z., Crandall, J., Rahwan, I., Rahwan, T.: Behavioural evidence for a transparency–efficiency tradeoff in human–machine cooperation. Nature Machine Intelligence **1**(11), 517–521 (2019)
46. Jøranson, N., Pedersen, I., Rokstad, A.M.M., Ihlebæk, C.: Change in quality of life in older people with dementia participating in Paro-activity: A cluster-randomized controlled trial. Journal of Advanced Nursing **72**(12), 3020–3033 (2016). DOI 10.1111/jan.13076
47. Joshi, S., Šabanović, S.: Robots for inter-generational interactions: implications for nonfamilial community settings. In: 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), pp. 478–486. IEEE (2019)
48. Khosla, R., Nguyen, K., Chu, M.T.: Assistive Robot Enabled Service Architecture to Support Home-Based Dementia Care. In: 2014 IEEE 7th International Conference on Service-Oriented Computing and Applications, pp. 73–80 (2014). DOI 10.1109/SOCA.2014.53
49. Koh, W.Q., Ang, F.X.H., Casey, D.: Impacts of Low-cost Robotic Pets for Older Adults and People With Dementia: Scoping Review. JMIR Rehabilitation and Assistive Technologies **8**(1), e25340 (2021). DOI 10.2196/25340
50. Kuwamura, K., Nishio, S., Sato, S.: Can We Talk through a Robot As if Face-to-Face? Long-Term Fieldwork Using Teleoperated Robot for Seniors with Alzheimer's Disease. Frontiers in Psychology **7** (2016). DOI 10.3389/fpsyg.2016.01066
51. Lane, G.W., Noronha, D., Rivera, A., Craig, K., Yee, C., Mills, B., Villanueva, E.: Effectiveness of a social robot, "Paro," in a VA long-term care setting. Psychological Services **13**(3), 292–299 (2016). DOI 10.1037/ser0000080
52. Leng, M., Liu, P., Zhang, P., Hu, M., Zhou, H., Li, G., Yin, H., Chen, L.: Pet robot intervention for people with dementia: A systematic review and meta-analysis of randomized

controlled trials. Psychiatry Research **271**, 516–525 (2019). DOI 10.1016/j.psychres.2018.12.032
53. Levine, E.E.: Community standards of deception: Deception is perceived to be ethical when it prevents unnecessary harm. Journal of Experimental Psychology: General **151**(2), 410 (2022)
54. Levine, E.E., Schweitzer, M.E.: Are liars ethical? on the tension between benevolence and honesty. Journal of Experimental Social Psychology **53**, 107–117 (2014)
55. Lombard, M.: At the heart of it all: The concept of presence. Journal of Computer-Mediated Communication **3**(2) (1997)
56. Long, H.A., French, D.P., Brooks, J.M.: Optimising the value of the critical appraisal skills programme (CASP) tool for quality appraisal in qualitative evidence synthesis. Research Methods in Medicine & Health Sciences **1**(1), 31–42 (2020). DOI 10.1177/2632084320947559
57. Lu, L.C., Lan, S.H., Hsieh, Y.P., Lin, L.Y., Lan, S.J., Chen, J.C.: Effectiveness of Companion Robot Care for Dementia: A Systematic Review and Meta-Analysis. Innovation in Aging **5**(2), igab013 (2021). DOI 10.1093/geroni/igab013
58. Mannion, A., Summerville, S., Barrett, E., Burke, M., Santorelli, A., Kruschke, C., Felzmann, H., Kovacic, T., Murphy, K., Casey, D., Whelan, S.: Introducing the Social Robot MARIO to People Living with Dementia in Long Term Residential Care: Reflections. International Journal of Social Robotics **12**(2), 535–547 (2020). DOI 10.1007/s12369-019-00568-1
59. Marchetti, E., Grimme, S., Hornecker, E., Kollakidou, A., Graf, P.: Pet-robot or appliance? care home residents with dementia respond to a zoomorphic floor washing robot. In: Proceedings of the 2022 CHI Conference on Human Factors in Computing Systems, pp. 1–21 (2022)
60. Matthias, A.: Robot lies in health care: When is deception morally permissible? Kennedy Institute of Ethics Journal **25**(2), 169–162 (2015)
61. Moharana, S., Panduro, A.E., Lee, H.R., Riek, L.D.: Robots for joy, robots for sorrow: community based robot design for dementia caregivers. In: 2019 14th ACM/IEEE International Conference on Human-Robot Interaction (HRI), pp. 458–467. IEEE (2019)
62. Moyle, W., Jones, C., Murfield, J., Thalib, L., Beattie, E., Shum, D., Draper, B.: Using a therapeutic companion robot for dementia symptoms in long-term care: reflections from a cluster-rct. Aging & mental health **23**(3), 329–336 (2019)
63. Moyle, W., Jones, C., Sung, B., Bramble, M., O'Dwyer, S., Blumenstein, M., Estivill-Castro, V.: What Effect Does an Animal Robot Called CuDDler Have on the Engagement and Emotional Response of Older People with Dementia? A Pilot Feasibility Study. International Journal of Social Robotics **8**(1), 145–156 (2016). DOI 10.1007/s12369-015-0326-7
64. Nass, C., Steuer, J., Tauber, E.R.: Computers are social actors. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems Celebrating Interdependence - CHI '94, pp. 72–78. ACM Press (1994). DOI 10.1145/191666.191703
65. Oleson, K.E., Billings, D.R., Kocsis, V., Chen, J.Y.C., Hancock, P.A.: Antecedents of trust in human-robot collaborations. In: 2011 IEEE International Multi-Disciplinary Conference on Cognitive Methods in Situation Awareness and Decision Support (CogSIMA), pp. 175–178. IEEE (2011). DOI 10.1109/COGSIMA.2011.5753439
66. Ong, Y.C., Tang, A., Tam, W.: Effectiveness of robot therapy in the management of behavioural and psychological symptoms for individuals with dementia: A systematic review and meta-analysis. Journal of Psychiatric Research **140**, 381–394 (2021). DOI 10.1016/j.jpsychires.2021.05.077
67. O'Brolcháin, F.: Robots and people with dementia: Unintended consequences and moral hazard. Nursing ethics **26**(4), 962–972 (2019)
68. Palmier, C., Rigaud, A.S., Ogawa, T., Wieching, R., Dacunha, S., Barbarossa, F., Stara, V., Bevilacqua, R., Pino, M.: Identification of ethical issues and practice recommendations regarding the use of robotic coaching solutions for older adults: narrative review. Journal of medical Internet research **26**, e48126 (2024)
69. Perugia, G., Rodriguez-Martin, D., Diaz Boladeras, M., Mallofre, A.C., Barakova, E., Rauterberg, M.: Electrodermal activity: Explorations in the psychophysiology of engagement with social robots in dementia. In: 2017 26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN), pp. 1248–1254. IEEE (2017). DOI 10.1109/ROMAN.2017.8172464
70. Pike, J., Picking, R., Cunningham, S.: Robot companion cats for people at home with dementia: A qualitative case study on companotics. DEMENTIA-INTERNATIONAL JOURNAL OF SOCIAL RESEARCH AND PRACTICE **20**(4), 1300–1318 (2021). DOI 10.1177/1471301220932780
71. Pino, M., Boulay, M., Jouen, F., Rigaud, A.S.: "are we ready for robots that care for us?" attitudes and opinions of older adults toward socially assistive robots. Frontiers in aging neuroscience **7**, 141 (2015)
72. Pu, LH., Moyle, W., Jones, C.: How people with dementia perceive a therapeutic robot called PARO in relation to their pain and mood: A qualitative study. JOURNAL OF CLINICAL NURSING **29**(3), 437–446 (2020). DOI 10.1111/jocn.15104
73. Raß, E., Unbehaun, D., Wulf, V., Lüssem, J., Eilers, H., Lenz, G., Tandler, J., Afzali, S., Eroglu, B.: Investigating the Potential and Impacts of Social Robots to Engage People with Advanced Dementia and their Caregivers: Early Insights from an Exploratory Ethnographic Study within a Protected Care Environment. PETRA '23: Proceedings of the 16th International Conference on PErvasive Technologies Related to Assistive Environments pp. 272–278 (2023). DOI 10.1145/3594806.3594826
74. Reeves, B., Nass, C.: The media equation: How people treat computers, television, and new media like real people. Cambridge, UK **10**(10), 19–36 (1996)
75. Riek, L., Howard, D.: A code of ethics for the human-robot interaction profession. Proceedings of we robot (2014)
76. Riek, L.D.: Healthcare robotics. Communications of the ACM **60**(11), 68–78 (2017)
77. Robinson, F.A., Bown, O., Velonaki, M.: Designing sound for social robots: Candidate design principles. International Journal of Social Robotics **14**(6), 1507–1525 (2022)
78. Rouaix, N., Retru-Chavastel, L., Rigaud, AS., Monnet, C., Lenoir, H., Pino, M.: Affective and Engagement Issues in the Conception and Assessment of a Robot-Assisted Psychomotor Therapy for Persons with Dementia. FRONTIERS IN PSYCHOLOGY **8** (2017). DOI 10.3389/fpsyg.2017.00950WE-SocialScienceCitationIndex(SSCI)
79. Sætra, H.S.: Social robot deception and the culture of trust. Paladyn, Journal of Behavioral Robotics **12**(1), 276–286 (2021). DOI 10.1515/pjbr-2021-0021
80. Sarabia, M., Young, N., Canavan, K., Edginton, T., Demiris, Y., Vizcaychipi, M.P.: Assistive robotic technology to combat social isolation in acute hospital settings. International Journal of Social Robotics **10**, 607–620 (2018)
81. Sather III, R., Mitcheff, M., Khan, A., Imtia, N.: Use of Humanoid Robot in Dementia Care: A Literature Review. Journal of Aging Science **9** (2021)
82. Schermer, M.: Nothing but the Truth? On Truth and Deception in Dementia Care. Bioethics **21**(1), 13–22 (2007). DOI 10.1111/j.1467-8519.2007.00519.x

83. Sharkey, A.: Robots and human dignity: A consideration of the effects of robot care on the dignity of older people. Ethics and Information Technology **16**(1), 63–75 (2014). DOI 10.1007/s10676-014-9338-5
84. Sharkey, A., Sharkey, N.: Children, the elderly, and interactive robots. IEEE Robotics & Automation Magazine **18**(1), 32–38 (2011)
85. Sharkey, A., Sharkey, N.: Granny and the robots: Ethical issues in robot care for the elderly. Ethics and Information Technology **14**(1), 27–40 (2012). DOI 10.1007/s10676-010-9234-6
86. Sharkey, A., Sharkey, N.: We need to talk about deception in social robotics! Ethics and Information Technology **23**(3), 309–316 (2021). DOI 10.1007/s10676-020-09573-9
87. Shibata, T.: Therapeutic Seal Robot as Biofeedback Medical Device: Qualitative and Quantitative Evaluations of Robot Therapy in Dementia Care. Proceedings of the IEEE **100**(8), 2527–2538 (2012). DOI 10.1109/JPROC.2012.2200559
88. Sorell, T., Draper, H.: Second thoughts about privacy, safety and deception. Connection Science **29**(3), 217–222 (2017)
89. Sparrow, R., Sparrow, L.: In the hands of machines? The future of aged care. Minds and Machines **16**(2), 141–161 (2006). DOI 10.1007/s11023-006-9030-6
90. Suijkerbuijk, S., Nap, H.H., Cornelisse, L., IJsselsteijn, W.A., De Kort, Y.A., Minkman, M.M.: Active involvement of people with dementia: a systematic review of studies developing supportive technologies. Journal of Alzheimer's Disease **69**(4), 1041–1065 (2019)
91. Sumioka, H., Yamato, N., Shiomi, M., Ishiguro, H.: A minimal design of a human infant presence: a case study toward interactive doll therapy for older adults with dementia. Frontiers in Robotics and AI **8**, 633378 (2021)
92. Tanioka, T., Yokotani, T., Tanioka, R., Betriana, F., Matsumoto, K., Locsin, R., Zhao, Y., Osaka, K., Miyagawa, M., Schoenhofer, S.: Development issues of healthcare robots: Compassionate communication for older adults with dementia. International journal of environmental research and public health **18**(9), 4538 (2021)
93. Thunberg, S., Rönnqvist, L., Ziemke, T.: Do Robot Pets Decrease Agitation in Dementia Patients? An Ethnographic Approach. SOCIAL ROBOTICS, ICSR 2020 **12483**, 616–627 (2020). DOI 10.1007/978-3-030-62056-1_51WE-ConferenceProceedingsCitationIndex-Science(CPCI-S)
94. Tummers-Heemels, A., Brankaert, R., Ijsselsteijn, W.: Between benevolent lies and harmful deception: reflecting on ethical challenges in dementia care technology. Ann Rev Cybertherapy Telemed **2021**, 15 (2021)
95. Turkle, S.: Authenticity in the age of digital companions. Interaction Studies **8**(3), 501–517 (2007). DOI 10.1075/is.8.3.11tur
96. Turner, A., Eccles, F., Keady, J., Simpson, J., Elvish, R.: The use of the truth and deception in dementia care amongst general hospital staff. Aging & Mental Health **21**(8), 862–869 (2017)
97. Wada, K., Shibata, T.: Robot Therapy in a Care House - Change of Relationship among the Residents and Seal Robot during a 2-month Long Study. In: RO-MAN 2007 - The 16th IEEE International Symposium on Robot and Human Interactive Communication, pp. 107–112. IEEE (2007). DOI 10.1109/ROMAN.2007.4415062
98. Wainer, J., Feil-Seifer, D.J., Shell, D.A., Mataric, M.J.: The role of physical embodiment in human-robot interaction. In: ROMAN 2006-The 15th IEEE International Symposium on Robot and Human Interactive Communication, pp. 117–122. IEEE (2006)
99. Waytz, A., Heafner, J., Epley, N.: The mind in the machine: Anthropomorphism increases trust in an autonomous vehicle. Journal of experimental social psychology **52**, 113–117 (2014)
100. Whelan, S., Burke, M., Barrett, E., Mannion, A., Kovacic, T., Santorelli, A., Oliveira, B., Gannon, L., Shiel, E., Casey, D.: The effects of MARIO, a social robot, on the resilience of people with dementia: A multiple case study. Gerontechnology **20**(1), 1–16 (2020). DOI 10.4017/GT.2020.20.1.413.10
101. Whelan, S., Murphy, K., Barrett, E., Krusche, C., Santorelli, A., Casey, D.: Factors Affecting the Acceptability of Social Robots by Older Adults Including People with Dementia or Cognitive Impairment: A Literature Review. International Journal of Social Robotics **10**(5), 643–668 (2018). DOI 10.1007/s12369-018-0471-x
102. World Health Organization: Dementia fact sheet (2023). URL `https://www.who.int/news-room/fact-sheets/detail/dementia`. Accessed: 2024-11-08
103. Yamazaki, R., Nishio, S., Ishiguro, H., Nørskov, M., Ishiguro, N., Balistreri, G.: Acceptability of a Teleoperated Android by Senior Citizens in Danish Society. International Journal of Social Robotics **6**(3), 429–442 (2014). DOI 10.1007/s12369-014-0247-x
104. Złotowski, J., Proudfoot, D., Yogeeswaran, K., Bartneck, C.: Anthropomorphism: opportunities and challenges in human–robot interaction. International journal of social robotics **7**, 347–360 (2015)